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Children watching birds during a refuge interpretive program

Environmental Consequences

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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 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 4.3 summarizes the effects predicted for each alternative and allows for a side-by-side comparison.

4.1.1 Regional, Historical, and Watershed Context

As required by the Council on Environmental Quality (CEQ) and U.S. Fish and Wildlife Service (Service) regulations implementing the National Environmental Policy Act (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 ecoregional 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.

John Heinz NWR is located within the Delaware River Basin, which encompasses 13,600 square miles and stretches approximately 330 miles from headwaters in New York State to its confluence with the Atlantic Ocean. The Delaware River watershed includes portions of Delaware, Maryland, New York, New Jersey, and Pennsylvania (DRBC 2008). Our project area (the refuge) is situated near the confluence of Darby Creek and the Delaware River and has a tidal range of about six feet.

Table 4.1. Regional Context for Impacts Analyses at John Heinz National Wildlife Refuge at Tinicum

John Heinz NWR	Entire refuge is 993 acres to up to 1,200 acres within the acquisition boundary
Delaware and Philadelphia Counties, PA	209,152 acres (326.8 miles ²)
Delaware River Basin	8,704,00 acres (13,600miles ²)
Partners In Flight Landbird Conservation Area Physiographic Region 44 (Mid Atlantic)	13, 891,658 acres (21,700 miles ²)
Bird Conservation Region 30	24,428,000 acres (38,170 miles ²)

Across a more localized regional landscape scale, John Heinz NWR protects a variety of unique resources and also provides a unique opportunity for the education and outreach near the urban center of the City of Philadelphia, the nation’s fifth largest metropolitan area (map 2.1) (US Census Bureau 2011). Connecting children and families with nature is a high priority national program of the Service. The urban interface of John Heinz NWR provides excellent opportunities for such environmental education and conservation outreach. The

ecosystems within John Heinz NWR, especially freshwater tidal marsh, support some of our nation's most biologically diverse assemblages of fish, wildlife, and plant species.

More than 133,000 visitors from around the Delaware Valley and beyond visit the refuge each year. John Heinz NWR 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.

John Heinz NWR's location near the confluence of Darby Creek and the Delaware River also plays a significant role in the habitats and species utilizing the refuge. As one of only a few large freshwater marsh expanses along the Delaware River, the refuge provides an important stopover for many species during migration up the Delaware River flyway. The expanse of freshwater tidal marsh also provides important spawning and nursery habitat for many riverine fish species. The refuge connects with regional wildlife corridors such as the Schuylkill and Delaware Rivers, and the developing local greenways along Darby and Cobbs Creeks.

Much of the land surrounding the refuge is, and has been, urbanized for nearly 200 years. Major land use changes over the 20th century however brought major impacts to the refuge site and surrounding landscape like never seen before. Interstate highway, international airport, and expanded residential and industrial construction made John Heinz NWR a biological island contrasted amongst a highly urbanized landscape.

The urban environment and high levels of historical disturbance of mainly upland portions of the refuge 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. Environmental contaminants may have a major impact on the health and fitness of wildlife present on the refuge. The Folcroft Landfill, which became part of the refuge in 1980, and the Clearview Landfill are part of the Lower Darby Creek Area Superfund Site. The aquatic environments of Tinicum Marsh and Darby Creek are also part of the Superfund Site. In all alternatives, the refuge would continue to provide technical support and continue to coordinate with the EPA regarding studies, monitoring, and contaminant remediation that is ongoing, and final closure design and implementation.

The refuge's ability to directly and beneficially impact the regional environment is limited because of its size, 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, socioeconomic, 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.

4.1.2 Evaluation of Environmental Impacts and Time Frames

Per Council of Environmental Quality (CEQ) and Service regulations on implementing the National Environmental Policy Act (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:

- The expected degree or percent of change in the resource from current conditions
- The frequency and duration of the effect during the 15-year planning horizon
- The sensitivity of the resource to such an effect or its natural resiliency to recover from such an effect
- The potential for implementing effective preventive or mitigating measures to lessen the effect

4.1.3 Management Actions Not Analyzed in Detail

The impacts of the management activities on the following list are not analyzed in detail in this document because they are both trivial in effect and common to all alternatives. The following would qualify for categorical exclusion under applicable regulations if independently proposed:

- (1) Operations and maintenance of existing infrastructure and facilities (unless major renovation is involved)
- (2) Issuance of new or revised management plans when only minor changes are planned
- (3) Law enforcement activities
- (4) Environmental education and interpretative programs (unless major construction is involved, or a significant increase in visitation is expected)
- (5) Research, resource inventories, and other resource information collection activities
- (6) Routine, recurring management activities and improvements, including managing invasive species
- (7) 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)
- (8) Minor vegetation plantings
- (9) Reintroducing native plants and animals
- (10) Minor changes in amounts or types of public use

“Extraordinary circumstances” in 43 CFR 46.215 are exceptions to our categorical exclusions. If any of these exceptions apply, we will conduct further NEPA analysis of the proposed action. Where possible and information is available, we provide discussions of how the below management actions could beneficially or adversely impact refuge resources. Actions that are not categorically excluded and that may require additional NEPA analysis beyond this draft CCP and EA are the following:

- (1) The restoration of 55-acre phragmites-dominated wetland to a healthier freshwater tidal wetland under all alternatives
- (2) Restoration and closure of Folcroft Landfill under all alternatives
- (3) Restoring some or all of the impoundment to freshwater tidal wetlands under alternatives B and C, respectively
- (4) Restoring formerly dredged open water to freshwater tidal marsh under alternative B
- (5) Opening the refuge to a controlled hunt
- (6) Construction of a noise barrier along interstate Route I-95 or other major sound mitigation measures determined in alternative C
- (7) Constructing a pedestrian bridge or other access to provide safe crossing of Route 420 under alternative C
- (8) Improving visitor access to freshwater tidal wetlands by supporting or providing non-motorized boat tours and/or use of multi-passenger vehicles for a wider diversity of refuge visitors under alternative C

We did not fully analyze these actions in this CCP for several reasons. The first two actions listed, the restoration of the 55-acre wetland and Folcroft Landfill, are outside the scope of this CCP and are being conducted by other Service offices or agencies. The Service's Chesapeake Bay ES Office is planning the wetland restoration and will conduct the NEPA analysis for the project. Similarly, the EPA is planning and conducting the NEPA analysis for the Folcroft Landfill closure and restoration.

For the remaining six actions, the refuge will conduct further NEPA analysis at a future time, if needed. Currently, we do not have enough specific and detailed information to adequately analyze potential impacts and comply with NEPA.

4.1.4 Adaptive Management Actions Common to All Resources

Adaptive management strategies are proposed for all management actions to mitigate uncertainties in information which the proposed activities are based on. 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 physical and biological environments are controlled and mitigated by special uses permits that specify the research activities, locations, frequency of activities and limitations, such as seasonal or tidal timing restrictions to mitigate potential impacts. Generally, these activities are considered to have short-term and localized adverse impacts to physical biological resources. However, the amount and variety of these activities could have potential adverse cumulative impacts as discussed in section 4.19.

4.1.5 Organization of Chapter 4

We have organized this chapter by major resource heading 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, cultural, and historic 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.

Physical Environment

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 potential benefits of our actions that would protect or improve air quality by

- conserving and protecting refuge lands to limit the growth of development, thereby limiting sources of emissions and reducing loss of forest vegetation;
- managing and restoring forests and wetlands to enhance carbon sequestration and reduce greenhouse gases;
- controlling invasive species;
- 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; and
- increasing public awareness through environmental interpretation and education.

We evaluated the potential for the proposed actions to cause increased emissions and adverse effects on air quality by

- using staff vehicles and equipment for regular management activities;
- expanding or remodeling administrative and visitor facilities;
- constructing additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds;
- invasive species control, including aerial spraying of invasive species;
- managing and restoring forests and wetlands to enhance carbon sequestration and reduce greenhouse gases;

emissions from increases in visitors from vehicles and facilities and trespassing by offroad vehicles; and

maintaining the existing impoundment and potential impacts from emissions of methane from the impounded area.

4.2.1 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 and would not vary significantly under any of the alternatives. We predict that refuge land management, regardless of alternative, would be expected to have a net positive effect on air quality.

Benefits

Our management activities should not adversely affect regional air quality. None of the alternatives would violate Federal Environmental Protection Agency (EPA) standards and 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, the 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 (O₃), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), and particulate matter (PM) less than 10 and 2.5 microns in diameter (PM₁₀ and PM_{2.5}), primarily through direct uptake and adhesion to stems and leaves (Escobedo et al. 2007). With respect to greenhouse gases, plants absorb carbon dioxide (CO₂) 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. Grasslands can function as carbon sinks if plant biomass is converted to soil (Buyanovsky and Wagner 1998).

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 wetlands would minimally 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 we believe there is a net long-term benefit to air quality. Management activities in these habitats such as removing invasive trees, controlling 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 would their impacts. Because of the urbanized nature of the region and the close proximity to heavily travelled roadways and the Philadelphia International airport, we do not expect our management actions to result in measurably improved regional air quality, but they would contribute marginally to improving local air quality.

The refuge does not practice prescribed burns due to the urban surroundings and the area of the refuge has no history of catastrophic wildfire. Humans cause most of the small fires in the area. Nevertheless, we would seek to minimize the possibility of serious fires and their associated health and safety concerns. We would assess the hazards associated with the wildland-urban interface along the refuge boundaries with privately owned land to ensure that our management practices are not creating excessive fuel loading that would lead to severe fires.

The visitor center was designed as a “green building” with energy efficient lighting, heat, and cooling. It uses recycled materials; reducing water use by recycling waste water for toilets, and uses native landscaping and rainwater harvesting. In compliance with Federal mandates, these and other energy efficient practices to reduce air emissions would be continued and expanded under all alternatives

Under all alternatives, we would continue to support the refuge’s connection to public transit and regional trail systems that decrease air emissions from vehicles and encourages non-motorized access to the refuge. Increasing public awareness of air quality issues would continue to be part of environmental education programs and the ways the public can improve air quality would continue to be communicated and demonstrated by displays, signs, and literature available in the visitor center.

Adverse Impacts

Maintenance of access roads, trails, and buildings and other facilities would cause negligible short-term, localized effects from dust and vehicle and equipment exhausts. The regular management actions that may affect air quality the most are emissions from staff vehicles and equipment, particularly routine law enforcement and maintenance vehicles. Periodic use of large gasoline pumps during flooding events to control water levels in the impoundment and Long Hook Creek and equipment emissions for repair of dikes and access roads after flooding events are more intensive, but less frequent management activities. These activities would likely occur to some degree no matter which alternative is selected, and specific management actions such as consolidating staff facilities and improving water control infrastructure are proposed in alternatives B and C to help mitigate these impacts.

Managing and restoring coastal plain communities and freshwater tidal wetlands are consistent with the refuge goals and are common to all of the alternatives in different degrees. Of these two activities, restoring plain communities and freshwater tidal wetlands would affect air quality the most. All of the alternatives include restoring tidal marsh on the 55-acre restoration site. Air quality impacts resulting from the release of carbon monoxide and particulate emissions would occur at the site during the restoration project, but are generally not considered far-reaching. Air quality impacts during construction include the release of carbon monoxide and particulate emissions. Exhaust from construction vehicles and particulates from disturbed soils during construction and prior to the establishment of cover vegetation would have a short-term effect on the immediate air quality around the construction operation, but should not significantly impact areas outside of the refuge. These effects are short-term, and would subside upon completion of construction activities. Once re-growth is initiated, the resulting plant community would continue to sequester carbon and uptake other pollutants. Long-term benefits of restoration would include healthier native plant communities that would perform more ecological services and support a greater number and of wildlife diversity year round, and in particular would provide additional healthy foraging and resting for migrant birds.

Under each alternative, the refuge would continue to use Service-approved chemicals to control invasive plants and for other management purposes (i.e., to create openings in emergent marshes to benefit a variety of waterbirds). Generally, the refuge only sprays chemicals 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 chemicals and their application procedures. Aerial spraying is used to control 10 to 15 acres of phragmites-dominated wetlands each year. Access to and treatment of these areas would not be possible by other means and any potential risk would be mitigated through proper application procedures, including established best management practices.

Refuge visitation is likely to rise, regardless of alternative, with an associated increase in the number of vehicles on the refuge. Most visitors to the refuge are local residents (about 72 percent), about 8,200 students typically arrive by van or bus annually, and a number of visitors arrive by foot or bicycle from surrounding neighborhoods. These factors reduce the overall emissions per visitor. Posted speed limits on the refuge are 15 mph or slower. Required lower speeds help ensure visitor safety and minimize disturbance to wildlife, but also minimize negative effects on air quality by minimizing vehicle emissions. In addition, the number of vehicles on the refuge at any given time is not expected to be sufficiently large to create a significant impact to air quality. By comparison, there are approximately 100,000 vehicles per day that travel on interstate highway I-95 and main roadways immediately adjacent to the refuge (DVRPC 2009). Given the urban area surrounding the refuge, visitor impacts on refuge and regional air quality are negligible.

We would continue to restrict use of motorized vehicles on trails for wildlife observation and other compatible recreation. We do not intend to provide access for motor boats, and currently provide access only for non-motorized boats such as canoes or kayaks, which have no impact on air quality. Darby Creek itself is considered a navigable waterway; therefore, it is under the jurisdiction of the U.S. Army Corps of Engineers and the State of Pennsylvania. As such, the refuge cannot prevent access by motorized boats traveling to the refuge from adjacent lands.

Trespassing by off-road vehicles (ORV), such as ATVs, impacts air quality locally at the Folcroft Landfill. In all alternatives, we would continue to prohibit and enforce regulations to prevent and reduce these activities. These impacts could be potentially eliminated as part of the restoration and closure of the Folcroft Landfill by installation of physical barriers or off-road vehicle access limitations. Increasing posted regulatory signs and improving access for law enforcement as part of the closure could also reduce the frequency of these illegal activities and wildfires. Remediation of Folcroft Landfill is under EPA's jurisdiction. We would continue to work with the EPA to minimize potential adverse effects to air quality.

Under all alternatives, we would continue to operate existing refuge facilities and vehicles. While emissions from heating and cooling refuge facilities and employee travel would contribute to air pollution, those emissions can be reduced through use of energy efficient systems and vehicles. With our current facilities and vehicles, we have implemented actions such as installing energy efficient windows, energy efficient lighting, heating, and cooling; using recycled materials; reducing water use by recycling waste water for toilets; and native landscaping and rainwater harvesting.

4.2.2 Impacts of Alternative A (Current Management)

Benefits

Benefits to air quality are the same as those discussed in section 4.2.1, *Impacts on Air Quality That Would Not Vary by Alternative*.

Adverse Impacts

In addition to the impacts discussed in section 4.2.1, *Impacts on Air Quality That Would Not Vary by Alternative*, we would continue to maintain 72 acres of grassland and wet meadow, primarily through mowing. Mowing can lead to a temporary and localized suspension of particulate matter. However, the limited mowing occurring under current refuge management is of negligible impact on local air quality.

Operation of the refuge buildings would continue to contribute negligibly to local stationary source emissions. We would continue to house maintenance and law enforcement programs in a separate facility 0.25 miles from the refuge administrative offices. The separation of these program facilities results in minimal vehicle travel by refuge staff and emissions from vehicle exhaust. Vehicles and equipment used by staff would contribute a negligible amount to local mobile source air emissions and particulates.

In 2009, we estimated 133,000 visits to the refuge and we expect a 5 percent average increase per year over the life of the plan. Given the urban area surrounding the refuge, this increase in visitation is expected to have negligible impacts on air quality.

4.2.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Benefits to air quality under alternative B are similar to those described previously in section 4.2.1, *Impacts on Air Quality That Would Not Vary by Alternative*. There would be continuing benefits to air quality from maintaining the natural vegetation on up to 314 acres of coastal plains and floodplain forests acres, 454 acres of refuge tidal marsh, and up to 64 acres of other habitats (based on total acreage within acquisition boundary). Natural vegetation serves to filter air pollutants, and maintaining the refuge lands precludes development and the introduction of attendant sources of pollutant emissions on the land.

Alternative B would provide some long-term benefits to the air quality as a result of the restoration of additional coastal plain and floodplain forests. This alternative also includes emphasis on improving riparian forests and coastal plain forests. Management activities in these habitats such as removing invasive trees, controlling invasive plants that suppress regeneration, and planting and protecting trees from deer browse all contribute to improvements in habitat quality and carbon sequestration capacity. Minor beneficial impacts in alternative B would be added from succession of 7 acres of grassland to forested uplands. One management action under alternative B critical to the success of the above activities is decreasing the deer population to numbers compatible with forest regeneration and carrying capacity. This would result in improved forest regeneration and some additional benefits to air quality.

This alternative would result in a decrease in approximately 77 acres of open water habitat associated with the conversion of approximately half of the 145-acre impoundment to freshwater tidal marsh. The currently recorded dissolved oxygen levels in the impoundment create an anoxic (very low or no oxygen) environment that supports bacteria that produce methane during the decomposition of organic material (EPA 2010). 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 tidal flow would improve dissolved oxygen levels and 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.

Adverse Impacts

The adverse impacts of alternative B are similar to alternative A; however, 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. The phased conversion of the 15-acre nonnative poplar stand to a mixed hardwood species would result in short-term, localized impacts from vehicle and equipment emissions and a short-term loss of carbon sequestration; however in comparison to alternative C, the phased approach would reduce the intensity of impacts by spreading the impacts out over time.

Construction activities associated with expanding administrative facilities under alternative B would cause short-term, localized increases in emissions from construction vehicles and equipment exhausts. However, these localized increases would be temporary and of negligible levels as compared to emissions from nearby roads and interstates. Operations of the expanded facility would result in slight increases in emissions from its heating and cooling systems. These would be partially offset by co-locating the law enforcement and maintenance programs in the same building that could result in a reduction of staff travel between facilities and the reduction in emissions from vehicle exhaust, as well as a reduction in heating and cooling system needs. As with the current facilities, we would employ “green” building practices to minimize energy consumption and associated emissions and effects on air quality.

Alternative B also anticipates an increase in refuge visits, from the 133,000 estimated in 2009 to around 196,300 over the next 15 years. Much of this increase is expected in the form of school groups or wildlife-dependent recreational uses. Under alternative B, increases in vehicle emissions from visitor vehicles is partially mitigated by increasing partnership efforts to connect the refuge with public transit and regional trail systems that decrease air emissions from vehicles and encourages non-motorized access to the refuge. This level of visitation is still minimal when compared to the overall local population and associated emissions as described in section 4.2.1, *Impacts on Air Quality That Would Not Vary by Alternative*.

Added public use associated with additional infrastructure including a recently completed outdoor pavilion, observation decks, and Route 420 contact station proposed under alternative B would cause negligible impacts to air quality from short-term, localized increases in emissions from vehicles and equipment.

4.2.4 Impacts of Alternative C

Benefits

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

Remodeling the visitor center would result in fewer long-term benefits in comparison to alternative B. Conversion of the entire 145-acre impoundment to a freshwater tidal wetland would potentially provide more air quality benefits than alternative B in terms of increased carbon sequestration and decreased methane emissions. A one-time, clearcut removal of the 15-acre stand of nonnative poplar would result in the short-term loss of mature trees and more carbon sequestering capacity than the phased removal approach proposed in alternative B.

Adverse Impacts

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

Remodeling the visitor center to collocate only the law enforcement program would have less short-term adverse effects on air quality since this would be a smaller-scale project. This alternative would result in more freshwater tidal wetland restoration, including restoration of the entire 145-acre impoundment. In comparison to alternative B, this would result in more short-term impacts to air quality from equipment exhaust and particulates from soil disturbance and construction.

In contrast to alternative B, alternative C would clear the entire 15-acre nonnative poplar stand in one season, concentrating vehicle and equipment emissions over a shorter time frame, increasing local air quality impacts during that time. Similar to alternative B, conversion to a shrub-scrub habitat type would not significantly reduce the amount of forested habitat and carbon sequestration capacity.

Alternative C anticipates an increase in refuge participation and visitation although not to the extent expected under alternative B. Alternative C would also result in slightly lower numbers of public use visitation when compared to alternative B. As noted in the discussion of *Impacts of Alternative B*, no significant adverse impacts on air quality are anticipated with this increase in visitation.

4.3 Impacts on Geology and Visual Resources

Chapter 2, “Affected Environment,” discusses the status of geologic history of the Coastal Plain and the geology of the refuge. Tinicum Marsh is designated as a registered National Natural Landmark (NNL) and an outstanding scenic geological feature in Pennsylvania as a representative example of a coastal plain marsh.

None of the alternatives presented would adversely impact the underlying geology or detract from the scenic quality of this landform. Construction of facilities (for example, expanded administrative offices, observation areas, and trails), habitat restoration efforts, and impoundment maintenance and improvement projects would impact the upper layers of fill or previously disturbed soils, but not impact the underlying geology. Freshwater tidal wetland restoration activities under all alternatives would remove or reduce the visibility of artificial structures (such as dikes) on the coastal plain landscape and could be designed to more closely duplicate coastal plain landforms. Potential impacts to soils are described below.

Visual resources (aesthetics) would not differ among the alternatives, and impacts are expected to be minimal. The extension of administrative offices proposed in alternative B would be the same height and exterior design as the current headquarters building. Where possible, a consistent design for public use infrastructure would be implemented in alternatives B and C.

4.4 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. Overall, the upland soils of the refuge are a mixed organic fill material from past dredging projects and the marsh soils are organic muck underlain by alluvial sediments.

Outside of the Folcroft Landfill area, there is some degree of soil contamination, but it is believed to be present below State and Federal levels for human contact and inhalation. Compaction is a localized problem in high traffic areas around the visitor center and some trails, but much of the heavy site use is confined to paved areas, gravel access roads, boardwalks, and observation areas. However, certain areas, particularly the dikes and access roads are experiencing ongoing erosion and are susceptible to damage during flooding events. We would continue to manage these areas to minimize human disturbance and to mitigate for natural processes that result in loss of valuable habitats, particularly at kingfisher and heron nesting sites.

We evaluated the potential benefits of our proposed actions that would conserve, restore, and improve soils, including the following:

- Limiting sources of sediment by maintaining forest and other vegetation cover and preventing erosion
- The potential of refuge habitat management and restoration projects to re-use excavated soils and improve soils in upland areas
- The potential invasive plant management to improve soils
- Potential of expanding public use facilities and signage to minimize soil loss and compaction

We evaluated the potential for the actions proposed to cause adverse effects on soils, including the following:

- Disturbing soils during non-regular refuge maintenance activities
- Improving riparian and coastal plain forests
- Disturbing soils during tidal marsh restoration projects
- Impacting soils by herbicide application and invasive plant management
- Disturbing soils during office and other major public use infrastructure construction projects

4.4.1 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. We predict that refuge land management, regardless of which alternative, would be expected to have a net positive effect on soil quality. The following management actions would benefit or impact soils under all alternatives dependent on the scale, frequency, and duration of these activities, and the sensitivity of the soils to erosion and compaction.

Benefits

Under all alternatives, we would continue to pursue land protection as described in the refuge's establishing documents. This would result in the permanent protection of approximately 1,200 acres and the attendant protection of soils from potential development or degradation. Conservation and protection of natural vegetation and soils on approximately 286 acres of floodplain and coastal plain forests, 282 acres of freshwater tidal marsh, 201 acres of open water habitat, and 72 acres of wet meadows and grasslands minimizes soil losses through erosion.

Managing and restoring forests and wetlands 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. The refuge would consider beneficial uses of any extra soils excavated onsite such as construction of a noise barrier and restoration of tidal wetlands in open waters.

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.

Adverse Impacts

Significant excavation and grading of soils common to wetland habitat restoration or hydrology restoration projects would occur no matter which alternative is selected, but the degree to which we practice them would vary, and thus would their impacts. In general, no soil from offsite would be brought onto the refuge unless bringing in clean soil is determined to be less disturbing to refuge resources than using onsite soils.

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, 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 note and correct any erosion problems during routine refuge monitoring and maintenance. We monitor parking and other concentration areas and have not observed excessive 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.

Unauthorized public use activities have the potential to impact soils through trampling and trespassing. Off-road vehicles such as ATVs can indirectly affect soils by loosening surface layers and compressing underlying layers. Coupled with a loss of plant cover, the result can be increased soil erosion (Hammit 1998). Trampling also decreases the abundance and diversity of soil organisms such as microbes, earthworms, arthropods, snails, and slugs, which often play a major role in nutrient cycling (Liddle 1997). Under all alternatives, we would continue to enforce regulations prohibiting off-trail use and non-authorized use of motorized vehicles (e.g., ATVs) to prevent soil erosion and compaction. This issue is mostly a concern at Folcroft Landfill.

Managing and restoring coastal plain communities and freshwater tidal wetlands are consistent with the refuge goals and are common to all of the alternatives in different degrees. Of these two activities, restoring plain communities and freshwater tidal wetlands would affect soil quality the most. Soil disturbance during construction activities and prior to the establishment of cover vegetation could increase soil erosion. However, we would follow established best management practices to avoid and minimize sedimentation impacts to the extent practicable.

Under all alternatives, we would continue to use Service-approved herbicides and pesticides to

- treat and control aquatic and terrestrial invasive plants to improve refuge habitats and restore native plant communities;
- control mosquitoes to protect public and wildlife health; and
- for other management purposes, such as to create openings in emergent marshes to benefit a variety of waterbirds.

Prior to using any herbicide or pesticide on the refuge, we must request approval, through a Pesticide Use Proposal. The refuge manager, regional pest management coordinator, and national pest management coordinator have the authority to approve chemicals and their application procedures. Currently, the refuge has approved Pesticide Use Proposals for five herbicides to treat aquatic and terrestrial invasive plant species and two pesticides to control mosquitoes. The approved herbicides are triclopyr, glyphosate, imazapic, imazamox, and aminopyralid. The pesticides are *Bacillus thuringiensis israelensis* and *Bacillus sphaericus*.

There is some minimal risk that herbicides and pesticides used for invasive plant and mosquito control could impact refuge soils by affecting soil microorganisms, persisting in the soils, and adsorption. The herbicides currently used on the refuge degrade in soils through microbial action, light, or both, with approximate half-lives ranging between 46 and 106 days (USDOE 2000a, USDOE 2000b, USDOE 2006a, USDOE 2006b). Both *Bacillus* species are naturally occurring soil bacteria and are not expected to have any adverse effects on soils (USEPA 1998, USEPA 1999). All herbicides and pesticides used on the refuge have been deemed safe for use on the refuge, when applied according to label instructions. We would mitigate any potential risk by using only herbicides and pesticides on the Field Station Approval list (as other pesticides require either Regional or Service Headquarter approval) and following proper application procedures. For more specific information on pesticides used on the refuge, contact the refuge manager.

Refuge visitation is likely to rise, regardless of alternative, with an associated increase in the utilization of trails and potential for increased soil erosion and compaction.

4.4.2 Impacts of Alternative A (Current Management)

Benefits

Benefits from refuge management are the same as those described under impacts that would not vary by alternative. Other potential beneficial impacts of alternative A, are described below:

Occasional dewatering of the 145-acre impoundment to support migratory birds or assist in disease prevention efforts exposes much of the impoundment soils to air which oxidizes some of the thick organic layer and indirectly improves soil quality and productivity. The current condition and arrangement of the existing water control structures limit the impoundment water levels that refuge staff can control; therefore, we cannot drain the entire impoundment and expose all of the soils to air.

Adverse Impacts

Currently, the refuge has about 1 mile of crushed gravel access roads to facilitate refuge management activities and recreational access for visitors (by foot, by bicycle, or special access for visitors with disabilities). Although these roads are pervious to precipitation, they do cause the compaction of soils and the loss of vegetation. These access roads are used only by refuge staff vehicles or by special

access permit. Gravel access roads are generally located in areas previously disturbed by the former access 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.

We also maintain approximately 2 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. These trails are designated for pedestrian use; however, refuge staff has observed unauthorized activities occurring on these trails such as bicycling. These unauthorized activities can increase soil compaction and erosion. Refuge staff minimizes these effects by posting appropriate signs and distributing literature, and refuge law enforcement staff continues to enforce refuge rules and regulations. We would continue to prohibit certain recreational activities, such as ATV's or mountain biking on these trails that would damage soils on the refuge.

Alternative A includes completing construction of an outdoor environmental education pavilion. This pavilion is located near the existing visitor center on lands that have already been disturbed. We are following best management practices to minimize potential for soil erosion during construction. Hiking trails, wildlife observation areas, parking areas, and other high-use areas would continue to be well maintained to keep soil effects to a minimum. Any erosion problems would be noted during routine refuge monitoring and corrected as soon as feasible.

4.4.3 Impacts on Soils Under Alternative B (Service-preferred Alternative)

Benefits

Benefits to soil would be similar to those that are common to all alternatives. 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 tidal marsh, and the associated removal of fill material would potentially restore historic soil profiles where previously buried, or remove or contain contaminated sediments.

Adverse Impacts

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

The refuge is proposing to expand the current refuge headquarters by adding on an office wing to collocate the law enforcement and maintenance programs with the other refuge programs and accommodate additional staff. Although the exact footprint of the proposed facilities has not been determined, we believe the addition would look similar to the conceptual design presented in appendix K. The expansion is expected to be about 1,800 square feet. Some ground disturbance is expected in the already disturbed area where the expansion would be located, as the area would need to be excavated. The expansion may also require a relatively small (probably less than half an acre) section of the grassy area adjacent to the current building to be removed to build the foundation of the expansion. These soils have already been disturbed and overall impacts to soils are expected to be minimal.

Phased removal of the 15-acre stand of nonnative poplar would result in the minor soil compaction and short-term loss of vegetative cover that could potentially increase soil erosion. By using a phased approach, the refuge minimizes soil impacts to the area at any one time and we would apply best management practices to reduce soil erosion and plant grasses to establish vegetative cover where needed.

Alternative B proposes construction of additional facilities including: a boardwalk, observation decks, kiosks, fishing access, and other small improvements. During the construction of these structures some upper layers of soils would be disturbed and compacted. By providing a path for users to cross over the wetlands and not through them, long-term effects to unsuitable and highly compactable soils would be avoided. One of the observation decks would re-use, if practical, existing concrete pilings to support the observation deck to minimize the impacts to soils; however, where needed new pilings would have to be driven into the soil.

The construction activity with the most potential disturbance to soils, particularly marsh soils, would be the construction of boardwalk that would extend out into the tidal marsh. The anticipated size of the boardwalk would be 200 to 300 feet long by 6 feet wide. Soil disturbance would be limited to the placing of pilings in the marsh area and the associated upland construction staging area. However, long-term soil disturbance is not expected, and the impact of these projects would be minimal. No construction other than placement of boardwalk pilings would be done in wetlands, resulting in short-term localized effects to wetland soils during construction and potential for long-term impacts on wetland plants from the shading effect produced by the boardwalk itself. As with other activities on the refuge that have the potential to disturb soils, the refuge would implement best management practices, including soil erosion plans as necessary, to minimize any negative effects on soils including erosion and compaction.

4.4.4 Impacts of Alternative C

Benefits

The benefits of alternative C are similar to alternative B.

Adverse Impacts

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

This alternative would result in more freshwater tidal wetland restoration, including restoration of the entire 145-acre impoundment. In comparison to alternative B, this would result in more short-term impacts to soil.

In contrast to alternative B, alternative C would cut and restore the entire 15-acre nonnative poplar stand at once. This would concentrate vehicle and equipment disturbance over a shorter time frame, potentially increasing local soil impacts.

As in alternative B, alternative C also anticipates an increase in refuge participation and visitation, as noted in the discussion of *Soil Impacts That Would Not Vary by Alternative and Impacts of Alternative A*. Although alternative C would also result slightly lower numbers of public use visitation when compared to alternative B. Added infrastructure under alternative C would primarily be focused around the Folcroft Landfill. These impacts would only occur once the site is remediated and released. The final site design would determine the location, size, and extent of infrastructure allowed in this location, and impacts would be addressed through a separate NEPA process. No significant increase in soil impacts is anticipated with this increase in visitation.

4.5 Impacts on Hydrology and Water Quality

As discussed in chapter 2, the hydrology on much of the refuge has been altered and water quality of the Darby Creek is generally poor and highly variable. The water quality at the refuge is variable and affected by point and non-point sources and related upstream impacts.

We evaluated the effects on hydrology and water quantity as a result of these management actions under each of the alternatives, including the following:

- Conserving and protecting refuge lands to limit the growth of development, thereby limiting sources of pollution and reducing losses of forest vegetation
- Protecting, conserving, and monitoring vernal pools that are important habitat for amphibians of special concern
- Improving water quality by managing and restoring freshwater tidal marsh and improving riparian forests and coastal plain forests, creating and maintaining buffers between habitats and high use areas, and restoring hydrologic function to these habitat
- Maintaining wildlife habitat and supporting wildlife in the impoundment by actively controlling water levels, and restoration of all or a portion of the impoundment to freshwater tidal marsh
- Controlling invasive species
- Increasing public awareness through environmental interpretation and wildlife-dependent recreation
- Implementing measures to control erosion and prevent spills or other pollutants during construction of public and administrative facilities, particularly large scale (over 20 acres) restoration projects
- Supporting regional restoration and riparian buffer projects, increasing visitor and public awareness through environmental interpretation and education and continuing existing partnerships to benefit water quality and hydrology

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

- Impacts to water quality from public use
- Impacts on water quality from the construction and management of facilities, including public use and expanding administrative offices.
- Impacts to water quality from managing and restoring freshwater tidal marsh and improving riparian forests and coastal plain forests, and restoring hydrologic function to these habitats
- Invasive plant control, including aerial spraying and controlling invasive species including the use of herbicides, on water quality
- 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
- Updating, expanding, and managing public use facilities and administrative offices
- Constructing, expanding, and managing additional public use facilities
- Increasing visitation and expanding the six priority public uses
- Planning for larger-scale public access projects such as construction of a pedestrian access at Route 420, construction of noise barrier(s), and consideration of more intensive public access such as guided tours in the marsh

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

Water quality in the refuge is a highly variable and complex phenomenon resulting from inputs of

three major waterways: Darby Creek, Cobbs Creeks (a major tributary to Darby Creek) and the Delaware River. The contribution from each of these sources at any given time varies depending upon tidal, hydrological, climatological, and anthropogenic conditions.

Benefits

Conservation and protection, of natural vegetation and soils on approximately 286 acres of floodplain and coastal plain forests, 282 acres of freshwater tidal marsh, 201 acres of open water habitat, and 72 acres of wet meadows and grasslands would continue to benefit water quality in the Delaware River watershed by limiting development in that part of the watershed and acting as a buffer against non-point-source pollution in the surrounding landscape. The benefits of wetlands to water quality are well established, and include trapping, recycling, and exporting sediments, nutrients, organic materials, and contaminants (Carter 1996). The existing and restored wetlands would filter water moving into the river and help improve water quality.

All of the alternatives propose restoring 55 acres of phragmites-dominated wetland to freshwater tidal marsh and closure and restoration of Folcroft Landfill. Both projects would improve water quality. Closure and restoration of Folcroft Landfill would permanently cap the landfill and would reduce contamination of Darby Creek and Tincum Marsh. Restoring 55 acres of phragmites-dominated wetland to freshwater tidal marsh would greatly benefit water quality of Tincum Marsh by improving biological exchange, regular tidal flushing, improving filtering and uptake of pollutants and suspended solids, and increasing dissolved oxygen concentrations.

Restoration of tidal marsh in this location may have a small, but positive impact on Tincum Township by helping to reduce flooding. By removing historic fill material and restoring tidal hydrology, we also increase the floodway capacity along this section of Darby Creek. While we do not anticipate this single action would reduce frequency of flooding, the restoration of historic hydrologic regimes and flood capacity in this location adds to the cumulative effects of other flood management efforts.

Adverse Impacts

The hydrology and land surface across much of the refuge has been altered. Drainage is impeded and some areas of the coastal plain and floodplain forests on the refuge are occasionally flooded (such as forests adjacent to dikes). These areas are topographically low features, which cause them to hold storm water and remain inundated for extended periods. Since these areas rely on surface water runoff or overbank flooding of Darby Creek, they can also be dry during extended period of drought. We would closely monitor and mitigate all of our routine activities that have some potential to result in chemical contamination of water directly through leakage or spills or indirectly through soil runoff. These include control of weeds and insects around structures, use of chemicals for de-icing walkways, and use of soaps and detergents for cleaning vehicles and equipment. Personnel would continue to take the following precautions to minimize the potential for the chemicals and petroleum products becoming a water quality problem:

- Pour or mix chemicals or petroleum products no closer than 100 feet from surface water and over a non-porous surface material.

- Train all staff in spill prevention and spill response.
- Clean all vehicle and equipment at the existing maintenance facility to minimize runoff.
- Ensure all pesticide applicators are State certified.
- Apply all pesticides according to Service policies. In particular, we would ensure application according to label instructions.

As discussed in section 4.4.1, the herbicides selected for refuge management are reviewed by the Regional Contaminants Specialist who is responsible for upholding Federal standards for water quality and soil protection. Only those chemicals approved by the Service will be used. It is also acknowledged that reducing our dependency on chemical pesticides would help protect refuge resources.

There is some minimal risk that herbicides and pesticides used for invasive plant and mosquito control could impact water quality on the refuge. Triclopyr (BEE) has a low potential to leach into ground water and a moderate potential for surface water runoff (USDOE 2000a). Glyphosate has a low leaching potential because it adsorbs rapidly and tightly to soil (SERA 2011). It degrades in water with an estimated half-life of 35 to 70 days, depending on the soil type (USFS 1997). Imazapic degrades in water with an estimated half-life of 1 to 2 days. The potential of imazapic to leach into surface water and groundwater is highly dependent on the soil type present where it is applied (USDOE 2006a). Imazamox is very rapidly degraded by light in water, with an estimated half-life of 7 hours (USEPA 1997). It has a very limited potential to leach into groundwater and surface waters (USEPA 1997). Aminopyralid is relatively immobile and non-persistent in soils and, therefore, has little potential to leach into surface and groundwater (USDOE 2006b). *Bacillus thuringiensis israelensis* and *Bacillus sphaericus* are not aquatic bacteria and are not expected to have any adverse impacts on water quality or hydrology (USEPA 1998).

Some potential exists for the concentration of herbicides to build up over time in river sediments, lakes, ponds, and wetland habitats. The potential depends on the balance of pesticide input and removal from the lake or pond system. Herbicide inputs may occur either through direct application, water inflow, or through re-suspension and diffusion from the sediment layer. Herbicide removal from the system may occur through outflow, degradation, volatilization, and settling or diffusion into the underlying sediment (Neitsch et al. 2001). The rate of herbicide degradation is an important consideration for assessing the effects of any herbicide on aquatic systems. By only using herbicides and pesticides approved for aquatic use in or near water, and employing the other best management practices described above, we anticipate little to no adverse impacts on water quality.

All of the alternatives include closure and restoration of Folcroft Landfill, which became part of the refuge in 1980. This landfill is part of the Lower Darby Creek Area Superfund Site, which also includes the Clearview Landfill, located just upstream of the refuge, and four other sites within a 2-mile stretch along Darby Creek (NOAA 2000). These sites would continue to impact water quality until cleanup and closure. Coordination with the EPA regarding contaminant remediation is ongoing.

The upstream impacts to water quality and risks of hazardous spills from neighboring roads, tank farms, industrial sites, and communities would continue

no matter which alternative would be selected. The refuge would continue to annually update management plans such as the Spill Prevention and Response Plan and would continue to monitor water quality. Stringent precautions in conducting refuge management activities would prevent chemical contamination of water directly through leaks or spills or indirectly through soil runoff.

Regardless of alternative, there would continue to be negligible impacts to refuge water quality from the use of vehicles and equipment by refuge staff in surveillance, monitoring, and routine facility maintenance activities on the refuge property. Trace amounts of petroleum products from vehicles and equipment may be carried into refuge water in rainfall runoff; minimal soil disturbance might also lead to negligible amounts of turbidity in runoff waters. Maintenance of access roads, ongoing trail, and other maintenance activities would cause negligible short-term, localized soil erosion. These activities could occur to some degree no matter which alternative is selected. We would minimize these impacts by using best management practices.

Refuge visitation is likely to rise, regardless of alternative, with an associated increase in the utilization of facilities and trails and the potential for increased soil erosion, trash and debris, and pollutants from vehicles such as grease and detergents. Vegetated buffers and swales and infiltration trenches would continue to capture and filter contaminants from the parking lots and heavy use areas. A significant amount of trash and debris from upstream areas would continue to be deposited in the refuge, especially when Darby Creek floods. The refuge would continue to support Darby Creek cleanup events; however these events, while good for public awareness, likely make little difference in the amount of trash and debris present in the system. We would continue the existing partnerships with the Darby Creek Valley Association, the Delaware Estuary Program, and continue to support ongoing research to better understand and improve the water quality of Darby Creek, Cobbs Creek, and the Delaware Estuary. The impacts of refuge management to water quality are negligible in relation to the cumulative watershed-scale influences impacting the refuge.

4.5.2 Impacts of Alternative A (Current Management)

Benefits

Benefits of refuge management on water quality and hydrology are similar to benefits that would not vary by alternative plus:

Hydrology and water quality would benefit by protecting refuge habitats from development. Refuge lands are surrounded by high density urban residential and industrial development. By maintaining and protecting the natural buffers and wetlands along Darby Creek, refuge lands help protect neighboring communities from additional impacts from flooding and stormwater pollutants. Vegetation helps filter pollutants, stabilize soils and 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 Darby Creek in order to reduce contaminants and stormwater impacts from the refuge. Habitat management actions such as invasive plant control would continue although it would be less extensive and would have fewer benefits in comparison to alternatives B and C. By maintaining current levels of invasive species control, we would continue to have minimal impacts on water quality as the result of habitat management.

The 145-acre impoundment 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 and supplemental pumping (see vegetation and wildlife for

specific impacts on these resources). Water levels would continue to be adjusted seasonally to mimic natural hydroperiods associated with unaltered riverine wetlands to provide the best possible habitat for priority migratory birds and wildlife species. The impoundment would continue to be managed to mimic historic hydrology; however, the ability to effectively manipulate impoundment hydrology would continue to be impeded due to the inadequate capacity of the existing water control infrastructure. The refuge would continue to use the remaining and functioning water control structure in the northeast corner of the impoundment.

Adverse Impacts

Potential adverse impacts to water quality are the same as *Adverse Impacts That Would Not Vary By Alternative* plus the potential adverse impacts of alternative A described below:

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 tidal flow and surface drainage, which helps build soils and encourages the establishment of phragmites and reduces the number and effectiveness of small tidal channels. Dikes 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. In the case of impoundment management, it can negatively impact the effectiveness of water level management for migratory bird stopover habitat.

Under this alternative, we would continue to monitor the deer population and impacts on the refuge. We would continue to prohibit hunting and would not implement any management efforts to control the deer population. This would likely allow the deer population to increase. Deer would continue to have minimal negative effects on water quality by reducing vegetative cover and disturbing soils on trails which could cause erosion and sedimentation, and would suppress forest regeneration that could benefit water quality.

Under alternative A, the risk of herbicide contamination, used in invasive plant control, to open water and wetland habitats would be minimal. Currently glyphosate-based herbicides are the primary chemicals used for refuge management operations. Glyphosate also quickly adsorbs to suspended soil particles in water, rapidly making it biologically unavailable. As discussed under section 5.2.1, we would minimize potential adverse effects to aquatic organisms by applying all herbicides according to label instructions and only using herbicides approved for aquatic use in and around waters and wetlands.

There would be little change to public and administrative facilities that would affect water quality. The area around the impoundment would continue to be one of the most heavily used areas of the refuge. It would continue to have the highest concentration of wildlife observation facilities, and would be frequently used for interpretative and educational programs.

In alternative A, we estimate that wildlife-dependent recreation would increase by about 15 percent, over the 15-year life of the plan. That presents an increased potential for adverse effects on refuge water quality through littering, soil sedimentation from fishing, hiking, biking, canoeing, and kayaking, and runoff of petroleum products from parking lots. The refuge would continue to minimize adverse impacts to water resources from visitors by routinely monitoring roads and trails for damage and by remediating problem areas. An increase in

recreational boating activities might lead to river and stream contamination. Public outreach would increase awareness of issues such as littering, invasive aquatic plants, introduction of nonnative fish, and lead contamination. Thus, outreach would help to mitigate risks associated with visitor use of waterways on the refuge. Adverse impacts to hydrology and water quality are expected to be less compared to alternatives B and C, because the increase in visits and overall visitor use is expected to be about half of the increase projected under the other alternatives.

4.5.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

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

Conversion of a portion of the 145-acre impoundment to a freshwater tidal wetland would have the similar benefits as other wetland restoration projects described in alternative A. These actions would restore tidal hydrology historically present in these areas. By doing so, the refuge would restore some of the natural floodway capacity historically present along this portion of Darby Creek. While we do not anticipate this single action would reduce frequency of flooding, the restoration of historic hydrologic regimes and flood capacity in this location adds to the cumulative effects of other flood management efforts.

Improving impoundment water level control infrastructure and adaptive management of water levels would improve the ability to manipulate impoundment water levels to improve dissolved oxygen (DO) levels in the impoundment.

More intensive management of coastal plain and freshwater tidal marsh habitats would increase the benefits in comparison to alternative A. The combination of establishing a deer management program, along with invasive species control efforts, would help to restore native plant communities that are indigenous to the coastal plain.

Under this alternative, we would complete installation of a water quality monitoring unit along Darby Creek on the refuge to implement long-term and continuous monitoring. This data would be used to inform refuge staff of localized water quality concerns and their influences on our habitat management and public uses.

Adverse Impacts

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

Additional restoration activities under alternative B would have minor, short-term impacts on localized hydrology. Poplars are known to have high evapotranspiration rates as compared to other hardwood trees. Clearing of the 15-acres of nonnative poplar forests would likely reduce the amount of evapotranspiration over the first several years while coastal plain and floodplain forest vegetation is restored to the area. Due to the relatively small scale of vegetative removal, we do not anticipate this change to significantly change local groundwater hydrology.

Conversion of a portion of the 145-acre impoundment to a freshwater tidal wetland would 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 implemented to minimize soil loss, erosion, and

reduce potential impact of equipment spills or leaks. Disturbance to vegetation and soils during construction would potentially cause short-term erosion and sedimentation to nearby water ways. Construction also increases the risk of hazardous material spills from equipment while present on site.

An increase in public use could cause increases in negative impacts on water quality. By increasing onsite refuge visitation by about 47 percent (about 63,300 visits) over the life of the CCP, we increase the likelihood of increased runoff from refuge parking lots and roads and increased sedimentation in refuge waterways from soil erosion associated with increased foot traffic. These impacts would be localized to refuge entrance points and trails. We would monitor these areas for potential impacts and would modify use or close areas as needed to protect resources.

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 platforms, blinds, kiosks, and an unstaffed visitor contact station along Route 420. The public infrastructure project with the most potential adverse impacts under alternative B is a boardwalk into the marsh. The boardwalk would be approximately 1,600 to 2,400 square feet. This project would mainly create short-term localized water quality impacts during construction access to the boardwalk and disturbing wetlands during placement of boardwalk pilings. The disturbed soils and suspended sediment would be managed using construction best management practices. 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.

4.5.3 Impacts on Hydrology and Water Quality (Alternative C)

Benefits

Benefits to water quality are the same as benefits of proposed actions in alternative B, plus the potential beneficial impacts of alternative C described below:

The complete conversion of the 145-acre impoundment 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 tidal hydrology. Restoration of the impoundment to tidal marsh would restore tidal hydrology historically present in this area. By doing so, the refuge would restore the natural floodway capacity historically present along this portion of Darby Creek. While we do not anticipate this single action would reduce frequency of flooding, the restoration of historic hydrologic regimes and flood capacity in this location adds to the cumulative effects of other flood management efforts.

Adding a controlled youth hunt in addition to wildlife specialists would assist in maintaining deer populations and would have the same water quality benefits as alternative B. As in alternative B, the combination of reducing the refuge deer population, along with invasive species control efforts, would help to restore native plant communities that are indigenous to the coastal plain.

Adverse Impacts

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

This alternative includes restoration of the entire 145-acre impoundment. In comparison to alternative B, this would result in more potential short-term impacts on water quality and hydrology. The area of soil disturbance would

increase, increasing the potential for erosion and sedimentation. It is unclear at this time if Tinicum Township would experience increased risks of flooding if the impoundment is restored. Increased flooding in the area would increase contamination, adversely affecting water quality. We would work with the township, qualified engineers, and hydrologists as needed to ensure proper design of the impoundment restoration to minimize potential risks of flooding.

In contrast to alternative B, alternative C would clear the 15-acre nonnative poplar stand and result in more disturbances of vegetation and soils, increasing the potential for erosion and sedimentation. Conversion of the 15-acre nonnative poplar stand to a shrub-scrub habitat type would likely result in little change in local hydrology. The initial, one-time clearing of 15-acres would likely have a short-term, negligible effect on groundwater and evapotranspiration in this location.

As in alternative B, alternative C also anticipates a similar increase in refuge participation and visitation, as noted in the discussion of *Impacts of Alternative B*, and no significant adverse impacts on water quality are anticipated with this increase in visitation. There is some additional, although minimal, potential adverse effects associated with opening a youth deer hunt since this usually involves off-trail access. These would be somewhat similar to those from the wildlife management specialists utilized under alternative B, but there would be fewer individuals—and thus fewer impacts.

Remodeling the visitor center to collocate only the law enforcement program would result in a slightly less water quality impact in comparison to alternative B, due to the reduced need for equipment and associated construction impacts.

4.6 Impacts on Noise

The refuge conducts its management in a noise-filled, urban environment. Traffic, airplanes, heavy equipment operation, industrial and commercial operations, building and road construction, all contribute to local noise and disturbance in varying degrees. Noise impacts are expected to be similar under each alternative. Source of noise would include traffic, the Philadelphia International Airport, mechanized equipment (mowing, brush-hogging, chainsaws, etc), firearms from the nearby Delaware County Training Facility, and construction projects. Noise from traffic would be minimal from refuge drives, due to low speeds and limited use.

Noise from human activities can have different impacts to wildlife depending upon the auditory communication system of the species and the intensity, duration, and timing of the noise. Research (Knight 1984) shows that human activities such as boating and fishing could disturb wintering bald eagles (especially adults). Boat noise disrupted feeding activity which reduced the eagles' energy intake. Avoidance flights simultaneously increased the energy expended by the eagles, which in turn magnifies their energy deficit. The same study found that some migrant birds are disturbed by the presence of visitors and that loudness was as significant of a disturbance as the number of people in this effect (Burger and Gochfeld 1998). As indicated by these examples and elsewhere, the effects of noise on particular species is dependent on the species' or individual's tolerance to noise.

A study on the impact of highways measured forest breeding birds in transects extending 1,200 feet (400 meters) from the edge of I-95 in Maine and found that four species were less abundant near the road while another six became more abundant near the roadway (Ferris 1979). Species that became less abundant near the road include the bay-breasted warbler, blue jay, Blackburnian warblers, and winter wrens. The six species that became more abundant near the road

included the chestnut sided warbler, white-throated sparrow, wood thrush, common yellowthroat, robin, and Tennessee warbler.

Noise can affect amphibians as well. In relation to the refuge, calls at these lower decibel ranges may easily be overpowered by ambient noise, depending on the location within the refuge, based on the existing average Day-Night Average Sound Level of 50 dB measured near Lindberg Boulevard. This is calculated to increase to 55.4 dB in 2007 and 56.5 dB in 2015 with the runway expansion project (FAA 2005).

Aircraft noise can have negative impacts on terrestrial and aquatic species. The severity of these impacts depends on the frequency of flights, the altitude the craft is flying at, the type of aircraft (i.e., fixed-wing versus helicopter), and the wildlife species (Gladwin et al. 1988). Wildlife responses to aircraft noise can vary greatly, from apparent habituation in many species (USDA 2010), slight reactions, such as calling or becoming more alert in white-tailed deer and turkey, flushing of waterfowl and small birds, and startle and jumping actions in fish (Manci et al. 1988, Gladwin et al. 1987). Generally, lower altitude flights and helicopters appear to be more likely to negatively impact species than higher altitude and fixed-wing aircrafts (Gladwin et al. 1987). In a survey of Service staff (Gladwin et al. 1987), waterfowl species were the most frequently reported animal group disturbed by aircraft. In this survey, national fish hatchery staff also reported fish deaths due to intense sonic booms that caused fish to jump out of their tanks or have seizures. A report on wildlife hazards at Philadelphia International Airport found a variety of wildlife species, using the airport property, for example waterfowl, migratory landbirds, and mammals (USDA 2010). This same study reported large numbers of animals feeding, resting, and nesting on the airport, indicating at least some level of habituation to noise and other associated disturbance from airport operations.

In light of this ambient noise in the refuge landscape, we considered how refuge management actions might add to the soundscape. We evaluated the effects of noise as a result of potential management actions under each of the alternatives.

4.6.1 Noise Impacts That Would Not Vary by Alternative

Benefits

There is no specific information on the soundscape of John Heinz NWR but there are clearly the sounds and noises of an urbanized landscape. Traffic, airplanes, heavy equipment operation, industrial and commercial operations, and building and road construction all contribute to community noise and disturbance in varying degrees.

By comparison, the refuge benefits the local soundscape by providing aspects of natural soundscapes uncommon in urban areas. The sounds of frogs calling, birds singing, fish jumping, and wind through the leaves provide benefits for both wildlife (in terms of breeding and territorial vocalizations) and visitors (in terms of wildlife-dependent recreation).

Adverse Impacts

John Heinz National Wildlife Refuge at Tinicum is northwest of the Philadelphia International Airport and is separated from the airport by I-95, a Southeastern Philadelphia Transportation Authority (SEPTA) rail line, and Bartram Avenue. The refuge is not aligned with any existing runway and is not on the direct approach or departure track for any of the existing runways.

The noise analysis completed for the airport's runway expansion environmental impact statement demonstrated that the refuge experiences noise levels between 45 and 60 decibels (dB) based on the Day-Night Average Sound Level

(DNL) recorded near the refuge. As documented by these measurements, the refuge is located in an area containing high levels of ambient noise as a result of surrounding commercial, industrial, and transportation activities. Ongoing maintenance activities, habitat restoration projects, and visitation would contribute negligible amounts of noise to existing background levels. Screamer-shells fired by refuge staff to flush birds for monitoring purposes may be used infrequently during day time hours. No activity identified under any alternative is expected to have a major or long-term impact on noise on the refuge or to adjacent lands.

4.6.2. Impacts of Alternative A (Current Management)

Benefits

Noise benefits would continue as described in *Noise Impacts That Would Not Vary by Alternative*.

In addition, we are planting trees along nonforested portions of the refuge that parallel I-95 in an attempt to reduce traffic sounds using a natural, long-term sound barrier. This barrier may improve audibility of nature sounds including frog calls and bird songs. This would improve the soundscape on the refuge by decreasing disturbance to visitors and wildlife associated with anthropogenic sounds.

Adverse Impacts

Noise impacts would continue as described in *Noise Impacts That Would Not Vary by Alternative*.

4.6.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Noise benefits would continue as described under alternative A. Noise benefits under this alternative may be slightly greater than alternative A since increased restoration efforts would likely increase habitat quality and result in associated increases in wildlife. This would improve the soundscape on the refuge by increasing the numbers and types of natural sounds on the refuge.

Adverse Impacts

Impacts of noise are expected to be slightly increased compared to alternative A.

Adverse impacts associated with refuge visitation would likely be slightly greater because of the increase in visitation compared to alternative A, but are expected to be negligible compared to the current soundscape.

Under alternative B, there would be noise from firearms used by wildlife management specialists, but only during daylight hours and very infrequently. As in alternative A, screamer-shells fired by refuge staff to flush birds for monitoring purposes may be used infrequently during day time hours. Construction of additional facilities and equipment-related noise associated with routine maintenance and operations would have short-term adverse effects. In general, noise generated by any of these sources could potentially have minimal, but temporary, effects on nearby wildlife and people in the form of encouraging flight response or avoidance of surrounding habitat. None of these activities are expected to have long-term adverse effects on the area's soundscape.

4.6.4 Impacts of Alternative C

Benefits

Noise benefits would continue as described in *Noise Impacts That Would Not Vary by Alternative*.

Unlike alternatives A and B, this alternative would explore construction of a more extensive sound barrier along I-95 to reduce sound impacts on birds, amphibians, and other wildlife.

4.7 Impacts on Vegetation

Adverse Impacts

Under alternative C there would be noise from firearms used by hunters and wildlife management specialists, but only during daylight hours and very infrequently. Screamer-shells fired by refuge staff to flush birds for monitoring purposes may be used infrequently during day time hours. As described under alternative B, construction of additional facilities and equipment-related noise associated with routine maintenance and operations would have short-term adverse effects. In general, noise generated by any of these sources could potentially have minimal, but temporary effects on nearby wildlife and people. None of these activities are expected to have long-term adverse effects on the area's soundscape.

As discussed in chapter 2, refuge lands include a variety of ecosystems including open water, forests, grasslands, and tidal and nontidal wetlands (see map 2.1). Many of the ecosystems (and the habitats they support) have been degraded, damaged, or destroyed as a result of the numerous impacts previously discussed. Despite these alterations, many of these impacted ecosystems have the potential to be restored through various management actions and specific projects. Other areas, including portions of the freshwater tidal marsh, contain healthy and intact plant communities. Some ecosystems support plant communities or species of concern.

We evaluated the following benefits to vegetation as a result of potential management actions under each of the alternatives:

- Conserving and protecting refuge lands to limit the growth of development, 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 habitat for species of special concern
- Conversion or restoration of certain areas of the refuge to more productive or unique wetlands and coastal plain shrub-scrub habitat
- Maintaining wildlife habitat and supporting wildlife in the impoundment by actively controlling water levels, and restoring a portion of the impoundment or the entire impoundment to freshwater tidal marsh
- 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

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

- Direct or indirect actions causing soil, hydrology, and water quality impacts that could adversely impact vegetation, and habitat productivity and integrity.

- Managing and restoring tidal marsh and improving riparian forests and coastal plain forests
- Invasive plant control
- 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
- Constructing, updating, expanding, and managing public use facilities and administrative offices
- Increasing visitation and expanding the six priority uses
- Planning for larger-scale public access projects such as construction of a pedestrian access at Route 420, construction of noise barrier(s), and consideration of more intensive public access such as guided tours in the marsh

4.7.1 Impacts on Vegetation That Would Not Vary by Alternative

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

Benefits

Under all of these alternatives, we would continue to pursue land protection as described in the refuge's establishing documents, which would benefit all habitat types on the refuge. As discussed previously, we would also continue restoration of 55 acres of phragmites dominated tidal marsh and would continue to support the remediation and restoration of the Folcroft Landfill.¹ By restoring the natural vegetation and hydrology, we encourage the natural physical, chemical, biological weathering, and other ecological processes that support the establishment and persistence of native vegetation. Overall, the protection, maintenance, and restoration of habitats are expected to benefit vegetation.

Protecting and Managing Habitats

Under all alternatives, the refuge would continue to protect existing wetlands. Restoration of freshwater tidal marsh proposed under all alternatives would generally result in improved biodiversity and habitat for rare plant species known to occur at the refuge. Restoration projects involving earthmoving and grading would consider climate change, natural landform, and transitional zones with project designs in order to replicate transitional vegetation and plant communities.

Under all alternatives we would continue to employ our Early Detection and Rapid Response monitoring in conjunction with other conservation partners, to prevent establishment of any known invasive aquatic plants.

Our invasive species control efforts would continue under all alternatives. These efforts are expected to result in a net benefit to native vegetation across the freshwater tidal marsh. These efforts include annual aerial herbicide application on 10 to 15 acres of phragmites within the existing freshwater tidal marsh.

¹ We will complete compliance with the National Environmental Policy Act for these projects separately.

Invasive species control of nontidal wetlands, including areas of wet meadows, would continue to focus on phragmites, as well as purple loosestrife. These treatments typically utilize spot foliar treatment of individual plants and populations to minimize unintended damage to nearby native vegetation.

Under all alternatives, the refuge would continue to protect areas of coastal plain 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. These efforts include annual foliar herbicide application on garlic mustard and other targeted invasive plant species. These treatments help control existing populations by minimizing the spread and reproduction of these species throughout the refuge.

Grassland habitats would benefit by continuing a transition from cool season to warm season grasses through regular herbicide applications and supplemental planting and seeding. This transition results in improved species diversity and habitat structure beneficial to wildlife.

Under all alternatives, the refuge would continue to protect areas of open water habitats and associated vegetation. No major management is proposed for Darby Creek itself. While Darby Creek is outside the jurisdiction of the Service, the refuge would continue to protect existing lands adjacent to the creek that influence aquatic vegetation in and along Darby Creek.

Offering Public Use

Public use can benefit vegetation through our education and interpretive actions proposed under all alternatives. By educating visitors on the importance and identification of vegetation, 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.

Adverse Impacts

As first discussed in section 4.4.1 *Impacts on Soils That Would Not Vary by Alternative*, we would continue to use Service-approved herbicides and pesticides to treat and control invasive plants and mosquitoes. By only applying approved herbicides and pesticides, using proper application procedures, and following best management practices, we anticipate only negligible adverse impacts to native vegetation on the refuge.

Protecting and Managing Habitats

Aerial spraying would continue to be used to control 10 to 15 acres of phragmites-dominated wetlands annually. There is minimal risk that the herbicides used could adversely impact nontarget, native plant species. Although some of the herbicides used on the refuge are highly selective, some could also affect nontarget plant species. We make every effort to minimize off-target application of herbicides and have successfully completed annual applications in previous years with minimal impacts to nontarget species and areas. We would continue to use proper application techniques and rates to minimize the potential to damage nontarget plant species.

Managing and restoring of forest communities are consistent with the refuge goals and are common to all of the alternatives in different degrees. Of these two activities, restoring forest communities and freshwater tidal wetlands would affect vegetation the most. 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, we would promote re-vegetation

of restored areas with native species typical of the target plant communities identified for each project.

Grassland habitats would benefit by continuing a transition from cool season to warm season grasses through regular herbicide applications and supplemental planting and seeding. This transition results in improved species diversity and habitat structure beneficial to wildlife.

Bacillus thuringiensis israelensis and *sphaericus* are not expected to have any adverse impacts to plants, including terrestrial, semi-aquatic, or aquatic species (USEPA 1998, USEPA 1999).

Offering Public Use

Public use can affect vegetation in a variety of ways including directly by trampling and indirectly through soil compaction which can affect root systems. We regularly monitor trails and roads and have not observed any major impact areas resulting from wildlife observation, photography, environmental education, or interpretive uses. 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 uses by 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 and the impacts would be minimized by best management practices.

Unauthorized public use activities have the potential to impact vegetation by trampling. This loss of plant cover can result in increased soil erosion (Hammit 1998). Under all alternatives, we would continue to enforce regulations prohibiting non-authorized use of vehicles (e.g., bicycles or ATVs) to prevent damage to vegetation.

4.7.2 Impacts of Alternative A (Current Management)

Benefits

Benefits from refuge management are similar to those described under *Impacts on Vegetation That Would Not Vary by Alternative*. Other potential benefits of alternative A include:

Protecting and Managing Habitats

Seasonal dewatering of the 145-acre impoundment to support migratory birds or assist in disease prevention efforts exposes much of the impoundment soils to air. This encourages establishment of native annual vegetation on exposed mudflats across the impoundment. The current condition and arrangement of the existing water control structures limits the amount refuge staff can control impoundment water levels.

Adverse Impacts

Protecting and Managing Habitats

The refuge forests would continue to be negatively affected by deer browse, which severely limits the development of quality forest structure including canopy trees, sub-canopy trees, understory shrubs, and a diverse ground cover. Excessive deer browse also greatly reduces the overall diversity of plant species across all habitats. Vegetation surveys conducted in preparation of the deer management plan (D'Angelo 2011) noted prominent browse lines were evident in all forested areas of the refuge. Successful regeneration of tree seedlings was not observed. As an example of this, during the early growing season forest regeneration surveys, only two tree seedlings were recorded. By the late growing season surveys, no tree seedlings were recorded. The two seedlings recorded

during the early growing season had apparently succumbed to browsing by deer and were not found. This indicates that the long-term preservation of nesting habitat, conservation of high-quality habitat, and restoration of degraded forested areas would not be feasible with continued impacts of an over-abundant deer population. The refuge ecosystems would continue to be altered to the extent that they become less favorable habitats for other wildlife.

Offering Public Use

We would continue to maintain approximately 2 miles of foot paths and trails consisting of mowed paths across fields, or paths cut through the woods. Occasional mowing or clearing would occur along these trails as part of ongoing trail maintenance.

Alternative A includes completing construction of an outdoor environmental education pavilion. Use and maintenance of existing trails, wildlife observation areas, parking areas, and other visitor facilities would continue to be maintained to keep effects on vegetation to a minimum. Any introductions of new invasive species or disturbance to existing vegetation would be noted during routine refuge monitoring and corrected as soon as feasible.

4.7.2 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Protecting and Managing Habitats

In addition to the benefits to vegetation described under *Impacts on Vegetation That Would Not Vary by Alternative*, alternative B would create a renewed focus on restoring and expanding freshwater tidal marsh within the refuge. Since protecting and preserving Tinicum Marsh is one of the refuge's original mandated purposes, and it supports the greatest number and diversity of species of conservation concern, we are seeking to focus a large degree of habitat management resources towards invasive species management, freshwater tidal marsh restoration, and monitoring for climate change adaptation. Restoration of additional freshwater tidal marsh would improve and expand the overall acreage of high-quality wetland habitat and the plant communities that comprise them. Marsh habitats also support many of the rare plant species known to occur on the refuge. We anticipate that, over time, restoration of tidal marsh would benefit and support the expansion of rare vegetation at this site.

Conversion of the 15-acre nonnative poplar stand to coastal plain and floodplain forest communities would restore native vegetation and structure to this portion of the refuge's forested habitats. Over the long term, this would help make the coastal plain and floodplain forest complex less fragmented on the refuge. This alternative would also initiate a deer management control program to reduce the size of the resident deer herd to promote natural regeneration of native species and enhance plant diversity and abundance.

Over the next 15 years, we would acquire or restore an additional 18 acres of coastal plain and floodplain forest, and manage the existing 34 acres of coastal plain forest and 261 acres of floodplain forest communities to provide healthy foraging and stopover habitat for migratory bird species and provide breeding habitat for the coastal plain leopard frog by maintaining a canopy dominated by native trees, increasing native understory shrub/sapling cover by 10 percent, and at least a 15 percent reduction in areal coverage of herbaceous, invasive species as compared to levels inventoried in 2005. Controlling the deer population would benefit refuge habitats, particularly forested areas.

Under alternative B, we would develop a long-term management plan for forest habitats to create mixed-age stands of hardwood species identified as primary components of coastal plain and floodplain target communities.

Alternative B would also begin converting some grassland habitat into forested habitat over the life of the plan. This would shift the plant community structure and species composition over this time. However, as outlined in chapter 2 and the refuge's draft Habitat Management Plan (appendix C), forested habitats tend to provide greater benefits to a wide array of conservation priority species. Under this alternative, we would convert 8 acres of cool-season grass meadow located on the southern edge of the refuge near I-95 to coastal plain forest. We would also allow an additional 6 acres of grassland located along the eastern boundary of the refuge to succeed to forest. Much of this area is surrounded by coastal plain or floodplain forest, and this area is dominated by cool-season grasses and invasive species such as phragmites.

Remaining grasslands would be enhanced to improve vegetative structure and species composition in order to more closely resemble the small grassland patches historically present in the Philadelphia area. Other grasslands within the refuge are within utility right-of-way corridors (some of which are not owned by the Service) that limit the potential options for habitat management.

Offering Public Use

In addition to the benefits to vegetation described under *Impacts on Vegetation That Would Not Vary by Alternative*, we would also utilize partnerships with local universities and regional researchers to define a baseline monitoring plan that continues monitoring of variables related to climate change impacts within the existing marsh, including vegetation trends. We would use this data to inform and improve long-term habitat management within the marsh.

Adverse Impacts

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

Protecting and Managing Habitats

Up to approximately 73 acres of open water habitat would be lost when restoration of the impoundment is completed. There would be negative effects on vegetation associated with construction staging areas, construction of the new dike, and tidal marsh restoration area. 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.

Phased removal of the 15-acre stand of nonnative poplar would result in the short-term loss of vegetative cover that could potentially increase establishment of nonnative invasive species. By using a phased approach, the refuge seeks to minimize these impacts and would apply best management practices to reduce potential for invasive species introductions and reestablish native vegetative cover where needed.

The refuge is proposing to expand the current refuge headquarters by adding on an office wing to collocate the law enforcement and maintenance programs with the other refuge programs. Although the exact footprint of the proposed facilities has not been finalized, the construction of any of the designs would have similar impacts on vegetation. Some ground disturbance is expected, as limited areas that are currently developed would be excavated. The expansion would also require a relatively small (probably less than half an acre) section of vegetated area adjacent to the current building to be removed to build the foundation of the expansion. This vegetation is already disturbed and overall impacts to vegetation are expected to be minimal.

Offering Public Use

Alternative B proposes construction of additional facilities including: a boardwalk, observation decks, kiosks, fishing access, and other small improvements. 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. One of the observation decks would re-use, if practical, existing concrete pilings to support the observation deck to minimize the impacts to vegetation. However, where needed, new pilings would have to be driven into the soil and disturb vegetation. The construction activity with the most potential disturbance to vegetation, particularly marsh vegetation, would be the construction of boardwalk that would extend 200 to 300 feet into the tidal marsh. Vegetation loss and disturbance would be limited to the placing of pilings in the marsh area and the associated shading of the boardwalk itself. However, the long-term impact of these projects would be minimal less than 0.01 percent of the refuge's current tidal marsh being affected. As with other activities that have the potential to disturb vegetation, the refuge will implement best management practices, including revegetation plans as necessary, to minimize any temporary negative effects on vegetation.

4.7.3 Impacts of Alternative C

Benefits

The benefits of alternative C are similar to alternative B.

Protecting and Managing Habitats

This alternative would result in more acres of freshwater tidal wetland restoration if fully implemented. The majority of this would come from restoring the entire 145-acre impoundment to tidal marsh. In contrast to alternative B, we would delay this restoration until we had at least 10 years of data on effects of climate change, primarily sea level rise, on the refuge and could compare this to updated regional climate change trends. This information would need to be incorporated into a feasibility study and proposed project designs.

Alternative C would convert a 15-acre forested stand dominated by a nonnative poplar to an early successional, shrub-scrub dominated habitat. This would reduce the dominance of the nonnative poplar species that (combined with excessive deer browse) continue to exclude native species regeneration. Over the long term this would establish and maintain a native shrub-dominated vegetative cover. This early successional habitat type is currently not found in high densities at the refuge.

Offering Public Use

Added infrastructure under alternative C would primarily be focused around the Folcroft Landfill. These impacts would only occur once the site is remediated and released. The final site design would likely have some impact on the location, size, and extent of vegetation allowed at the site.

Adverse Impacts

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

Protecting and Managing Habitats

Forest management would continue invasive species control and monitoring the impacts of high deer populations. A deer control program would be initiated, including a controlled hunt program and wildlife control specialists, to reduce the deer herd.

Conversion of a 15-acre forested stand dominated by a nonnative poplar to an early successional, shrub-scrub, dominated habitat would result in a temporary

loss of vegetation across this area, as well as a permanent loss of forest vegetation. However, this loss is relatively small when compared to the remaining forest acreage maintained by the refuge.

Offering Public Use

Compared to alternatives A and B, there would be potential for more people walking off-trail on the refuge increasing, risks of trampling vegetation. Since the refuge would initiate a controlled hunt program, refuge staff would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on vegetation.

As in alternative B, alternative C also anticipates an increase in refuge participation and visitation. However, alternative C would also result in slightly lower numbers of public use visitation when compared to alternative B. Effects of increased visitation under alternative C are expected to be similar to those described under alternative B.

4.8 Federally Listed and Recently Delisted Species

There are no known federally listed species on the refuge at this time. However, the recently delisted bald eagle occurs on the refuge and there is potential habitat on and adjacent to the refuge for the federally endangered shortnose sturgeon. As part of the National Wildlife Refuge System, one of our highest priorities is the conservation and management of federally listed or recently delisted species. State-endangered species (including amphibians, reptiles, birds, and plants) also occur on the refuge, and are addressed under their individual taxonomic sections.

Bald eagle

Although we removed the bald eagle 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. The refuge is identified on a list of bald eagle watching sites in Pennsylvania and the successful breeding pair has drawn wide media attention to the refuge. Bald eagles remain a priority for conservation on the refuge. We would continue to adhere to the management guidelines for bald eagles in Pennsylvania. We evaluated each of the alternatives for its potential to beneficially or adversely affect the habitats where breeding, wintering, and foraging bald eagles concentrate.

Shortnose sturgeon

As mentioned above, there is potential habitat on and adjacent to the refuge for the federally listed, endangered shortnose sturgeon. While this species is not known yet to occur on the refuge, management activities could have minor effects on water quality in the Delaware River where this species is known to occur.

As part of our effects analysis, we evaluated the potential negative and positive effects on both the bald eagle and the shortnose sturgeon. Our actions that would conserve, restore, improve, or increase habitats for these species include the following:

- Improving water quality
- Improving riparian forests and coastal plain forests
- Managing and restoring freshwater tidal marsh
- Controlling invasive species

- Increasing public awareness through environmental interpretation and wildlife-dependent recreation

We also evaluated the potential for the proposed actions to cause adverse effects on habitats of federally listed and recently delisted species including the following:

- Disturbance to listed species from public use
- Impacts on habitat quality from the construction of facilities and other management actions (e.g., habitat restoration and maintenance)
- The potential impacts from the aerial spraying of invasive species, forest improvements, impoundment water level manipulation, or marsh restoration

4.8.1 Impacts on Endangered and Threatened Species That Would Not Vary by Alternative

Benefits

One known breeding pair of eagles occurs on the refuge. This species is not only a species of priority conservation concern, but its presence on the refuge affords valuable opportunities for environmental education and interpretation. Eagles nest in the coastal plain forest and floodplain forest habitats adjacent to open waters. Given that the breeding territory size of eagles ranges between 1,700 to 5,300 acres (Gerrard et al. 1992, Anthony et al. 1993), we do not anticipate any additional nesting pairs of eagles to be found on the refuge.

Under all alternatives, the refuge would continue to restrict access and management activities when and where appropriate near eagle nesting sites and continue monitoring the breeding success of known pairs. Long-term benefits to eagles are anticipated through the ongoing management of coastal plain and floodplain forests and open waters around the refuge. Associated benefits such as increasing native plant diversity, managing for mixed aged stands, promoting water quality, and improving habitat would also benefit nesting, foraging, and resting habitat for this species. 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 bald eagles.

The refuge would continue to coordinate with the Pennsylvania Game Commission and Department of Conservation and Natural Resources, along with our conservation partners, to ensure that we utilize the best available science in our management decisions.

Remediation of Folcroft Landfill, restoration of refuge habitats, continued land acquisition and protection of vegetation and water resources, all benefit water quality on the refuge and to a minimal extent off-refuge. Improved water quality provides minimal benefits to shortnose sturgeon in the Delaware River.

Adverse Impacts

Refuge management actions, public use, and construction projects could have adverse effects on bald eagles using the refuge. We would carefully plan all refuge management actions in or nearby nesting habitat to ensure that we do not inadvertently alter potential nesting site characteristics. While foot traffic from visitors is not likely to impact eagles utilizing the existing nest location, we would continue to employ outreach efforts to trail users to avoid any potential noise disturbance created from trail use.

Construction of new interpretive infrastructure, such as the webcam viewing the existing eagle nest, will follow protocols outlined in the National Bald Eagle

Management Guidelines and Pennsylvania Bald Eagle Management Plan to ensure minimal negative impacts.

Under all three alternatives, public use, refuge management actions, and construction projects could have short-term, localized adverse effects on water quality. As stated previously, we would follow best management practices to minimize potential adverse effects associated with these activities, including best management practices for soil erosion and for preventing spills. Given that the eagle nest is located in a portion of the refuge inaccessible to the public, and without major facilities, we expect the likelihood of impacts to be minimal regardless. Although there may be short-term negative impacts to bald eagle foraging areas, these impacts would be very localized. Because bald eagles tend to have large ranges and are highly mobile foragers (Elliott et al. 2006), we expect these impacts to be minimal. These activities are not expected to have noticeable effects on water quality within the Delaware River; therefore, no adverse effects are expected on shortnose sturgeon.

4.8.2 Impacts of Alternative A (Current Management)

Benefits

Benefits to shortnose sturgeon are the same as those discussed in *Impacts That Would Not Vary by Alternative*.

In addition to the benefits described under *Impacts That Would Not Vary by Alternative*, bald eagles may also be affected by drawdown of the refuge impoundment. Depending on the timing, the drawdown of the impoundment reduces the overall acreage of available open water habitat for eagle foraging. Based on observations (Stolz and Phillips personal communication 2011), this may actually concentrate the fish present in the impoundment and improve foraging efficiency. As a result, the drawdowns are thought to have a net-neutral or slightly beneficial effect.

Adverse Impacts

Adverse impacts to bald eagle populations are similar to those discussed in *Impacts That Would Not Vary by Alternative*, plus the following.

In addition to activities common to all alternatives, alternative A continues the current management practice of manipulating water levels within the 145-acre impoundment in order to provide seasonal migration stopover habitat for various bird groups such as waterfowl, wading waterbirds, and shorebirds. As discussed above, the drawdown of the impoundment may reduce the overall acreage of available open water habitat for eagle foraging. This temporary alteration of habitat is unlikely to result in any major loss of habitat for known eagle populations because areas of freshwater tidal marsh, along with open waters of Darby Creek and the Delaware River, continue to provide suitable amounts of available habitat.

Potential adverse impacts on shortnose sturgeon are described under *Impacts That Would Not Vary by Alternative*.

4.8.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Alternative B would provide long-term benefits to the bald eagle as a result of the restoration of additional coastal plain and floodplain forests. The conversion of the 15-acre nonnative poplar stand to a mix of hardwood species would provide improved rest, roosting, and nesting habitat. The restoration of additional freshwater tidal marsh would also provide additional forage habitat for eagles as well (Andrew and Mosher 1982, Green 1985, Campbell et al. 1990).

The additional nursery habitat for fish species could also benefit shortnose sturgeon populations by contributing to their prey base. This contribution is expected to be negligible.

Adverse Impacts

This alternative would result in a decrease in up to 73 acres in open water habitat associated with the conversion of up to half of the 145-acre impoundment to freshwater tidal marsh. This conversion of habitat types would reduce the available open water acreage near the known nesting site. However, the planned habitat type, freshwater tidal marsh, is another favorable foraging habitat for eagles (Andrew and Mosher 1982, Green 1985, Campbell et al. 1990); as a result, no substantial adverse impacts from restoring portions of the impoundment are expected on this species.

The restoration of the 15-acre nonnative poplar stand to native forest could result in a localized, short-term loss of habitat for bald eagles. We would follow the recommendations in the National Bald Eagle Management Guidelines and the Pennsylvania Bald Eagle Management Plan to ensure minimal negative impacts. We would also complete the restoration in several phases, so that at any one time fewer than 10 acres would be impacted.

Alternative B also anticipates an increase onsite visitation to the refuge from the 133,000 estimated in 2009, to around 196,300 over the next 15 years. Much of this increase is expected in the form of school groups or wildlife-dependent recreational visitors. Eagles typically avoid nest sites with nearby human activity (boat traffic, pedestrians) and buildings or development (Buehler et al. 1991). The current nesting site is over 400 feet from the nearest trail and is inaccessible to visitors, and no new trails would be constructed near the known nesting areas. An increase in general trail use is unlikely to create noise impacts or disturbances of note, especially in relation to the ambient noise and disturbance already present from regional rail line and Bartram Avenue traffic located roughly 700 feet from the nesting site.

Noise from construction activities could potentially carry to eagles and be a disturbance; however, most infrastructure improvements identified under this alternative are located well beyond the landscape buffer distance requirements highlighted in the National Bald Eagle Management Guidelines. We would follow the Service's guidelines to ensure there are no adverse effects to eagles on the refuge including observing season restrictions and landscape buffer zones.

Potential adverse impacts on shortnose sturgeon are described under *Impacts That Would Not Vary by Alternative*.

4.8.4 Impacts of Alternative C

Benefits

Similar to alternative B, alternative C would maintain and restore most habitats utilized by bald eagles on the refuge. The restoration of additional freshwater tidal marsh would provide additional forage habitat for eagles as well (Andrew and Mosher 1982, Green 1985, Campbell et al. 1990).

The additional nursery habitat for fish species could also benefit shortnose sturgeon populations by contributing to their prey base. This contribution is expected to be negligible.

Adverse Impacts

Compared to alternatives A and B, this alternative would result in the most decrease in open water habitat with the restoration of the entire 145-acre impoundment to freshwater tidal marsh. This conversion of habitat types would

reduce the available open water acreage near the known nesting site. However, eagles are known to nest up to 1 mile (1.6 kilometers) from open water (Anthony and Isaacs 1989). Areas of freshwater tidal marsh, along with open waters of Darby Creek and the Delaware River continue to provide suitable amounts of available habitat so any potential adverse impacts are expected to be minimal.

In contrast to alternative B, alternative C would convert the 15-acre nonnative poplar stand to a shrub-scrub habitat type. Shrub-scrub is not a habitat type that provides significant resting, breeding, or foraging habitat for bald eagles. Conversion to a shrub-scrub habitat type would not significantly reduce the amount of forested habitat, but it would reduce the overall acreage of forested habitats near open water or tidal marsh habitat.

Compared to alternatives A and B, there would be more people walking off-trail on the refuge if opened to hunting. Since the hunt would be controlled, refuge staff would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on these species.

As in alternative B, alternative C anticipates an increase in refuge participation and visitation. However, alternative C would also result in slightly lower numbers of public use visitation when compared to alternative B. As noted in the discussion of *Impacts of Alternative B*, minimal adverse impacts on eagle nesting sites are anticipated with this increase in visitation. We would continue to monitor the eagles present on the refuge and make changes in management or access as needed to continue our protection of this species.

As with alternative B, construction activities could have adverse effects on bald eagles. We would continue to adhere to Service guidelines as described under alternative B to ensure there are no adverse effects to bald eagles on the refuge, including observing landscape buffer zones and seasonal restrictions.

4.9 Impacts on Landbirds

The conservation and management of forested and grassland habitats are a priority of the refuge and consistent with its establishment purposes, as well as 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 (e.g., osprey, peregrine falcon, sedge wren, and the short-eared owl), including the following:

- Improving riparian forests and coastal plain forests
- Managing and restoring freshwater tidal marsh
- 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 landbird focal species, including the following:

- The disturbance of listed species from public use
- The impacts on habitat quality from the construction of facilities

- The potential impacts from the aerial spraying of invasive species, forest Improvements, impoundment water level manipulation, or marsh restoration.
- Expanding office facilities
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds.

4.9.1 Impacts on Landbirds That Would Not Vary by Alternative

Benefits

Besides the bald eagle, several other State-listed endangered or threatened landbirds use the refuge including osprey, peregrine falcon, sedge wren, and the short-eared owl. These species primarily use coastal plain and floodplain forests for breeding, foraging, and resting habitats. Habitat use does extend into other habitat types, for example Osprey hunt in open water and riverine habitats. Sedge wrens nest and forage primarily in freshwater tidal marsh and nontidal wetlands. Peregrine falcons also hunt in grassland and wetland habitats.

Several other landbirds that are not State-listed, but identified as regional conservation priorities, are included in this group as well. Species such as American woodcock, marsh wren, prothonotary 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 Pennsylvania's Wildlife Action Plan.

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 coastal plain and floodplain forests and other terrestrial habitats around the refuge. Invasive species management and supplemental plantings help enhance and restore the habitats 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 Pennsylvania Game Commission and Department of Conservation and Natural Resources, along with our conservation partners, to ensure that we use the best available science in our management decisions related to State-listed species.

Adverse Impacts

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 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. For example, invasive species control can be detrimental to landbirds if proper timing and application are not considered. Short-eared owls have been known to nest on the refuge under colonies of mile-a-minute vines within the 15-acre nonnative poplar stand. As a result, our invasive species control efforts for both the nonnative poplar and mile-a-minute are completed outside of the nesting season, generally from mid-March to mid-September in the Northeast (Holt and Melvin 1986; Tate and Melvin 1987, 1988; Combs and Melvin 1989).

We do not expect negative impacts to land birds associated with herbicide or pesticides used on the refuge. All of the herbicides used on the refuge are practically non-toxic to birds (USDOE 2000a, USDOE 2000b, USDOE 2006a,

USDOE 2006b, USEPA 1997). Triclopyr, glyphosate, and imazapic also have no to low potential to bioaccumulate in bird tissues (USDOE 2000a, USDOE 2000b, USDOE 2006a). According to the USEPA (1998), no studies have found *Bacillus thuringiensis israelensis* to be toxic to birds. *Bacillus sphaericus* is not expected to have any adverse impacts to any nontarget species (USEPA 1999).

In general, the presence of humans disturbs most wildlife, which typically results in a temporary displacement without long-term effects on individuals or populations. Disturbance varies by wildlife species involved and the type, level, frequency, duration and the time of year activities occur. Disturbance can cause shifts in habitat use, abandonment of habitat, and increased energy demands on affected wildlife (Knight and Cole 1991). Miller et al. (1998) found bird abundance and nesting activities (including nest success) increased as distance from a recreational trail increased in both grassland and forested habitats. In this study, common species (e.g., American robins) were found near trails and rare species (e.g., Blackburnian warblers) were found farther from trails. In some cases there is a clear link between the extent of disturbance and either the survival or reproductive success of individuals (Schulz and Stock 1993), but in many cases disturbance acts in a more subtle way by reducing access to resources such as food supplies or nesting sites (Gill et al. 1996). Bird flight in response to disturbance can lower reproductive success by exposing individuals and nests to predators. For recreation activities that occur simultaneously (hiking, biking, and horseback riding) there would likely be compounding negative impacts to wildlife (Knight and Cole 1991).

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). The extent of that disturbance along the trail also depends on visibility and the density of vegetation. For songbirds, Gutzwiller et al. (1994) found that low levels of human intrusion altered the singing behavior of some species. Disturbance may also affect the reproductive fitness of males by hampering territory defense, mate selection, and other reproductive functions of vocalizations (Arrese 1987). Disturbance, which leads to reduced singing activity, would make males rely more heavily on physical deterrents, which are time- and energy-consuming in defending territories (Ewald and Carpenter 1978).

As discussed throughout this document, the refuge is located in a highly urban environment, with substantial baseline disturbance associated with the international airport, I-95, several State routes, and numerous houses, businesses, 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.

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 2009). The cumulative negative effects of cats on wildlife are impossible to quantify; however, the growing body of literature 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 do not manage feral cat populations on the refuge. 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.

4.9.2 Impacts of Alternative A (Current Management)

Benefits

Benefits to landbirds are the same as those discussed in *Impacts on Landbirds That Would Not Vary by Alternative*, in addition to the following.

The prothonotary warbler and other landbirds utilize mature deciduous floodplain, riverine, and swamp forests primarily for migratory stopover and foraging habitat at the refuge (DeGraaf et al. 1980, Christman 1984). Under alternative A, we would continue to provide flooded habitats in the floodplain forests, but would not attempt to restore them to higher quality for the prothonotary warblers (Petit and Petit 1996).

As described under section 4.8.3, depending on the timing, the drawdown of the impoundment reduces the overall acreage of available open water habitat for osprey foraging but may actually concentrate the fish present in the impoundment and improve foraging efficiency. For this reason, the drawdowns are thought to have a net-neutral or slightly beneficial effect.

Adverse Impacts

Adverse impacts to landbirds are the same as those discussed in *Impacts on Landbirds That Would Not Vary by Alternative*, in addition to the following.

In addition to activities common to all alternatives, alternative A continues the current management practice of manipulating water levels within the 145-acre impoundment primarily to provide seasonal migration stopover habitat for various bird groups such as waterfowl, wading waterbirds, and shorebirds. While the drawdown of the impoundment may reduce the overall acreage of available open water habitat for osprey foraging, this temporary alteration of habitat does not result in any major loss of habitat for osprey. Area of freshwater tidal marsh, along with open waters of Darby Creek and the Delaware River continue to provide suitable amounts of open water habitat.

4.9.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Compared to alternative A, alternative B would provide additional long-term benefits to landbirds through the protection and restoration of additional coastal plain and floodplain forests, freshwater tidal marsh, and grassland enhancements. The conversion of the 15-acre nonnative poplar stand to a mix of hardwood species would provide improved habitat structure and species composition needed for various warblers and other forest birds like the short-eared owl, peregrine falcon, and wood thrush. Phased removal and reforestation of this area would help minimize short-term impacts or habitat loss. The restoration of additional freshwater tidal marsh would improve nesting habitat for landbirds such as the sedge wren or marsh wren, while also improving forage habitat for short-eared owls and peregrine falcons (AOU 1983).

We would also maintain and improve the larger patches of grassland to provide the most benefit to species that use this habitat. 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 and potentially nesting.

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 Impacts

Restoration of freshwater tidal marsh, forests, and grasslands under alternative B would likely result in short-term and infrequent disturbances to landbirds during the construction and maintenance of these areas. We would continue to monitor known nest locations and adjust our management to minimize impacts on landbirds.

Restoration of the 15-acre nonnative poplar forest would result in the short-term loss of nesting habitat for the short-eared owl. This species currently nests under canopy cover created by the nonnative, invasive mile-a-minute vine found throughout this portion of the refuge. Phased clearing of the 15-acre area would reduce the impact on long-term disturbance to nesting sites. The short-eared owl builds temporary nest sites and tends to be a habitat generalist in terms of selecting nest locations. As a result, we anticipate that the conversion to coastal plain or floodplain forest in this area would result in a net-neutral benefit for the short-eared owl.

Alternative B anticipates an increase in refuge participation and visitation, from the 133,000 estimated in 2009, to around 196,300 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, use of existing trails poses minimal potential impact to nesting landbirds. Most current visitation occurs on the trails surrounding the impoundment and forests located east of the impoundment (Stolz personal communication 2010). This overall trend in where visitation occurs is likely to remain the same, although there is potential that additional visitation could be made available at the Folcroft Landfill site upon its closure and release. The potential for public access in light of site remediation and long-term maintenance has yet to be determined at the time of this writing. Opportunities for additional access would need to be evaluated in the future.

We would take all necessary measures to mitigate those potential adverse effects, particularly where group educational activities are involved. We would minimize potential adverse effects by spreading visitation out over time and, if possible and beneficial, space. Under this alternative we would pursue additional school groups to visit the refuge during slower seasons (i.e., fall and winter). We would also pursue opening additional trails and visitor facilities, such as overlooks, on the Folcroft Landfill site after site remediation is completed and the area has been cleared for public use. 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, or curtail or discontinue them.

Added public use infrastructure proposed under alternative B, such as boardwalks and kiosks, would not be constructed near known nesting areas. Construction timing would also be considered where necessary to avoid potential disturbance to nesting species, 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. Construction of some of these infrastructure improvements would result in a minor loss of grasslands. However, effects on grassland dependent species are expected to be minimal since habitat patches are generally small (less than 10 acres) and no nesting is known to occur in these areas.

Expansion of office facilities proposed under alternative B would have a minimal short-term adverse impact on landbirds utilizing the floodplain forests or

grasslands around the visitor center. The majority of the building expansion footprint would be contained within an area already covered by asphalt pavement. A small portion of edge woodland (less than 0.1 acres) along the refuge border near Lindbergh Boulevard would likely be lost as a result of construction. No State-listed species or species of conservation concern are known to nest within, or adjacent to, the proposed construction footprint. As a result, no significant, long-term impacts are expected as a result of the office facility construction.

4.9.4 Impacts of Alternative C

Benefits

Alternative C differs slightly from alternative B in benefits to landbirds. This alternative would restore the 15-acre nonnative poplar stand to a shrub-scrub community. This habitat type is currently under-represented across the refuge and region. Its conversion on the refuge would benefit various warbler species and other songbirds that benefit from dense shrub cover. Restoration of the entire 145-acre impoundment to freshwater tidal marsh would provide increased benefits (compared to alternative B) by providing additional nesting habitat for landbirds such as the sedge wren or marsh wren, while also increasing foraging habitat for many land bird species including short-eared owls and peregrine falcons (AOU 1983).

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 Impacts

Adverse impacts to landbirds are similar to those discussed in alternative B. In contrast to alternative B, alternative C would result in less acreage of forested habitat (26 fewer acres) and grasslands (6 fewer acres). The acres lost from these habitats would coincide with an equal increase in shrub-scrub habitat.

This conversion of habitat types would provide habitat for some landbirds, but not specifically for those identified as State-listed species or focal species of conservation concern such as prothonotary warbler, short-eared owl, or osprey (Holt and Melvin 1986, Stasz 1996, AOU 1983). Despite this, the acreage targeted for conversion is relatively small (approximately 8 percent) in total land cover in comparison to other upland forest and grassland habitats.

Short-eared owls nesting in the nonnative poplar forest (as described under alternative B) would experience greater displacement in nesting opportunities under alternative C due to the single large-scale clearing of the entire 15-acre area. We would time the restoration to avoid the nesting season for this species. In addition, as described under alternative B, this species is a nesting generalist and is likely to find suitable nesting habitat elsewhere throughout the refuge. As a result, we anticipate a minimal negative impact on this species over the short term until individuals identify new nesting sites.

As in alternative B, alternative C also anticipates a similar increase in refuge participation and visitation, although alternative C would also result 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. Compared to alternatives A and B, there would be more people walking off-trail on the refuge if opened to hunting, increasing potential for disturbance. Since the hunt would be controlled, refuge staff would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on these species.

4.10 Impacts on Open Water and Wetland Bird Species

The conservation and management of open water and wetland habitats are a priority of the refuge. Their management is consistent with the refuge's purposes and our CCP goals. We evaluated the management actions each of the alternatives proposes for their potential to benefit or adversely affect open waters and wetland habitats and their associated focal species.

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of waterbird focal species (e.g., American bittern, great egret, king rail, and least bittern), including the following:

- Managing and restoring freshwater tidal marsh
- 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 waterbird focal species, including the following:

- The disturbance of species from public use
- The impacts on habitat quality from the construction of facilities
- The potential impacts from the aerial spraying of invasive species, forest improvements, impoundment water level manipulation, or marsh restoration
- Expanding office facilities
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds

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

Benefits

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. Long term benefits to waterbirds are anticipated through the ongoing management of existing freshwater tidal marsh and the impoundment, primarily in the control and reduction of purple loosestrife and phragmites. Management efforts to control purple loosestrife and phragmites can provide long-term habitat benefits to some wetland bird species (Gibbs and Melvin 1992, Hammerson and Mehlman 1995).

The refuge would continue to coordinate with Pennsylvania Game Commission and Department of Conservation and Natural Resources, along with our conservation partners, to ensure that we utilize the best available science in our management decisions related to State-listed species.

Waterfowl and shorebirds that are not State-listed, but still of regional conservation priority, would continue to utilize freshwater tidal marsh, open waters and associated mudflats along Darby Creek. Restoration of the 55-acre phragmites-dominated wetland to freshwater tidal marsh would add beneficial habitat for many open water and wetland bird species.

Adverse Impacts

Some wetland birds may be present during aerial applications of herbicides for phragmites control and may experience direct contact with herbicides if they do not flush ahead of the helicopter flyover, or if spray misses the targeted

application patch. We do not expect this as a frequent occurrence, as those species (such as American bittern) show no strong affiliation with dense stands of phragmites (Gibbs and Melvin 1992, Hammerson and Mehlman 1995). If waterbirds do come in direct contact with herbicides, as mentioned in section 4.9.1, all of the herbicides used on the refuge are practically non-toxic to birds (USDOE 2000a, USDOE 2000b, USDOE 2006a, USDOE 2006b, USEPA 1997). Also as mentioned above, neither of the pesticides used on the refuge are expected to adversely impact birds (USEPA 1998, USEPA 1999).

Bennett and Zuelke (1999) summarize several studies indicating that recreation activities 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). 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 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, or curtail or discontinue them.

Public users of the areas along Darby Creek, the 145-acre impoundment, and tidal marsh could damage marsh grasses or disturb nesting or foraging marsh birds or otherwise degrade these areas. This can occur through the 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.

Boaters that access the refuge from Darby Creek could disturb species using these habitats. The refuge does not own or control access for most of Darby Creek. We do post speed limits for motorized boats within refuge waters to minimize disturbance to wildlife and habitats. Erosion problems caused by power boats are addressed by the creation of no wake zones and State boating regulations.

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 and roads. Overall, the effects from public use are expected to have minimal adverse effects on birds utilizing open water and wetland habitats. There are few visitor facilities (e.g., trails) in these habitats due to the presence of open water and saturated soils; therefore, they are relatively inaccessible to the public. The size and dense vegetation supported by freshwater tidal marsh and portions of open water should provide adequate buffers to protect wetland bird species like American bittern against human disturbance (Gibbs and Melvin 1992). Boaters that access the refuge from Darby Creek could disturb species using these habitats. The refuge does not own or control access for most of Darby Creek. We do post speed limits for motorized boats within refuge waters to minimize disturbance to wildlife and habitats.

4.10.2 Impacts of Alternative A (Current Management)

Benefits

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

In addition to activities common to all alternatives, alternative A continues the current management practice of manipulating water levels within the 145-acre impoundment in order to provide seasonal migration stopover habitat for

various bird groups such as waterfowl, wading waterbirds, and shorebirds. As discussed in chapter 3, alternative A, and documented by a regional study of refuge impoundment management (Green et al. 2008) the proper management of impoundment water levels creates beneficial stopover habitat for waterfowl, wading waterbirds, and shorebirds. Areas of freshwater tidal marsh, along with open waters of Darby Creek and the Delaware River would also continue to provide available nesting, foraging, and stopover habitat for water birds.

Adverse Impacts

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

4.10.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Alternative B would provide long-term expansion of open water and wetland habitats through the restoration of additional freshwater tidal marsh. The restoration of large freshwater tidal marsh areas would increase nesting, foraging, and migratory stopover habitat for waterfowl, shorebirds, and wetland wading birds (AOU 1983, Brown and Dinsmore 1986, Frazer et al. 1990, Gibbs and Melvin 1990).

Restoration of up to half of the impoundment would add to the benefits provided by freshwater tidal marsh. More detailed comparison of use of freshwater tidal marsh and the 145-acre impoundment by birds on the refuge would be evaluated further under this alternative to ensure that the most beneficial array of marsh and open water habitat is provided. Constructing a new dike and reconfiguring the impoundment would include installing a new water control structure. This would benefit associated waterbirds by improving our ability to control water levels within the impoundment to better address needs of migrating birds.

Expanded restoration of freshwater tidal marsh, including portions of the 145-acre impoundment, would allow us to improve our education and interpretation about the importance of tidal marsh habitat, habitat restoration, and wildlife conservation. The added level of environmental education and environmental interpretation outlined in alternative B would increase awareness about the importance of open water and freshwater tidal marsh habitat for waterbirds. Understanding the value of its conservation would potentially create long-term benefits for these species and their habitats.

Adverse Impacts

The conversion of up to half of the 145-acre impoundment would result in a loss of nontidal open water habitat from the refuge. However, the adverse effects on wildlife as a result of this would likely be negligible, since most waterfowl, wetland wading birds, and shorebirds readily utilize freshwater tidal marsh and open waters and mudflats which are available elsewhere on the refuge (AOU 1983, Brown and Dinsmore 1986, Frazer et al. 1990, Gibbs and Melvin 1990). Under this alternative, we would retain some of the open water impoundment habitat, limiting potential adverse effects associated with this project.

Construction of this, and other restoration projects proposed under alternative B, would result in short-term disturbances to soils, vegetation, hydrology, and soundscapes of localized portions of habitat used by open water and wetland birds. We would undertake considerations during our construction and its timing to minimize these impacts. We anticipate the long-term benefit of this habitat to exceed any minor, short-term impact on these species' habitat.

Alternative B anticipates an increase in refuge participation and visitation, from the 143,200 estimated in 2010, to around 196,300 over the next 15 years. 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. Most current visitation occurs on the trails surrounding the impoundment and forests located east of the impoundment (Stolz personal communication 2010). This overall trend is where visitation occurs and is likely to remain the same.

Added public use infrastructure proposed under alternative B such as boardwalks and kiosks would not be constructed near known nesting areas. Public viewing areas with regular use near rookeries have documented no impact on species such as egrets (DeMauro 1993). Construction timing 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.

4.10.4 Impacts of Alternative C

Benefits

Compared to alternative B, alternative C varies slightly in its benefits to open water and wetland birds. The restoration of the entire 145-acre impoundment to freshwater tidal marsh would improve foraging and nesting habitat for State-listed wetland wading birds such as the American bittern, least bittern, and king rail (AOU 1983, Brown and Dinsmore 1986, Gibbs and Melvin 1990) as well as waterfowl like the American black duck, lesser scaup, and northern pintail (AOU 1983, AOU 1998, Frazer et al. 1990). Marsh and adjacent intertidal mudflats along Darby Creek and marsh channels would also continue to provide foraging and stopover habitat for migratory shorebirds such as black-bellied plover, greater yellowlegs, and lesser yellowlegs (AOU 1983, Stiles and Skutch 1989).

Similar to alternative B, a more detailed comparison of use of freshwater tidal marsh and the 145-acre impoundment by birds on the refuge would be evaluated further under this alternative to ensure that the most beneficial array of marsh habitat is provided.

Adverse Impacts

Similar to alternative B, alternative C anticipates an increase in refuge visitation. As noted in the discussion of *Impacts of 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.

Compared to alternatives A and B, there would be more people walking off-trail on the refuge if opened to hunting, increasing the potential for disturbance. Since the hunt would be controlled, refuge staff would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on these species.

Alternative C also would develop a secondary method of transportation that would allow visitors to gain access to portions of the freshwater tidal marsh either via a tram, shuttle bus, or boat tour. Detailed plans for this component are not in development at this time. A full evaluation of impacts would be required prior to developing this activity. Depending on the frequency, duration, and method of transportation, providing any of these options could pose disturbance to populations of open water or wetland birds on the refuge. We would continue to only pursue a transportation option that minimizes the impact on wildlife and the habitats they utilize.

4.11 Impacts on Fisheries

The nearby Delaware River holds a unique distinction as being one of North America's few great rivers without a dam on the main channel, allowing for the continued passage of fish and a biologically connected river ecosystem. In past years, however, the fisheries in and around Philadelphia have been degraded by human influences. Channelization and damming of headwater streams, modification to the original river channels through dredging, deepening, and filling, increased sediment loads, alteration to flow rates and patterns, and the removal of tidal marsh habitat have combined to put the future of this resource in jeopardy. Contaminants from adjacent landfills have also been documented as negatively impacting the health of some fish on the refuge (Pinkney et al. 2004). One of the largest remaining migrations of anadromous fish along the east coast of the United States passes almost unnoticed along the shoreline of Philadelphia every year. Every spring, generally from April to June, tens of thousands of shad, herring, and alewife migrate from the Atlantic Ocean up the Delaware River to spawning grounds in the vast network of headwater tributaries (PNHP 2008). The Delaware River is also home to the federally listed, endangered shortnose sturgeon. Individuals from the Delaware River population spawn in the freshwater section of the Delaware River from mid-winter to early spring and spend the summer near the mouth of Delaware Bay (Hastings and O'Herron 1987 et al., NMFS 1998). Because this species prefers larger rivers (Dadswell et al. 1984) sturgeon are not expected to occur in waters passing through the refuge.

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 along Darby Creek. 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 across the refuge. The largemouth bass and sunfish populations in refuge waters appear to supply quality recreational angling opportunities as does Hoy's Pond. Some fish are nearly 16 inches (400 mm) in total length (Sweka and Mohler 2010).

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 benefits of our actions that would conserve, restore, improve, or increase habitats of fish species likely to utilize refuge habitats, including the following:

- Managing and restoring coastal plain and floodplain forests, the 145-acre impoundment, grasslands, open waters, and freshwater tidal marsh
- 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 fish, including the following:

- The disturbance of species from public use
- The impacts on habitat quality from the construction of facilities
- The potential impacts from the aerial spraying of invasive species, forest improvements, impoundment water level manipulation, or marsh restoration
- Expanding office facilities
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds

4.11.1 Impacts on Fisheries That Would Not Vary by Alternative

Benefits

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. Controlling phragmites throughout freshwater tidal marsh habitats has an indirect benefit for fish. The build-up of leaf litter from phragmites raises marsh elevations, which in turn affects the hydrologic regime that creates the little shaded rivulets and pools that fish need for nurseries and foraging. Over time, these nursery areas would likely disappear without phragmites control.

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.

Protection and conservation of tidal portions of Darby Creek, in combination with freshwater tidal marsh, provides a unique and productive habitat for many fish species. Some estuarine species, such as killifishes and mummichogs (*Fundulus spp.*), complete their entire life cycle in estuarine portions of rivers, creeks, and tidal marshes. Anadromous fish, such as the blueback herring and alewife, use tidal streams and rivers like Darby Creek and its side channels as nursery habitat for juveniles (Odum et. al. 1984). American eel, the only catadromous fish species in Atlantic Coast estuaries, spends most of its adult life in freshwater estuaries and are common in tidal creeks, rivers, and marsh channels (Lippson et al. 1979). Thus, improving water quality and restoring suitable channel morphology where possible is critical to maintaining healthy biological integrity, diversity, and environmental health (BIDEH) parameters that support these and other fish species.

The restoration of the 55-acre freshwater tidal marsh project would likely include the development of shallow, sinuous, marsh surface channels that support spawning and nursery habitat for estuarine and freshwater fish species. This would increase and improve foraging and nursery habitat for fish species using the refuge's waters.

We would continue to work with EPA to complete the eventual remediation and closure of Folcroft Landfill. This effort is expected to reduce long-term contaminant levels within Darby Creek, and at least marginally in the Delaware River, and as a result would increase the health of aquatic resources utilizing the refuge.

We would also continue to work with neighboring entities (such as Philadelphia International Airport and Tinicum Township) to complete conservation-related projects that would restore biological connections and suitable habitat for fish species of Federal, State, or regional conservation priority.

Several dam removal and other fish barrier removal efforts along Darby Creek have been implemented in the past few years supporting the National Fish Habitat Action Plan (NFHAP 2008) Strategy 3. While these efforts are mainly located beyond the boundaries of John Heinz NWR, Strategy 3 can be supported at the refuge by freshwater tidal marsh restoration efforts that incorporate the development of shallow, sinuous, marsh surface channels that support spawning and nursery habitat for estuarine and freshwater fish species.

The refuge would also continue to coordinate with Pennsylvania Fish and Boat Commission, along with our conservation partners, to ensure that we utilize the best available science in our management decisions related to State-listed species.

Adverse Impacts

The restoration of the 55-acre freshwater tidal marsh project could cause localized temporary impacts to fishery resources due to soil disturbance and sedimentation. We would take precautions necessary to minimize the impacts associated with a large-scale wetland restoration. Detailed information on how this would be addressed would be developed during the restoration plan development.

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 along Darby Creek and other areas of the refuge. By providing fishing opportunities, we do pose impacts to individual fish. However, 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 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.

Environmental contaminants have a major impact on the health and fitness of fish present on the refuge. The Folcroft Landfill, which became part of the refuge in 1980, is part of the Lower Darby Creek Area Superfund Site. The Lower Darby Creek Area includes four other sites within a 2-mile stretch along Darby Creek (NOAA 2000). Of the five sites, only Folcroft Landfill is located on the refuge. In all alternatives, the refuge would continue to provide technical support and continue to coordinate with the EPA regarding studies, monitoring, and contaminant remediation that is ongoing, and final closure design and implementation.

Other sources of environmental contamination can be created by stormwater runoff from surrounding lands and the watershed. Our use of herbicides

in invasive species control could also potentially cause small localized and temporary contamination in the event of an unintentional spill or misapplication. Triclopyr is highly toxic to freshwater fish, but has little potential to bioaccumulate (USDOE 2000a). Since we use triclopyr to treat upland invasive species on the refuge and it has a low potential to leach into groundwater and a moderate potential for surface water runoff (USDOE 2000a), we do not anticipate any adverse impacts to refuge fish. Imazapic is slightly toxic to freshwater fish, but has a low potential to bioaccumulate in fish tissue (USDOE 2006a). Since we use imazapic to treat upland invasive species on the refuge, we do not anticipate any adverse impacts to refuge fish. Glyphosate formulations labeled for terrestrial uses are moderately toxic to freshwater fish and have little to no potential to bioaccumulate (USDOE 2000b). Formulations labeled for aquatic and terrestrial uses are practically non-toxic to freshwater fish, and also have little to no potential to bioaccumulate (USDOE 2000b). Both imazamox and aminopyralid are practically non-toxic to fish and aminopyralid is not expected to bioaccumulate in fish tissue (USEPA 1997, USDOE 2006b). *Bacillus thuringiensis israelensis* and *Bacillus sphaericus* are also not expected to have any adverse impacts to fish species (USEPA 1998, USEPA 1999). By continuing to only apply approved herbicides and pesticides, use proper application procedures, and follow best management practices, we anticipate little to no adverse impacts to fish on the refuge.

4.11.2 Impacts of Alternative A (Current Management)

Benefits

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

Adverse Impacts

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

4.11.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

In addition to benefits discussed in *Impacts That Would Not Vary by Alternative*, alternative B would provide long-term expansion of wetland habitats through the restoration of additional freshwater tidal marsh. The restoration of large freshwater tidal marsh areas would expand and improve nursery, cover, and forage habitat for fish species of conservation concern (PNHP 2008).

This alternative would also include several stormwater improvement projects (such as vegetated swales and rain gardens) with the intention of reducing the impact of stormwater runoff generated by the refuge. While this would be a negligible improvement to stormwater inputs into Darby Creek, it would reduce the refuge's specific inputs and provide a demonstration for our neighboring partners and municipalities to utilize and replicate elsewhere throughout the watershed.

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

Adverse Impacts

Impacts to fisheries are similar to those discussed in *Impacts That Would Not Vary by Alternative*.

Alternative B also anticipates an increase in refuge visitation, from the 133,000 estimated in 2009, to around 196,300 over the next 15 years. 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. In 2009, the refuge estimated roughly 4,950 angler visits to the refuge. A corresponding increase in angling along with general visitation would result in an increase of up to around 6,600 angling visits per year over the life of the CCP. 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.

The expansion of office facilities proposed under alternative B would not impact any open waters. The majority of the building expansion footprint would be contained within an area already covered by asphalt pavement or a small portion of edge woodland (less than 0.1 acres) along the refuge border near Lindbergh Boulevard. Stormwater runoff generated from this construction would be relatively small and likely discharged to a combination of rain barrels and the stormwater treatment wetland already in place near the visitor center.

Added public use infrastructure proposed under alternative B such as boardwalks and kiosks would result in a negligible decrease in the amount of available open water, mostly associated with the placement of pilings to support the board walk. These facilities are not expected to generate any significant additions to stormwater discharge and therefore be of minimal impact to fisheries.

Construction of visitor services facilities and habitat restoration projects could result in short-term, localized soil disturbance, which has potential to increase sedimentation to Darby Creek and other waters on the refuge. 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.

4.11.4 Impacts of Alternative C

Benefits

Benefits to fisheries are similar to those discussed in *Impacts of Alternative B*. Restoration of the entire impoundment would provide additional nursery, cover, and forage habitat for fish species of conservation concern (PNHP 2008).

Adverse Impacts

Adverse impacts to fisheries are similar to those discussed in *Impacts of Alternative B*.

One difference when compared to alternative B is that the refuge would hold off on future tidal marsh restoration, which would delay short-term negative effects associated with restoration efforts but would also delay benefits to fish species utilizing this habitat type for nursery areas or cover.

Similar to alternative B, alternative C anticipates an increase in refuge participation and visitation, although alternative C would also result in 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. Development of a transportation system is not likely to cause any major impacts to fisheries populations. However, a boat tour route would need to consider impacts related to access and travel along Darby Creek or its side channels to avoid disturbance. Because hunters and wildlife control specialists would not hunt in open waters, there would be no adverse effects on fish species.

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

4.12 Impacts on Mammals

Mammals in southeast Pennsylvania occupy a diverse array of habitat types, food webs, and play an important role in the ecosystems within the refuge boundary. As a taxonomic group, mammals would benefit from the refuge land protection and management of coastal plain and floodplain forests, grasslands, shrub-scrub, open waters, and wetlands. Likewise, refuge habitats would benefit from careful attention to the impacts on mammals resulting from any of its activities.

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

There are no State-listed mammals known to exist on the refuge. No bat species of conservation concern are known to utilize the refuge. The marsh rice rat, considered to be extirpated from Pennsylvania, utilizes freshwater tidal marshes similar to those found on the refuge (PNHP 2008, Kruczek 2004). To date, no inventories have been conducted to assess potential presence or absence of this species on the refuge. River otters have been found in the rivers adjacent to the refuge (PNHP 2008). The open waters of Darby Creek throughout the refuge provide suitable habitat for otter. The refuge is listed as an area important to the conservation and protection of Pennsylvania's mammal populations under the Important Mammal Area (IMA) program, developed by the Pennsylvania Biological Survey. The area is noted as supporting northern river otter use on occasion and being the last potential location for the marsh rice rat in the Commonwealth (PNHP 2008).

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of mammal species likely to utilize refuge habitats:

- Managing and restoring freshwater tidal marsh
- Controlling invasive species
- Establishing a white-tailed deer control program
- 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 mammals:

- The disturbance of species from public use
- The impacts on habitat quality from the construction of facilities

- The potential impacts from the aerial spraying of invasive species, forest improvements, impoundment water level manipulation, or marsh restoration
- Expanding office facilities
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds

4.12.1 Impacts on Mammals That Would Not Vary by Alternative

Benefits

The programs that hold potential for impacts on mammals, and that would continue regardless of the alternative we select, are our strategies for habitat improvement measures and controlling invasive or nuisance species. Each of those 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 to be completed in a manner that would minimize potential impacts to individual species.

The refuge would continue to coordinate with Pennsylvania Game Commission and Department of Conservation and Natural Resources, along with our conservation partners, to ensure that we utilize the best available science in our management decisions related to State-listed species.

Adverse Impacts

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 the control of invasive species. While there are no anticipated adverse impacts associated with the herbicides and pesticides themselves (USDOE 2000a, USDOE 2000b, USDOE 2006a, USDOE 2006b, USEPA 1997, USEPA 1998, USEPA 1999), the temporary loss of habitat on a very small scale may occur where invasive species control or diversity objectives warrant clearing an entire monoculture stand of a given species. The timing of herbicide applications to be most effective varies depending on the 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 re-grow, 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.

Overall, the effects from public use are not likely to have an impact on mammals. Limiting visitors to existing trails prevents unintended disturbance to terrestrial mammals. Rare mammals potentially present such as the marsh rice rat and the river otter, are adequately buffered from human disturbance by the waters of Darby Creek and expanses of freshwater tidal marsh. 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 help encourage habitat conservation over time at a cost of only negligible impact to refuge resources.

4.12.2 Impacts of Alternative A (Current Management)

Benefits

Benefits to mammals are the same as those discussed in *Impacts That Would Not Vary by Alternative*.

Adverse Impacts

In addition to the impacts to mammals discussed in *Impacts That Would Not Vary by Alternative*, failing to control the deer population would have negative impacts on mammal habitats and potentially mammal populations on the refuge. Habitats for wildlife have diminished considerably over the past few decades as urban and suburban development has expanded throughout southeast Pennsylvania. As a result, the remaining protected lands must support a wide variety of wildlife in a limited area. Competition among wildlife species for space and foraging habitat is intensified. At the refuge, the damage caused by deer to forest regeneration is documented by monitoring plots established by USDA-APHIS (D'Angelo 2011). Monitoring results record the presence of oak and maple saplings within fenced deer exclosures, while similar vegetation outside of the exclosures is continually browsed to the ground. Nonnative, invasive plants, which are often considered less palatable by deer, have become the dominant vegetation types in many areas. These impacts currently affect forest understory and the invertebrates, amphibians, reptiles, birds, and mammals dependent on this vegetation zone. The long-term implications of this indicate that these forested habitats could lose the ability to replace themselves over time if the deer population on the refuge is not controlled.

4.12.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Alternative B would provide long-term expansion of wetland habitats through the restoration of additional freshwater tidal marsh. The restoration of large freshwater tidal marsh areas would improve available habitats to support potentially rare mammals such as the marsh rice rat and river otter (PNHP 2008, Dubec et al. 1990, Kruchek 2004).

Restoration of coastal plain or floodplain forest to the 15-acre area currently dominated by nonnative poplar would improve available native species cover and forage for mammals. Clearing nonnative poplar in phases, such as clearings up to 5 acres in size, over several years would reduce potential impacts to mammals. As discussed in *Impacts That Would Not Vary by Alternative*, management actions may temporarily displace individual species, but no long-term impacts are expected as a result of the forest conversion.

White-tailed deer have become a major source of damage to forest and herbaceous vegetation on the refuge (D'Angelo 2011). The draft deer management plan (D'Angelo 2011) developed for the refuge by USDA-APHIS as well as the extensive report *Managing White-tailed Deer in Forest Habitat from an Ecosystem Perspective: Pennsylvania Case Study* (Latham et al. 2005), detail the ecological impacts of overabundant deer populations on plant biodiversity and other wildlife.

This alternative would initiate a deer management program for the refuge. As we attempt to strengthen the biodiversity and integrity of the forests and wetlands on the refuge, controlling the white-tailed deer population is imperative. Under this alternative, the refuge would utilize wildlife control specialists to effectively reduce the deer population to targeted levels that would allow herbaceous plant and tree regeneration. For urban habitats such as the refuge, deer densities less than 10 deer per square mile are recommended (D'Angelo 2011). Once the desired herd target is achieved, the deer population would be maintained through persistent annual harvest (D'Angelo 2011). This level of reduction would benefit refuge forest and wetland habitats by restoring natural regeneration of

vegetation, reducing the potential spread of Lyme disease, improving the health of remaining resident deer, and enhancing the habitat conditions available for other wildlife.

Adverse Impacts

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

Compared to alternative A, there would be increased off-trail disturbance associated with wildlife control specialists. Refuge staff would establish set times and seasons and would monitor locations and numbers of wildlife control specialists to ensure there are no long-term effects on mammals.

The expansion of office facilities proposed under alternative B would have no adverse impact on mammals utilizing the floodplain forests or grasslands around the visitor center. The majority of the building expansion footprint would be contained within an area already covered by asphalt pavement. A small portion of edge woodland (less than 0.1 acres) along the refuge border near Lindbergh Boulevard would likely be lost as a result of construction. Added public use infrastructure proposed under alternative B such as boardwalks and kiosks would not impact known mammal dens or burrows, and footprints of these structures would be small, with minimal impacts on their habitats. Most kiosks would be located in areas already disturbed (e.g., existing parking areas and along existing trails). Any potential impact anticipated from proposed construction projects would be minimal and unlikely in occurrence.

4.12.4 Impacts of Alternative C

Benefits

Benefits to mammals are similar to those discussed in *Impacts of Alternative B*.

One difference when compared to alternative B is that the refuge would hold off on future tidal marsh restoration, which would delay benefits to rare mammals potentially present, such as the marsh rice rat or the river otter. Also, the conversion of nonnative poplar forests to a shrub-scrub dominated habitat would not have any major shift in mammal populations, but individual species may be displaced over the short term.

Deer management would also be initiated under alternative C, but in contrast to alternative B, the primary method of control would be utilization of a specialized archery hunt program. Controlling the deer population would improve refuge habitats for wildlife including mammals, although we anticipate the benefits under alternative C would occur over a longer time period.

Adverse Impacts

Adverse impacts to mammals are similar to those discussed in *Impacts of Alternative B*.

As in alternative B, alternative C anticipates an increase in refuge visitation, although alternative C would also result slightly lower numbers of public use visitation when compared to alternative B. As noted in the discussion of *Impacts That Would Not Vary by Alternative*, negligible adverse impacts on mammals are anticipated with the expected increase in visitation or development of a transportation system.

Allowing a specialized hunt under alternative C may require a longer time to effectively reduce the deer population to a level consistent with recommendations within the deer management plan. The refuge would employ wildlife control specialists after the managed hunt to control the deer population under this

4.13 Impacts on Amphibians and Reptiles

alternative. Delays in controlling the deer population would result in delays in recruitment of native plants and subsequent improvement in the quality of refuge habitats. This would mean delayed benefits to mammals using the refuges habitats. Compared to alternatives A and B, there would be increased off-trail disturbance associated with the deer hunters and wildlife control specialists. Since the hunt and use of wildlife control specialists would be controlled, refuge staff would establish set times and seasons and would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on mammals.

Amphibians in southeast Pennsylvania occupy a wide range of habitat types. As one of the oldest metropolitan centers in the United States, the Philadelphia area has experienced substantial habitat degradation, destruction, and fragmentation due to the conversion of land to agriculture and then urban and suburban development. Extensive marshes were drained and filled, destroying much of the habitat for a number of species that thrived in the coastal plain, including reptiles and amphibians (PNHP 2008).

As a group, amphibians and reptiles would benefit from the refuge land protection and management of coastal plain and floodplain forests, grasslands, shrub-scrub, open waters, and wetlands. Amphibians and reptiles on the refuge consist largely of relatively common species found across the northeast. Occasionally, the refuge has found southern species utilizing its habitats, species of conservation concern like the diamondback terrapin. The status of some amphibians, such as salamanders, on the refuge is unknown. No individual salamanders have been observed to date, although no formal inventories have been conducted (Stolz and Phillips personal communication 2010).

The refuge does support at least one State-endangered amphibian: the coastal plain leopard frog. The refuge provides important habitat for this species that are identified as a priority for conservation in Philadelphia County (PNHP 2008). The coastal plain leopard frog breeds in still, shallow, permanent or temporary waters. Egg masses may be attached to vegetation or float free in shallow water (Ryan and Winne 2001), and this species is known to breed on the refuge.

The refuge also supports a State-threatened reptile: the red-bellied turtle. These turtles occupy large deep aquatic habitats such as ponds, rivers, and creeks but are known to inhabit terrestrial habitats as well. They prefer soft bottom and abundant aquatic vegetation. Eggs are laid in nests dug in soft soil in open areas usually within 100 yards of water (USFWS 1981). Like the leopard frog, the refuge provides important habitat for this species also identified as a priority for conservation in Philadelphia County (PNHP 2008).

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of amphibians and reptiles likely to utilize refuge habitats, including the following:

- Managing and restoring coastal plain and floodplain forests, the 145-acre impoundment, grasslands, open waters, and freshwater tidal marsh
- 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 amphibians and reptiles, including the following:

- The disturbance of listed species from public use
- The impacts on habitat quality from the construction of facilities
- The potential impacts from the aerial spraying of invasive species, forest improvements, impoundment water level manipulation, or marsh restoration
- Expanding office facilities
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds

4.13.1 Impacts on Amphibians and Reptiles That Would Not Vary by Alternative

Benefits

Under all alternatives, the refuge would continue to restrict access and management activities when and where appropriate near known breeding sites and would continue limited population monitoring for frogs. The refuge would continue to protect and maintain breeding areas known to support both the coastal plain leopard frog and red-bellied turtle. Under all alternatives, the refuge would continue to maintain vernal pool habitat and create new vernal pools where appropriate.

Long-term improvements in water quality, especially related to the reduction of contaminants through the closure and remediation of Folcroft Landfill, would create benefits to environmental health and populations of amphibians and reptiles. Amphibians and reptiles would likely continue to be impacted by environmental contaminants that are not related to refuge activities but are known to occur in waters around the refuge. A study conducted on the refuge between 2000 and 2002 documented that background pollution places a developmental burden on the life history of turtles on the refuge (specifically painted and snapping turtles) and that these effects can be exacerbated by exposure to additional hazards, such as crude oil (Bell 2005). Under all alternatives, we would continue to work together with our environmental partners to remediate and rehabilitate the known Superfund sites within the EPA's Lower Darby Creek Area in order to reduce the effects of contaminants on amphibians and reptiles.

We anticipate long-term benefits to amphibians and reptiles through the ongoing management of existing freshwater tidal marsh and the impoundment, primarily the control and reduction of nonnative species, such as purple loosestrife and phragmites. The abundance of nonnative plant species is often an indicator of decreased environmental health (Maerz et al. 2009) and can negatively impact native reptiles and amphibians by altering the structure and other characteristics (e.g., moisture levels and microclimates) of habitat (Watling et al. 2011). Management efforts to control purple loosestrife and phragmites can provide long-term habitat benefits by reducing dense vegetation cover, allowing native plant species to re-vegetate the area, and restoring native habitat characteristics. The refuge would continue to coordinate with Pennsylvania Fish and Boat Commission and our conservation partners to ensure that we utilize the best available science in our management decisions related to State-listed species.

In addition, restoration of the 55-acre freshwater tidal marsh project would provide expanded habitat for the red-bellied turtle and reduce the extent of aerial herbicide applications as native vegetation becomes reestablished.

We would also continue to work with neighboring entities (such as Philadelphia International Airport and Tinicum Township) to complete conservation-related

projects that would restore habitats suitable for amphibian and reptile species of State or regional conservation priority.

Adverse Impacts

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 applications of herbicides and may experience direct contact with herbicides if they are present during applications, or if spray misses the targeted application patch. There is limited information on the impacts to amphibians and reptiles from the herbicides and pesticides used on the refuge. By only applying approved herbicides and pesticides, using proper application procedures, and following best management practices, we anticipate only negligible adverse impacts to amphibians and reptiles. Other management activities, such as inventory and monitoring programs, would continue to be completed in a manner that would minimize potential impacts.

The restoration the 55-acre freshwater tidal marsh project could result in localized temporary impacts due to soil disturbance and sedimentation to surrounding waters. To the extent practicable, we would avoid construction during reptile and amphibian breeding periods and take efforts to exclude species from the work area during construction. We would take precautions necessary to minimize the impacts associated with a large-scale wetland restoration. Detailed information on how this would be addressed would be developed during the restoration plan development.

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. The refuge restricts trail access to known breeding areas during the breeding seasons. Added infrastructure related to environmental education and interpretation could potentially cause additional disturbance or lead to short-term, isolated stormwater runoff or sedimentation during construction. However, these disturbances, if present, would be infrequent and of negligible impact.

4.13.2 Impacts of Alternative A (Current Management)

Benefits

Benefits to amphibians and reptiles are the same as those discussed in *Impacts on Amphibians and Reptiles That Would Not Vary by Alternative*.

Adverse Impacts

Impacts to amphibians and reptiles are the same as those discussed in *Impacts on Amphibians and Reptiles That Would Not Vary by Alternative*.

Water level management within the 145-acre impoundment would continue to take foraging and overwintering habitat for the red-bellied turtle into account when timing drawdowns.

Similar to the adverse impacts for alternative A discussed for mammals above, overbrowsing of deer would continue to have negative effects on amphibian and reptile habitats, and potentially their populations on the refuge. The greatest impacts appear to be in forested habitats and the species that depend on them.

4.13.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Alternative B would provide additional benefits compared to alternative A through long-term expansion of wetland habitats and the restoration of additional freshwater tidal marsh. The restoration of large freshwater tidal marsh areas, including up to half of the 145-acre impoundment, would improve available habitats to support red-bellied turtles and other amphibians or reptiles of conservation concern (PNHP 2008). Retaining approximately half of the impoundment would protect known basking, foraging, and nesting locations for this species as well.

Restoration of the 15-acre area currently dominated by nonnative poplar to coastal plain or floodplain forest would improve available native species cover for species such as the coastal plain leopard frog. Clearing nonnative poplar in phases, such as clearings up to 5 acres in size, over several years would reduce potential impacts to individuals. Management actions may temporarily displace individuals of these species, but no long-term impacts are expected as a result of the forest restoration.

This alternative would also initiate a 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 Impacts

Impacts to amphibians and reptiles are similar to those discussed in *Impacts on Amphibians and Reptiles That Would Not Vary by Alternative*.

The restoration of additional freshwater tidal marsh would potentially result in short-term, localized temporary impacts due to soil disturbance and sedimentation. To the extent practicable, we would avoid construction during reptile and amphibian breeding periods and take efforts to exclude species from the work area during construction. We would take precautions necessary to minimize the impacts associated with a large-scale wetland restoration during the restoration plan development.

In addition, the expansion of office facilities proposed under alternative B is not expected to have any long-term adverse impact on amphibians and reptiles utilizing the floodplain forests or grasslands around the visitor center. The majority of the building expansion footprint would be contained within an area already covered by asphalt pavement. A small portion of edge woodland (less than 0.1 acres) along the refuge border near Lindbergh Boulevard would likely be lost as a result of construction. No known or potential breeding habitat is found within the proposed footprint.

Added public use infrastructure proposed under alternative B, such as boardwalks and 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 feel that these disturbances, if present, would be infrequent and of negligible impact.

Compared to alternative A, there would be minor increases in off-trail disturbance from wildlife control specialists used to control the deer population. Since the use of wildlife control specialists would be controlled through a special use permit, refuge staff would establish set times, seasons, and locations and

would monitor this program to ensure there are no long-term effects on these species or their habitats.

4.13.4 Impacts of Alternative C

Benefits

Benefits to amphibians and reptiles are similar to those discussed in *Impacts of Alternative B*.

One difference when compared to alternative B is that the refuge would hold off on future tidal marsh restoration, which would delay benefits to rare amphibians and reptiles that utilize this habitat type. Also, the conversion of nonnative poplar forests to a shrub-scrub dominated habitat would not have any major impacts on amphibian and reptile populations, but individual species may be displaced over the short term.

Water level management within the 145-acre impoundment would continue to take foraging and overwintering habitat for the red-bellied turtle into account when timing drawdowns.

Deer management would also be initiated under alternative C, but in contrast to alternative B, we would implement a managed hunt as well as using wildlife control specialists. The long-term benefits to vegetation as it relates to amphibian and reptile populations would still be achieved, but likely over a slightly longer timeframe.

Adverse Impacts

Adverse impacts to amphibians and reptiles are similar to those discussed in *Impacts of Alternative B*.

As in alternative B, alternative C anticipates an increase in refuge participation and visitation, although alternative C would also result in slightly lower numbers of public use visitation when compared to alternative B. As noted in the discussion of *Impacts on Amphibians and Reptiles That Would Not Vary by Alternative*, we anticipate minimal long-term adverse impacts on amphibians and reptiles with an increase in visitation. Development of a transportation system could pose an increased risk of mortality related to increased motorized traffic along refuge access roads. However, we would undertake precautions to minimize potential impacts related to a shuttle bus or tram route to minimize disturbance or individual turtle mortality. This would need to be analyzed further before implementation.

Compared to alternatives A and B, there would be increased off-trail disturbance associated with the deer hunters and wildlife control specialists. Since the hunt and use of wildlife control specialists would be controlled, refuge staff would establish set times and seasons and would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on mammals.

4.14 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; and
- filters of sediment, nutrients, and other contaminants, making conditions better for fish and aquatic life (e.g., mussels).

Judging from the diverse bird community during breeding season, particularly foliage gleaners, forest litter gleaners, and woodpeckers, and by the seed and nut production of the trees, apparently there are enough pollinator and prey base resources to sustain forest life, at least for the forest species now present. Therefore, we must operate on the assumptions that our management would affect invertebrates the least if we conduct it during the dormant season (overwintering pupae and larvae excepted) and that a diversity of plant life begets a healthy diversity of insect life, and vice versa.

No mussel surveys have been conducted on Darby Creek to date. However, recent findings along the nearby Delaware River indicate that invertebrate conservation may be an added focus along Darby Creek. A series of mussel beds was identified in the stretch of river connected to the confluence with Darby Creek. Seven mussel species were identified within the Delaware River, including two species that were thought to be extinct in Pennsylvania and New Jersey: the alewife floater and the tidewater mucket. Other species included two species considered critically imperiled, two species considered vulnerable, and one common species (see chapter 2 for details).

We evaluated the benefits of our actions that would conserve, restore, improve, or increase habitats of invertebrates likely to utilize refuge habitats, including the following:

- Managing and restoring coastal plain and floodplain forests, the 145-acre impoundment, grasslands, open waters, and freshwater tidal marsh
- 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, including the following:

- The disturbance from public use
- The impacts on habitat quality from the construction of facilities
- The potential impacts from the aerial spraying of invasive species, forest improvements, impoundment water level manipulation, or marsh restoration
- Expanding office facilities
- Construction of additional wildlife observation infrastructure such as boardwalks, observation decks, and viewing blinds

4.14.1 Impacts on Invertebrates That Would Not Vary by Alternative

Benefits

Our land protection and management provides a wide array of general habitat types and microhabitats that serve as foraging, breeding, and overwintering habitat for many groups of invertebrates.

Removing invasive species permits native plants to reestablish and expand. That especially benefits the 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 their 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 presume that removing these nonnative plants and planting or allowing native species to regenerate would be beneficial to native invertebrates. Any dependence on those plants is minimal and, therefore, removing them would not result in unacceptable losses in the insect populations.

The restoration of the 55-acre freshwater tidal marsh project would provide expanded vegetation diversity and available invertebrate habitat as native vegetation becomes reestablished. Planting native trees, shrubs, and herbaceous species is another strategy that, over time, would benefit invertebrates by providing a diversity of food sources for which host-specific insects have evolved, as is the case for numerous species of moths and butterflies, and for more generalist species such as native bees.

Adverse Impacts

Maintaining refuge grounds currently involves mowing of roadsides, parking areas, walking paths, and small lawn areas, and spraying glyphosate-based herbicide on the parking lots, trails, around buildings, walkways, signs, and kiosks. 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 the Service approves the herbicides we use in controlling invasive species because of their neutrality on animal life, invertebrates that come into direct contact with an herbicide or its surfactant may experience mortality, reduced fitness, or abnormal development. Triclopyr (BEE) is moderately to highly toxic to aquatic and estuarine invertebrates (USDOE 2000a). It is practically non-toxic to honeybees (USDOE 2000a). Since we use triclopyr to treat upland invasive species on the refuge and it has a low potential to leach into groundwater and a moderate potential for surface water runoff (USDOE 2000a), we anticipate little to no adverse impacts to aquatic invertebrates. Glyphosate and imazapic are both practically non-toxic to honeybees and slightly toxic to freshwater invertebrates (USDOE 2000b, USDOE 2006a). Aminopyralid is practically non-toxic to aquatic invertebrates, while imazamox is practically non-toxic to both aquatic invertebrates and honeybees (USDOE 2006b, USEPA 1997). *Bacillus thuringiensis israelensis* has little to no toxicity in many terrestrial invertebrates. However, it is moderately toxic to some freshwater invertebrates and minimally toxic to honey bees. *Bacillus sphaericus* is not expected to have any adverse impacts to any nontarget species (USEPA 1999). Since we treat limited portions of the refuge each year, overall negative effects on invertebrate populations are expected to be minimal.

It is also possible that some 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.

The restoration the 55-acre freshwater tidal marsh would result in localized impacts to aquatic invertebrates and terrestrial invertebrates in staging areas due to soil disturbance and sedimentation. Without a more detailed restoration plan, it is not possible to fully analyze the impacts of the restoration on invertebrates at this time. We will analyze these impacts in a separate, subsequent NEPA process once we have developed the detailed restoration plan. We will also include precautions and mitigation strategies in the restoration plan to help minimize the impacts associated with a large-scale wetland restoration.

Artificial lighting for the security of existing facilities and administrative buildings, such as the visitor center and maintenance building, is a potential source of adverse impact 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, and some species of moths thrive in well-lit communities or cities. When compounded with other disturbances, such as habitat fragmentation, unnatural lighting may weaken or eliminate local populations (Frank 2002).

A century ago, collectors used to find hundreds of species in large quantities attracted to the early electric lights in big cities. Today, lamps in big cities such as Washington, D.C., Philadelphia, and Boston rank among the worst places to collect moths and reductions have been noted in other locations. Several explanations have been posited: declines in moth populations, dilution of moths among thousands of city light sources, and diffuse background light suppressing flight to light behavior, even genetic shifts in behavior. 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.

4.14.2 Impacts of Alternative A (Current Management)

Benefits

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

Adverse Impacts

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

4.14.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Alternative B would provide long-term expansion of wetland habitats through the restoration of additional freshwater tidal marsh. The restoration of large freshwater tidal marsh areas would improve available habitats for invertebrates of conservation concern, specifically for dragonflies and damselflies (PNHP 2008). Increased knowledge and understanding of invertebrate populations

resulting from U.S. Forest Service inventory would help us better quantify the effects on invertebrate species on the refuge.

Conservation of forested habitats is another recommendation for invertebrate conservation in Philadelphia (PNHP 2008). Restoration of coastal plain or floodplain forest to the 15-acre area currently dominated by nonnative poplar would improve vegetation diversity in this portion of the refuge. We would also be converting some small grasslands to forest habitats under this alternative. As a result, we expect this to provide beneficial habitat for invertebrates utilizing forest vegetation. To this extent, the initiation of a deer control management program across the refuge would also improve available beneficial habitat for invertebrates.

The populations of Lyme disease-bearing ticks, *Ixodes scapularis* (the blacklegged or “deer” tick), are believed to be related to increased densities of the white-tailed deer population and changing habitats on a landscape scale (Stafford 2007). That leads to increased chances of contact with humans. At least from a human disease perspective, reducing an overabundance of deer would likely help suppress the tick population, which would benefit the human population, although not the ticks. To what extent Lyme disease affects other mammals is unknown. The ticks are known to parasitize other reptile, amphibian, and bird species.

Adverse Impacts

Impacts to invertebrates are similar to those discussed in *Impacts That Would Not Vary by Alternative*.

Similar to the adverse impacts from the 55-acre marsh restoration discussed above in *Impacts That Would Not Vary by Alternative*, the restoration of additional freshwater tidal marsh areas and the conversion of a portion of the impoundment would potentially result in localized temporary impacts to soil disturbance, vegetation, and sedimentation. Without a more detailed restoration plan, it is not possible to fully analyze the impacts of the restoration on invertebrates at this time. We would more fully analyze these impacts in a separate, subsequent NEPA process once we have developed a detailed restoration plan. We will also include precautions and mitigation strategies in the restoration plan to help minimize the impacts associated with a large-scale wetland restoration. Overall, we feel that the short-term impacts on habitat disturbance during construction would be negligible by comparison to the long-term benefits created by restoration of the diverse plant communities associated with freshwater tidal marsh.

Although we have yet to conduct a formal forest health inspection for diseases and pests, observations by staff while conducting bird or other surveys have not yet suggested an infestation to the level that would warrant intervention. However, we foresee that we may need to control for forest pests, such as the gypsy moth, in the future. We would consult with forestry experts and the Service authority on pesticide use for recommendations on the least harmful products and methods of averting impacts on non-target species.

In addition, the expansion of office facilities proposed under alternative B would have no long-term adverse impacts on invertebrates utilizing the floodplain forests or grasslands around the visitor center. The majority of the building expansion footprint would be contained within an area already covered by asphalt pavement. A small portion of edge woodland (less than 0.1 acres) along the refuge border near Lindbergh Boulevard would likely be lost as a result of construction.

Added public use infrastructure proposed under alternative B such as boardwalks and kiosks may have short-term, localized impacts to individuals but likely would not impact a large enough area to cause any adverse effects on local invertebrate populations.

4.14.4 Impacts of Alternative C

Benefits

Benefits to invertebrates are similar to those discussed in *Impacts of Alternative B*.

In addition, under this alternative the 15-acre nonnative poplar forest would be converted to scrub-shrub habitat. Over time, the establishment of native shrubs would provide additional habitat and a unique vegetation type for the refuge. Additional research would be needed to determine the net impact of this shift in habitat type over time on invertebrates.

Adverse Impacts

Adverse impacts to invertebrates are similar to those discussed in *Impacts of Alternative B*.

By comparison, one difference in alternative C would be the conversion of the 15-acre nonnative poplar forest that would be targeted to develop into a shrub-scrub early successional habitat. This would be accomplished through a one-time clearing of the entire 15-acre area, which would result in a short-term loss of invertebrate habitat in this area. As discussed under *Impacts of Alternative C, Benefits* above, over time the establishment of native shrubs would provide additional habitat and a unique vegetation type for the refuge. Additional research would be needed to determine the net impact of this shift in habitat type on invertebrates.

Similar to the adverse impacts described in *Impacts on Invertebrates That Would Not Vary by Alternative* and *Impacts of Alternative B*, alternative C would result in localized, temporary impacts to aquatic invertebrates, as well as terrestrial invertebrates in staging areas, due to soil disturbance and sedimentation during the restoration of additional freshwater tidal marsh areas and the conversion of the entire 145-acre impoundment. Without a more detailed restoration plan, it is not possible to fully analyze the impacts of the restoration on invertebrates at this time. We would more fully analyze these impacts in a separate, subsequent NEPA process once we have developed a detailed restoration plan. We would also include precautions and mitigation strategies in the restoration plan to help minimize the impacts associated with a large-scale wetland restoration.

4.15 Impacts on Public Use and Access

Annual refuge visitation is estimated to be 133,000 visits to the refuge in 2009. While no formal survey has been conducted, observations by refuge staff indicate that most visitors to the refuge engage in some form of wildlife-dependent recreation. Environmental interpretation programs and environmental education programs are thought to be the two activities with the most participants (see table 2.4). Over 13,300 people visited the visitor center in 2009. A summary of participants in refuge programs is provided on table 2.4. Being located in a large urban center allows the refuge to host a variety of visitors that include: school groups, homeschoolers, youth groups, family groups, anglers, birders, paddlers, bicyclists, refuge neighbors, surrounding community members, tourists (primary local, but regional, national and international visitor numbers are growing), as well as corporations and businesses.

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

Benefits

The main goals of the visitor services program would continue to be to work 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 Philadelphia, the staff of John Heinz NWR 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.

Under all alternatives, the refuge would continue to allow at least five of the six designated priority public uses. While hunting itself is not supported under all alternatives, we would continue to support hunting as an activity by sponsoring related activities such as hunter-education and archery programs and the Pennsylvania chapter of the Federal Junior Duck Stamp “Conservation through the Arts” program. We would continue to promote the concept of connecting children with nature in all of our compatible public use programming. Our partners, Friends, and other volunteers would continue to help us expand those and other priority public use programs. Leashed dogs would continue to be permitted on designated trails which may encourage public use of the refuge for users beyond anglers, birdwatchers, etc, and may lead to more people (including young families and seniors with pets) gaining an appreciation for the refuge’s resources.

The visitor center would continue to be free to the public and accessible by public and private transportation. 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.

Adverse Impacts

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.

Dogs frequently accompany recreationists to the refuge. Their presence 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). Lenth and Knight (2006) found, in areas that prohibited dogs, mule deer were less active up to 160 feet from recreational trails. In areas that allowed dogs, mule deer showed reduced activity within at least 320 feet of trails. The same study found similar adverse effects for small mammals including squirrels, rabbits, chipmunks, and mice. This means that there is a certain area around recreational trails that becomes unsuitable habitat for certain wildlife species, even though the habitat would otherwise be suitable (Lenth and Knight 2006). 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). In all

alternatives, the refuge permits dogs on leash as long as the activity is restricted to designated access road corridors.

4.15.3 Impacts of Alternative A (Current Management)

Impacts on public use and access would be the same as *Impacts on Public Use and Access That Would Not Vary by Alternative*, in addition to the following.

Benefits

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

No major additions or changes in facilities would occur, except for ongoing upgrades to meet ADA-accessibility requirements, installation of a webcam at the bald eagle nest, and completion of an outdoor pavilion for environmental education. The refuge would continue to allow already approved public uses. These include plant and wildlife research, wildlife observation and photography, environmental education and interpretation, and recreational fishing.

Adverse Impacts

Hunting is, and would continue to be, prohibited on the refuge due to safety concerns and compliance with local regulations. We predict a slight increase in visitor numbers per year on the refuge, and would expect a commensurate increase in demand for refuge programs. However, under alternative A, we would continue to provide the same level of programming as we currently do. This would result in less programming in comparison to that provided under alternatives B and C, and we would likely not meet the increased demand for refuge programs.

Our current environmental education staff would continue to implement existing programs. Volunteers and teachers would continue to directly lead most of the educational programs on refuge. As a result, refuge staff would have less direct interaction with and influence on the education and interpretive content shared by outside volunteers and teachers.

4.15.4 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Under alternative B, we would expand facilities and programs for five of the six priority public uses. We would build upon our existing programs (alternative A) to make upgrades in interpretive infrastructure necessary to improve accessibility and utilize newer technologies to convey our interpretive goals. We would complete our visitor services step-down plan. This would provide details on focused themes and messages for education and interpretation programs, identify and prioritize target audiences, and provide strategies on how to reach out to specific audiences (e.g., bilingual programs and materials, specific events or materials for people with special needs). We would expand upon our existing mix of guided interpretive tools, Service-sponsored events (such as the Cradle of Birding Festival and National Wildlife Refuge Week), and partner-sponsored events to increase annual participation from its current level (13,300 participants in 2009) to up to 26,000 participants within 15 years of plan approval.

Over the life of the plan, we would continue to expand onsite and offsite environmental interpretation opportunities to visitors, students, and area residents. These opportunities would the refuge's natural and cultural resources and its contribution to conserving those resources in the Delaware Estuary

and enhance the infrastructure and facilities necessary to provide a quality interpretive experience.

Under alternative B, we would expand the existing suite of programs we provide to elementary, middle, and high school students from across southeastern Pennsylvania. Added staff and expanded programming would result in more direct contact between Service staff and children, as well as other visitors. Added staff and expanded programming would also improve the overall quality of visitor experience. By expanding partnerships and developing a team of trained volunteers to interact with visitors, we would connect with more visitors and communicate the refuge and Service mission better. Under alternative B, we would use the results of our Stakeholder Needs Assessment to ensure refuge programs are integrated with both environmental education users (e.g., schools) and other area environmental education providers.

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*.

4.15.5 Benefits and Impacts on Public Use and Access of Alternative C

Benefits

Environmental education is one of the original mandated purposes of John Heinz NWR as highlighted in alternative A, objective 3.1. Under alternative C, education would focus on high school, college, and early professional age students. Focusing on older students could potentially result in more on-the-ground research, inventory, and monitoring that could inform long-term refuge management. This focus could improve our refuge-specific knowledge of refuge resources, which would inform future management and decisionmaking.

Under alternative C, we would expand existing opportunities for all six priority public uses at John Heinz NWR, with an emphasis on expanding infrastructure to improve wildlife observation opportunities. Under this alternative, we would offer a controlled hunting program as part of our deer herd reduction efforts. This alternative, when compared to others, offers the only opportunity for public hunting on the refuge.

Environmental interpretation infrastructure would also be expanded under alternative C. Infrastructure components such as trails, boardwalks, viewing platforms, and a shuttle service are considered as more intensive alternatives for encouraging and directing interpretation as compared to alternative B.

Adverse Impacts

In contrast to alternative B, this alternative would focus on providing higher-level education to college-aged and conservation professional development. While this would help train a new group of interested individuals participating directly in the conservation workforce, we would not likely be able to direct as much staff resources into education and interpretation for younger visitors. As such, this alternative would not fulfill the Service's policy on connecting children with nature as well as in alternative B. Alternative C would also result in slightly lower numbers of public use visitation when compared to alternative B.

While we would create a controlled hunting program under alternative C, initiation of this program would likely result in the temporary, short-term closure of portions of the refuge to other uses to ensure public safety. However, we do not anticipate any large-scale or long-term impacts on public access or use as part of alternative C.

4.16 Impacts on Cultural and Historic Resources

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

Benefits

As summarized in chapter 2, our coordination with the Pennsylvania Historical and Museum Commission's Bureau for Historic Preservation and the Service's regional cultural and historic resource liaison identified no known cultural or historic resources within the refuge boundaries. Much of the refuge contains disturbed lands or fill material that was introduced to the site since the 1950s. As a result, no cultural and historic resources have been identified or appear likely on refuge lands and no impacts to these resources are anticipated.

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 and C. 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.

Adverse Impacts

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

4.17 Impacts to the Socioeconomic Environment

Chapter 2, "Affected Environment," discusses the socioeconomic environment of the refuge and its context within the greater Philadelphia area. The refuge management activities of economic concern in the analysis are the following:

- 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
- Effects of refuge management on local townships

As discussed in chapter 2, the economic contribution of the refuge in terms of visitor spending, salaries of refuge personnel, and tax revenues is minor compared to the Philadelphia region as a whole. The total refuge visitor expenditures were estimated at \$1.1 million in FY 2006, while visitors to the greater Philadelphia area generated over \$5.5 billion during the same time period. In 2009, the refuge received over 133,000 visitors and the greater Philadelphia area over 36 million visitors. The salaries of refuge staff generate less than \$800,000 of income and tax revenue, which constitutes less than 0.1 percent of the \$2.6 billion of employment income and \$1.2 billion in taxes generated by tourism in the Greater Philadelphia area in 2009 (Carver and Caudell 2007).

Although the refuge economic contribution is relatively minor, tourism and recreation contribute significantly to the local economy. The majority of the visits (approximately 72 percent) 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 Philadelphia area. With over 200,000 grade school students in the area and 80 degree-granting institutions, the refuge is uniquely situated to provide environmental education and interpretation at the grade school level to a wide audience and encourage research oriented activities at the refuge through partnership with colleges and universities. The Philadelphia area has a long history of conservation and there are several nonprofit organizations that provide environmental education to students and the public in Philadelphia, Delaware, Chester and Montgomery Counties.

4.17.1 Impacts on Socioeconomic Environment That Would Not Vary by Alternative

Of the management activities that would not vary by alternative, the following would benefit or adversely affect the socioeconomic environment of the refuge: protecting land, maintaining facilities, implementing the 55-acre restoration project, supporting research and Friends of Heinz Refuge group activities at the refuge, and implementing existing priority public use opportunities. We discuss the general impacts below and the details of the impacts specific to each alternative in the next section.

Benefits

Implementation of the 55-acre restoration project is common to all alternatives and this may provide a short-term contribution to the local economy in terms of contractor income, expenditures, and purchase of goods and services for restoration activities. It is impossible to predict the impacts to the local economy until the work is awarded.

Ongoing public uses related to wildlife-dependent recreation, environmental education, and interpretation 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, and lodging. We 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 continue to provide monetary assistance to help pay for busing students to and from the refuge for field trips.

We would continue to provide meeting space to conservation organizations and agencies upon request in order to facilitate decisionmaking and coordination related to regional conservation and environmental protection.

Adverse Impacts

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, most of the refuge is marsh and wetlands and is not suitable for development. The Service is currently authorized to protect 1,200 acres in fee title within its existing, approved refuge boundary. By October 2010, the refuge acquired 993 acres in fee title and concerted efforts to acquire additional land within the refuge boundary are not a primary focus of refuge management. Instead the Service would engage in conversations related to donation or purchase of suitable habitat as the opportunities arise.

4.17.2 Impacts on Socioeconomic Environment in Alternative A

Benefits

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. The economic contribution of the refuge was evaluated as part of a nationwide survey and analysis conducted in 2006 (Carver and Caudell 2007). In that year, the refuge recorded 106,491 visits. Ninety-eight percent of visits were for non-consumptive purposes such as hiking, wildlife observation, and photography. The majority of the visits (approximately 72 percent) were by nearby residents.

Total visitor expenditures related to recreation on the refuge was estimated at about \$1.1 million in FY 2006 (Carver and Caudell 2007). Non-residents spent most of the money generated from refuge visits (67 percent), a total of \$719,500. Based on the analysis conducted by the evaluation, the analyzed demand associated with refuge visitor recreational spending totaled \$1.7 million. This amount represents the total dollars generated to the local economy as the result of refuge visits. This demand resulted in an estimated 14 non-Service jobs, which generated \$536,300 in income and \$241,400 in tax revenue. Non-resident visitors generated \$1.1 million in economic stimulus to the local economy (Carver and Caudell 2007).

Adverse Impacts

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

4.17.3 Impacts of Alternative B (Service-preferred Alternative)

Benefits

Over the 15-year life of the plan, alternative B is expected to benefit the local economy by increasing visitation by 47 percent or an estimated 63,300 additional annual visits resulting in an increase in total visitor expenditures within the 15-year time frame of this CCP. A visit is defined as an individual, uninterrupted visit to the refuge for any length of time in a day. One person may make multiple visits to the refuge in one day if they leave and return. Several of the management actions in alternative B are specifically designed to take advantage of the regional tourism and include the following:

- Developing a specialized partnership with local historical sites (Fort Mifflin and Bartram's Gardens) to co-schedule and promote events
- Creating specialized materials for use at local hotels to advertize the refuge as a visitor destination and appeal to overnight visitors
- Developing partnership with PENNDOT, SEPTA, and Philadelphia Airport to improve the visibility and transportation connections to the refuge

At this time, it is unclear how restoration of part of the 145-acre impoundment would affect flooding in Darby Creek. Breaching of dikes along Darby Creek and restoring part of the impoundment would improve floodway access along the creek, thereby reducing the overall impact of flood waters in the area and pressure for flood control in areas adjacent to the refuge. However, this benefit would be negligible on its own and needs to be considered in light of broader floodway management across the area. This would also reduce the capacity of the impoundment, which could have adverse effects on flood control (see below).

Based on the nationwide survey and analysis conducted in 2006 the non-resident visitors (28 percent) contributed \$719,500 or \$19.60 per visitor to the local economy and residents contributed \$380,500 or \$4.96 per resident visitor. Using the 2006 dollar figures, alternative B would result in a projected additional 55,000 non-resident visitors contributing an additional \$1,078,000 to the local economy, and an additional 141,300 resident visitors contributing \$700,848 to the local economy.

Adding five refuge staff would result in a negligible increase in benefits to the local economy in jobs, income, and expenditures. Expansion of refuge administrative facilities, creation of interactive exhibits, construction of boardwalks, and work to upgrade kiosks, a contact station, and signs would provide minor contributions to the local economy through expenditures for labor, materials, and services.

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 Impacts

There are several environmental education centers in the region that offer fee-based programs, while there are no fees for refuge educational programs. The content of the refuge programs are designed to meet Pennsylvania education standards and therefore could be similar to and compete with programs at other environmental education centers in the area. The refuge recently completed Phase II of the Environmental Education Stakeholder Needs Assessment and would use the results to develop programs that address specific environmental education needs, are unique to the refuge, and that would not duplicate or be in competition with other environmental education centers. In our opinion, the refuge does not compete or detract from other environmental education programs in the area and the freshwater tidal marsh offers a unique experience to students and teachers alike.

Breaching of up to half of the impoundment for tidal marsh restoration purposes would reduce the water capacity of the impoundment, and may affect our ability to buffer local areas from potential flood events. This could have an adverse effect on neighboring properties that view the 145-acre impoundment as a floodwater storage area. The actual influence of the impoundment area on the Darby Creek floodway, as well as its restoration to freshwater tidal marsh, will be analyzed in more detail during the feasibility studies completed prior to restoration design. While we do not maintain or restore habitats for flood control purposes, we would work with neighboring municipalities when planning the impoundment restoration to avoid or minimize to the maximum extent practicable potential adverse effects.

4.17.4 Impacts of Alternative C

Benefits

Alternative C proposes different management actions designed to increase visitation discussed in alternative B and staffing levels. However, the benefits of increased visitation and visitor expenditures would resemble those in alternative B. The alternatives differ in that alternative C proposes a transportation shuttle and a commercial partnership with paddling access to the marsh, however it is expected that these actions would provide a minimal economic benefit. It is not possible to estimate the potential economic impact of proposed shuttle service or commercial paddling as these plans are not developed.

Similar to the discussion under alternative B, we don't know what the effects of restoring the impoundment to tidal marsh would be. Breaching of dikes along Darby Creek and restoring all of the impoundment would improve floodway access along the creek, potentially reducing the overall impact of flood waters in the area and pressure for flood control in areas adjacent to the refuge. However, this benefit would be negligible on its own and needs to be considered in light of broader floodway management across the area. This would also eliminate the water capacity of the impoundment, which could have adverse effects on flood control (see below).

Adverse Impacts

Adverse effects would be the same as discussed under alternative B except that breaching of the entire impoundment for tidal marsh restoration purposes would eliminate the refuge's ability to manipulate water levels in the impoundment in response to anticipated or experienced flood events. Compared to alternative B, this could have a larger adverse effect on neighboring properties that view the 145-acre impoundment as a floodwater storage area. The actual influence of the impoundment area on the Darby Creek floodway, as well as its restoration to freshwater tidal marsh, will be analyzed in more detail during the feasibility studies completed prior to restoration design. While we do not maintain or restore habitats for flood control purposes, we would work with neighboring municipalities when planning the impoundment restoration to avoid or minimize the maximum extent practicable potential adverse effects.

4.18 Cumulative Impacts

According to the CEQ 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.

4.18.1 Cumulative Impacts on the Physical Environment

Air Quality

We predict no cumulative impacts on Class I airsheds. With our partners, we would continue to contribute to improving air quality through management of native upland and wetland vegetation, which ensures that those areas would continue to filter out many air pollutants harmful to humans and the environment. We also strive to reduce energy consumption with "green" infrastructure and products.

Water Quality

Due to the extent and complexity of pollution and environmental contaminant sources within the Darby Creek watershed, we do not anticipate that any of the alternatives would produce significant adverse cumulative impacts on water quality. We would continue to use best management practices and measures to

control erosion and sediments in all ground-disturbing operations to ensure their impacts are minimal.

Alternatives B and C and, to a lesser extent, alternative A, call for increased attention to habitat restoration or enhancement projects, floodplain and adjacent land acquisition, and improvements in water quality in terms of both chemistry and reduced sediment. Collectively, and over time, those actions would improve the ability of the wetland system to process nutrients and store carbon and, along with other basin-wide regulations and initiatives, contribute to improvements in hypoxia in the Delaware Estuary and overall climate change. Restoring and managing riparian habitat would help restore tributaries and improve water quality, resulting in a more diverse and dynamic system.

Although the rates and amounts of sediment leaving the refuge and eventually reaching Darby Creek and the Delaware River may reduce over time, none of the alternatives would adequately address sedimentation problems in the Darby Creek. Thus, the actions in the alternatives are not expected to cumulatively improve the continued deficit in the water quality of the river or bay. Actions taken to ensure the long-term health of forest habitat and acquire and manage a variety of habitats, would result in improved water quality

Soils

Due to the highly disturbed soils in the refuge, we believe that adverse impacts of refuge management on soil structure and productivity would be negligible and would not vary significantly under any of the alternatives. We predict that refuge land management, regardless of which alternative, would be expected to have a net positive effect on soils. The following management actions would benefit or impact soils under all alternatives dependent on the scale, frequency, and duration of these activities, and the sensitivity of the soils to erosion and compaction.

The greatest past and present adverse impacts on refuge soils occurred from agriculture and development. Under all of the alternatives, we expect to restore native plant communities on lands that otherwise would be threatened by conversion or, in some cases dominated by invasive species. Overall, the upland soils of the refuge are a mixed organic fill material from past dredging projects and the marsh soils are organic muck underlain by alluvial sediments.

Soil disturbance would be greatest during restoration of freshwater tidal marsh areas, the greatest extent of which would likely occur under alternative B, and to a lesser extent under alternative C. Even though alternative C results in a higher acreage of freshwater tidal marsh, nearly all of that acreage is expected as a result of restoration of the impoundment to tidal marsh. Restoration of the 145-acre impoundment would likely not require as extensive soil excavation or grading as in other areas proposed for restoration. We do not anticipate any cumulative impacts to soils on the refuge, as soil erosion and sedimentation controls would be implemented as appropriate on all proposed construction projects.

There is some degree of soil contamination, but it is believed to be present below State and Federal levels for human contact and inhalation. Compaction is a localized problem in high traffic areas around the visitor center and some trails, but much of the heavy site use is or would be confined to paved areas, gravel access roads, boardwalks, and observation areas. However, certain areas, particularly the dikes and access roads, experience ongoing erosion and are susceptible to damage during flooding events. We would continue to manage refuge dikes and Folcroft Landfill to minimize human disturbance and to mitigate for natural processes that result in loss of valuable habitats, particularly at bald eagle and heron nesting.

4.18.2 Cumulative Impacts on the Biological Environment

All of the alternatives would maintain or improve native biological resources on the refuge, in the Delaware Estuary, and in the Mid-Atlantic region ecosystem. The combination of our management actions with those of other conservation organizations and landowners could result in beneficial cumulative effects by

- increasing the protection and management of Federal trust species, State-listed threatened or endangered species, and other native species;
- protecting or improving upland and wetland habitats that are regionally declining or affected by development; and
- controlling invasive plants and nuisance animals.

The biological resources that we would manage to control, prevent, or eliminate, such as invasive plants, are not natural components of those areas; we would not consider the loss of those biotic components an adverse effect.

Habitat improvements under the alternatives should benefit rare or declining species and marginally benefit species federally listed as threatened or endangered. Appendix A lists species of conservation concern in the area that would benefit from management. In particular, we target State-listed bird, amphibian, reptile, and Federal trust species. For some species, such as bald eagles, the refuge may provide a source for populations expanding onto adjacent lands or, conversely, may provide habitat for expanding populations searching for new habitats to utilize.

Although all of the alternatives either maintain or increase monitoring and controlling invasive plants and animals, we expect infestations to continue to increase and expand to new areas. All alternatives have a strong biological monitoring component, with increases in surveying the species and habitats under alternatives B and C, and research and coordination with others. That additional information not only would aid decisionmaking that benefits fish and wildlife on the refuge, but also would add to the body of knowledge collected by other agencies, which can affect resource decisionmaking over a broader landscape.

Alternatives B and C outline proposed actions to initiate control efforts on the overabundant deer populations existing on the refuge. Alternative B would utilize wildlife control specialists, while alternative C would utilize a combination of a controlled hunt program (to also foster additional wildlife-dependent recreation) along with use of wildlife control specialists. Under either alternative, control efforts would likely result in benefits to the many other biological resources that utilize the refuge by aiding in restoration of native plant communities and forest structure.

Each alternative anticipates an increase in refuge visitation. Alternative A would continue current management and make no additions or improvements to account for added visitation. Alternative B would result in the greatest amount of added infrastructure, but also provide the most opportunity for public uses and added access for the increased visitation expected. Alternative C would focus most public use improvements on Folcroft Landfill once it is released by the EPA and opened for public access by the Service. Alternative C would have similar levels of visitation, but visitors would largely utilize existing infrastructure for much of the next 15 years.

The refuge does allow fishing according to State regulations. Fishing results in the direct loss of individual fish. We describe the site-specific impacts of

our fishing program earlier in this chapter and in appendix B, “Compatibility Determinations.” As described in those sections, we do not believe current or planned levels of fishing would have any cumulative adverse effects on fish populations.

4.18.3 Cumulative Impacts on the Socioeconomic 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. All of the alternatives would maintain the existing landscape. Consequently, no adverse impacts would be expected, including changes in the community character or demographic composition.

Implementing any of the alternatives would likely result in several minor beneficial impacts on the social communities near the refuge and in the region as a whole. We expect public use of the refuge to increase, thereby increasing the number of days visitors spend in the area and, correspondingly, the level of visitor spending in the local community. Fully funding the additional staffing in alternatives B and C would also make a small, incremental contribution to the employment, income, and spending in the local community.

Various objectives in alternatives B and C would have varying degrees of impact on the recreational use of the refuge. Earlier sections detailed specific impacts on individual uses, such as hunting, fishing, and observing or photographing wildlife. Cumulatively, each alternative has a different economic impact since it affects the level of public use. The table at the end of this chapter summarizes the cumulative impact by alternative. Each alternative takes a different approach to managing the variety of recreational uses on the refuge, ranging from current management (alternative A) to an integrated approach (alternatives B and C) that seeks to conserve wildlife and habitat while providing additional diverse wildlife-oriented recreational opportunities for visitors.

These varying alternatives would have some cumulative impacts, because we expect the demand for nearly all recreation to grow while the amount of refuge space and natural resources stays relatively constant. In alternative A, current uses would continue without much change. Alternatives B and C attempt to strike a reasonable balance to ensure that the refuge remains a destination of choice for both wildlife and people. If successful, that integrated approach may have positive, long-term impacts on natural resources on the refuge, and social and economic impacts on the communities beyond through improving fish and wildlife habitat and raising awareness and stewardship of the environment.

Our working relationships with the State of Pennsylvania, area colleges and universities, private landowners and others should improve in terms of the responsiveness to inquiries and speed of joint projects under alternatives B and C. That improvement mainly would result from the increased staffing in key areas such as biology, public use, and maintenance.

More emphasis on environmental education and interpretation in alternatives B and C should foster more understanding and appreciation of resource issues and needs, and could lead to increased political support and funding, which could positively affect fish and wildlife resources in the refuge and the Delaware Estuary. The increased outreach of these alternatives could also positively affect land use decisions outside the refuge by local governments and private landowners, and thus lead to increased fish and wildlife populations over a broader area.

4.18.4 Cumulative Impacts on the Cultural and Historical Environment

As noted, no known cultural or historic resources have been identified on the refuge. Regardless, the refuge staff would, during the early planning of actions, continue to work with our regional archaeologists and consult with the State Historic Preservation Officer and other parties as appropriate to ensure compliance with NHPA and other applicable laws and regulations.

We expect none of the alternatives to have significant adverse cumulative impacts on cultural resources on the refuge. Depending on the alternative, beneficial effects would vary, because of the changes proposed in habitat management and increasing environmental education and interpretation programs. Alternatives B and C would both increase the amount of cultural and historic resource interpretation integrated into environmental education and interpretation. As a result, we would expect a small beneficial increase in awareness and appreciation of these resources.

4.18.5 Cumulative Impacts Related to Climate Change

The 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 decisionmaking.” This Order ensures that climate change impacts are taken into account in connection with Departmental planning and decisionmaking. Additionally, it calls for the incorporation of climate change considerations into long-term planning documents, such as a CCP.

The Wildlife Society (TWS) 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 (IPCC) 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 TWS report, “...other likely components of ongoing 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 TWS 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 our visitor center), along with reduced travel, more energy efficient vehicles, and other conservation measures.

In our professional judgment, most of the 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 TWS 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've highlighted the need to address climate change, specifically in regards to sea level rise and new species introductions on the refuge. We have proposed a series of strategies involving monitoring, accounting for sea level rise during restoration planning, and other potential impacts of climate change as it relates to the long-term protection and management of habitats in light of our defined refuge purposes and proposed goals outlined in this draft CCP/EA.

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/>. The Service's Northeast Region also co-hosted a workshop in June 2008 titled "Climate Change in the Northeast: Preparing for the Future." 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 native marshes, forests, open waters, and grasslands. Protecting the integrity of wetlands and managing for fully functioning riparian forests and biological corridors areas is also a priority for refuge management, which has been identified as a priority area of focus for conservation (Seavy et al. 2009). We have identified monitoring elements, which will be fully developed in the IMP 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 IMP so that we can make adjustments accordingly. The Service is working to establish long-term monitoring protocols and sites to document future trends in sea level rise in the Northeast Region. At John Heinz NWR, we have authorized the Partnership for the Delaware Estuary and the Academy of Natural Sciences to establish long-term monitoring sites across Tinicum Marsh, in conjunction with similar monitoring stations they are placing throughout the Delaware Estuary. When completed, we would ensure that researchers monitoring effects of sea level rise on the refuge do so in a manner compatible with Service monitoring protocols to allow for regional comparisons. Our results and reports, and those of other researchers on the refuge, would be shared within the conservation community.

- **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. As outlined in chapter 2, 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 re-directed 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 resiliency 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 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.

- **Recommendation #7:** Translocate individuals: This recommendation suggests that it may sometimes be necessary to physically move wildlife from one area to another to maintain species viability. However, it is cautioned that this tool has potential consequences and should only be used in severely limited circumstances as a conservation strategy.

We have no plans to translocate plants or animals within the 15 year time frame of this CCP.

- **Recommendation #8:** Protect coastal wetlands and accommodate sea level rise: This recommendation relates to actions that could ameliorate wetland loss and sea level rise, such as purchasing wetlands easements, establishing riparian and coastal buffers, restoring natural hydrology, and refraining from developments or impacts in sensitive wetlands and coastal areas.

Our responses to recommendations #2, #3, and #6 above identifies our objectives to establish fully functioning riparian areas, protect wetlands, and maintain healthy native habitat. Our initiation of long-term monitoring would help us to identify adaptive courses of action as the need arises. For example, this information can help inform future restoration projects to ensure restored tidal marshes and wetlands function at current and projected sea levels. Unfortunately, the limited footprint of the refuge and lack of nearby undeveloped uplands limits opportunities for expanding buffer areas and purchasing additional easements and properties.

- **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, in combination with the naturally wet conditions 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. We 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 #12:** Adjust yield and harvest models: This recommendation suggests that managers may have to adapt yield and harvest regulations in response to climate variability and change to reduce the impact on species and habitats.

We do not have plans for any significant harvest activities. Our monitoring program would include detecting population trends in focal species to alert us to any significant changes.

Regarding animal harvest through proposed fishing and hunting programs, the refuge does not set harvest regulations. In terms of deer hunting, annual monitoring and harvest goals would be determined for deer control purposes. Opening the refuge to a deer hunt would require a separate EA and subsequent compatibility determination in order to address effects of hunting including cumulative impacts.

- **Recommendation #13:** Account for known climatic conditions: This recommendation states we should monitor key resources through predictable short-term periodic weather phenomenon, 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, 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 of climate change. In particular, the Service is developing Landscape Conservation Cooperatives throughout the country. The refuge would continue to support these nationwide 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, we also are planning actions to enhance or replace ecosystem processes. Freshwater tidal marsh restoration, reduction of deer populations, and restoration of forest habitats all involve actions that address ecosystem functions. Further, 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 hear about many opportunities for land protection or habitat restoration through that 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 HMP. We will develop a detailed step-down IMP designed to test our assumptions and management effectiveness in light of ongoing changes. With that information in hand, we would either adapt our management techniques, or reevaluate or refine our objectives as needed.

4.18.6 Unavoidable Adverse Effects

Unavoidable adverse effects are the effects of those actions that could cause harm to the human 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, marsh restoration projects would produce minor, short-term, localized, adverse effects. 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.

Some habitat types on the refuge would be adversely affected. In alternatives B and C, for example, we proposed restoration of a portion or all of the 145-acre impoundment. However, historically this area was tidal marsh.

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. In areas where we are converting nonnative poplar forest to native species, we would consider habitat requirements and timing restrictions in order to protect State-listed species such as the short-eared owl. These owls, unlike other owl species, are ground nesting. Suitable habitat for nesting is found elsewhere on the refuge so we do not expect significant adverse consequences. Under alternative B, these short-term adverse impacts are further minimized by completing restoration work using a phased approach. Restoration would be spread out over approximately 5 years.

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 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 individuals. However, this activity constitutes a relatively minor impact on fisheries populations. In addition, alternatives B and C propose management actions that would result in improved and increased habitat for fisheries. The deer management programs proposed under alternatives B and C would also result in the unavoidable adverse loss of individuals. However, the overall health of the refuge's deer population would likely improve by reducing competition for limited resources. There would be long-term benefits to refuge habitats, particularly upland habitats, and the other species that depend on them.

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.

4.18.7 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.

Expansion of the visitor center and some expanded infrastructure would be considered to be ir retrievable commitments. However, we believe these improvements to be necessary to improve the effectiveness of refuge management and public uses. As a result, the commitment of resources required for them are relatively small by comparison to the benefits gained through efficient staff resource management and improved visitor services.

4.18.8 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 the 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. All of the alternatives would maintain the existing landscape. Consequently, no adverse impacts would be expected including changes in the community character or demographic composition.

Overall, we expect that none of the alternatives would place 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.

4.19 Summary of Environmental Consequences by Alternative

Table 4.2. A Summary of the Foreseeable Consequences of each Alternative.

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Air Quality</p>	<p>Refuge land management would help reduce any future direct and cumulative impacts by maintaining natural vegetative cover on up to 993 acres, requiring that all upgrades to existing facilities, or all new facilities, be energy efficient, and by allowing limited public uses to those that are appropriate, compatible, and wildlife-oriented activities. Collectively, these management actions would help reduce the potential for additional synthetic sources of emissions in the surrounding landscape.</p> <p>Alternative A would include fewer ground-disturbing and construction activities that would introduce additional short-term emission sources than alternatives B and C.</p> <p>We would continue to house maintenance and law enforcement programs in a separate facility ¼ mile from the refuge administrative offices. The travel on access roads and maintenance of access roads, dikes, or other facilities would cause short-term, localized effects from the exhausts of vehicles or other equipment and suspended particles from gravel surfaces and disturbed soils.</p> <p>The regional vehicle emissions resulting from 133,000 visitors to the refuge would continue to be negligible in comparison to ambient air quality and emission from an urbanized area.</p>	<p>Long-term benefits for air filtering and carbon sequestration from land protection would be similar to those in alternative A, except added forest habitat restoration and management would result in a small amount of additional air filtering and carbon sequestration.</p> <p>Construction activities involved in land management and expanding administrative facilities to collocate staff in one facility would cause short-term, localized effects from construction vehicles and equipment exhausts would occur.</p> <p>Expanding refuge programs, outreach efforts and improving facilities and exhibits is expected to increase visitation over the 15-year period of the plan. An increase in local vehicle emissions would result from the increase in visitation, but it would be negligible in comparison to ambient air quality and emissions from a variety of industrial and urban land uses surrounding the refuge.</p> <p>These impacts are not expected to exceed Federal Clean Air Act air quality standards. No Class I air quality areas are affected.</p>	<p>Air quality impacts would be similar to those described under alternative B, except for restoring the entire 145-acre impoundment to freshwater tidal marsh which would have more short-term impact due to construction activities.</p> <p>Long-term benefits for air filtering and carbon sequestration from land protection and deer management would be similar to those in alternative B.</p> <p>Short-term impacts due to construction emissions would be similar to alternative B, however the duration and timing of those impacts would vary by comparison.</p> <p>Impacts due to the increase in visitation would be similar to alternative B.</p>
<p>Under all of the alternatives, synthetic sources of emissions from refuge activities and visitor vehicles are negligible compared to emissions associated with the industrial and urban land uses of the Philadelphia area, adjacent highways and rail line and the nearby Philadelphia International Airport. We would continue to support the connection to regional trail systems that encourage non-motorized access to the refuge and non-motorized use of trails for wildlife observation and other compatible recreation. There are no major stationary or mobile sources of air pollution present on the refuge nor would any be created under any of the alternatives.</p> <p>All of the alternatives include restoring tidal marsh on the 55-acre restoration site. Air quality impacts resulting from the release of carbon monoxide and particulate emissions would occur at the site during the restoration project, but are generally not considered far-reaching. Exhaust from construction vehicles and particulates from disturbed soils during construction and prior to the establishment of cover vegetation would have an effect on the immediate air quality around the construction operation, but should not significantly impact areas outside of the refuge. These emissions would subside upon completion of construction activities.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Hydrology and Water Quality</p>	<p>Long-term benefits for hydrology and water quality would result from protecting up to 993 acres within the approved refuge boundary. In addition, significant management emphasis on maintaining riparian buffers, treating invasive plants, especially Phragmites, and restoring disturbed refuge uplands would increase benefits for water quality and hydrology.</p> <p>Some risks to water quality from herbicide use exist in conjunction with invasive plant management. Such impacts are minimized by using only approved herbicides, having a spill plan, and using the herbicide as instructed by the manufacturer and refuge policy.</p> <p>We would continue to monitor impoundment water quality parameters and support volunteer based monitoring of Darby Creek to better inform management actions.</p> <p>Additional visitation to the refuge poses a minimal risk to water quality and hydrology through runoff and pollutants from vehicles.</p>	<p>Overall impacts would be the similar to alternative A.</p> <p>Improving impoundment water level control infrastructure and adaptive management of water levels would improve the ability to manipulate impoundment water levels to improve dissolved oxygen (DO) levels in the impoundment.</p> <p>Installing a network of water quality monitoring equipment along Darby Creek within the refuge and implementing long-term and continuous monitoring would provide additional information to guide management actions in regards to water quality and adaptation to climate change.</p> <p>Restoration of a portion of the 145-acre impoundment to a freshwater tidal wetland would restore the historic hydrologic regime to portions of this area and create a significant improvement in local DO levels and biological exchange with the Tincum Marsh. Construction may result in localized sedimentation that will be minimized through use of appropriate BMPs.</p> <p>Potential for impacts associated with land management, forest conversion, and increased visitation will be monitored to minimize impacts of refuge hydrology and water quality.</p>	<p>Overall impacts would be the same as those for alternatives A and B, except restoration of the entire impoundment would expand short-term adverse impacts and long-term benefits described in alternative B.</p> <p>As with alternative B, potential for impacts associated with land management, forest conversion, and increased visitation will be monitored to minimize impacts of refuge hydrology and water quality. The duration and timing of some land management activities would vary as compared to alternative B.</p>
<p>Under all of the alternatives, we would continue to support existing partnerships for volunteer monitoring of Darby Creek and to assess and manage for water quality improvements impacting the refuge as time and resources allow. We would annually review and refresh staff in spill response protocols and emergency protection measures. We would also continue to coordinate with EPA and other stakeholders to remediate Folcroft and Clearview Landfills and minimize water quality and environmental health impacts related to contaminants associated with these sites.</p> <p>None of our proposed refuge management activities should adversely affect local or regional hydrology and water quality. None would violate Federal or State standards for contributing pollutants to water sources; all three would comply with the Clean Water Act.</p> <p>Continue to partner with Tincum Township to manage stormwater inputs into the impoundment and open waters along Long Hook Creek in an effort to minimize flooding in the Township.</p> <p>Construction activities at the 55-acre restoration site would have a short-term impact on water quality, although all necessary soil erosion and sediment controls would be used to minimize this impact. In addition, the contractor would be required to complete a plan that describes measures to prevent hazardous materials (e.g. fuel and oils) from impacting water quality.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
Effects on Soils	<p>Long-term benefits for soils from protecting up to 993 acres within the approved refuge boundary.</p> <p>Increased visitation could potentially result in localized soil compaction or erosion. Refuge staff will monitor trails to evaluate ongoing impacts and needs to minimize impacts.</p> <p>Minor soil displacement and loss would result from maintenance activities, installation of interpretative infrastructure, and construction of outdoor pavilions.</p>	<p>Long-term benefits for soils from land protection would be similar to alternative A.</p> <p>Short-term soil compaction and erosion from trail maintenance crews and refuge visitors, but impact area limited to existing trails.</p> <p>Restoration of a portion of the 145-acre impoundment to freshwater tidal marsh would impact soils along construction and access roads, although soil erosion and sediment controls would minimize this impact.</p> <p>Minor soil displacement of already disturbed soils would result from proposed 1,800 square-foot expansion of headquarters/visitor contact facility.</p> <p>Construction of up to 300 feet of boardwalk within the freshwater tidal marsh would result in temporary disturbance and minor wetland fill associated with the footings used to support the boardwalk structure.</p> <p>Increased visitation under alternative B could result in increased potential for soil compaction and erosion along trails and other access areas. Refuge staff would monitor trails and access areas to evaluate any impacts as a result of increased use.</p>	<p>Long-term benefits for soils from land protection would be similar to alternative B.</p> <p>Overall impacts would be the same as for alternatives A and B, except restoration of the entire impoundment would result in increased short-term adverse impacts and long-term benefits described in alternative B.</p> <p>Removal and conversion of a 15-acre stand of nonnative gray poplar to a shrub-scrub dominated habitat would potentially result in soil compaction and erosion, although any necessary soil erosion and sediment controls would be used to minimize this impact.</p> <p>Increased visitation under alternative C could result in increased potential for soil compaction and erosion along trails and other access areas. Refuge staff would monitor trails and access areas to evaluate any impacts as a result of increased use.</p>
<p>Under all alternatives, the refuge would expand its ownership of lands within the approved acquisition boundary, which would provide long-term protection of soils.</p> <p>The refuge would continue to experience localized impacts due to public use, vehicular traffic, and occasional construction disturbance.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Noise</p>	<p>Establishment of tree plantings along I-95 would result in a slight reduction of noise impacts on localized portions of the refuge.</p>	<p>Soundscapes and noise impacts would be similar to alternative A, except:</p> <p>Short-term negative impacts on natural soundscape would increase as compared to alternative A as a result of increased visitation and construction activities.</p> <p>Periodic, short-term noise impacts would be generated from firing of non-lethal screamer shells for monitoring purposes as well as firearms related to deer management activities.</p> <p>No long-term effects on the natural soundscape of the refuge.</p>	<p>Soundscapes and noise impacts would be similar to alternative B, except:</p> <p>Under alternative C, the refuge would explore construction of a physical sound barrier along I-95.</p>
	<p>The soundscape of John Heinz NWR clearly contains the sounds and noises of an urbanized landscape. Traffic, airplanes, heavy equipment operation, industrial and commercial operations, and building and road construction all contribute to community noise and disturbance in varying degrees.</p> <p>The noise analysis completed for the PHL runway expansion environmental impact statement demonstrated that the refuge experiences noise levels between 45 and 60 decibels (dB) based on the Day-Night Average Sound Level (DNL) recorded near the refuge. A noise monitoring site on Lindberg Boulevard south of the refuge showed an average DNL of 50 dB. This is calculated to increase to 55.4 dB in 2007 and 56.5 dB in 2015 with the runway expansion project (FAA 2005).</p>		

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Vegetation</p>	<p>We would continue forest management focused primarily on invasive species control and monitoring the impacts of high deer populations.</p> <p>Long-term preservation of nesting habitat, conservation of high-quality habitat, and restoration of degraded forested areas would not be feasible with continued impacts of an over-abundant deer population.</p> <p>Construction of an environmental education pavilion would result in the permanent loss of mostly cool season, old field vegetation.</p> <p>Seasonal water level management in the 145-acre impoundment would be used to promote growth of annual vegetation and mudflats.</p>	<p>This alternative would emphasize restoration of freshwater tidal marsh that would result in expanded freshwater tidal marsh vegetation.</p> <p>Implementing a deer management control plan would reduce the deer herd and promote natural regeneration of native species, and provide added competition in control of invasive species.</p> <p>Invasive plant control in marsh, forest, and grassland habitat would result in short-term losses of available vegetative cover. This impact would be offset by long-term benefits of increasing native plant species diversity and richness.</p> <p>Conversion of 15 acres of nonnative poplar forest to coastal plain or floodplain forest would result in short-term impacts due to removal of vegetation and loss of cover. In the long term this area will reestablish native vegetation.</p> <p>Conversion of 14-acres of grassland to coastal plain or floodplain forest will result in expanded acreage of forest habitats, along with a corresponding loss of grassland habitat.</p> <p>Infrastructure construction projects, such as boardwalks and facility expansions, will result in small scale and localized loss of grassland or marsh vegetation.</p> <p>Restoration construction projects will result in a short-term, localized, and temporary loss of vegetation during completion of work. Long-term benefits will be created to vegetation as a result of restoration projects.</p> <p>Increased visitation could potentially result in added off-trail usage and impacts as a result of soil compaction and trampling of vegetation. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p>	<p>This alternative would potentially undertake restoration of the entire 145-acre impoundment to freshwater tidal marsh. If pursued, this restoration would be delayed at least 10 years to evaluate future sea level rise trends. Delay of this work would postpone the benefits of added marsh vegetation.</p> <p>Invasive plant control in marsh, forest, and grassland habitat would result in short-term losses of available vegetative cover, but long-term benefits of increasing native plant species diversity and richness.</p> <p>Long-term benefits from conversion of a 15-acre stand of nonnative gray poplar to a shrub-scrub dominated habitat which is not found on the refuge and that would provide habitat for a variety of species of concern.</p> <p>Restoration construction projects will result in a short-term, localized, and temporary loss of vegetation during completion of work. Long-term benefits will be created to vegetation as a result of restoration projects.</p> <p>Increased visitation could potentially result in added off-trail usage and impacts as a result of soil compaction and trampling of vegetation. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p>

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Vegetation (cont.)</p>	<p>Under all alternatives we would continue to monitor and manage invasive species that cause environmental harm, such as the decline of native species and disruption of environmental processes. We would continue to employ IPM approach and adaptive management to control invasive plant species. We would also continue to promote visitor and public awareness of invasive plant species issues which could result in increased management of invasive plant species in the region.</p> <p>Completion of the 55-acre marsh restoration will result in a short-term, localized, and temporary loss of vegetation during completion of work. Long-term benefits will be created to vegetation as a result.</p> <p>Continue to conduct annual aerial herbicide application on 10 to 15 acres of phragmites within the existing freshwater tidal marsh to reduce invasive species populations. This may result in potential for minimal off-target damage to native vegetation.</p> <p>Continue education and interpretation of native and invasive vegetation to encourage volunteer based control of invasive species.</p> <p>Public use can affect vegetation in a variety of ways including directly by trampling and indirectly through soil compaction which can affect root systems. We regularly monitor trails and roads and have not observed any major impact areas resulting from wildlife observation, photography, environmental education, or interpretive uses.</p> <p>Grassland habitats would benefit by continuing a transition from cool season to warm season grasses through regular herbicide applications and supplemental planting and seeding. This transition results in improved species diversity and habitat structure beneficial to wildlife.</p> <p>Occasional mowing or clearing would occur along trails as part of ongoing trail maintenance under all alternatives, resulting in the promotion of disturbance tolerant species along mowed areas.</p>		

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Federal Endangered and Threatened Species</p>	<p>Depending on the timing, the drawdown of the impoundment reduces the overall acreage of available open water habitat for eagle foraging, but may potentially increase foraging efficiency.</p> <p>Continue to maintain nesting and foraging habitat for bald eagles and potential foraging habitat for shortnose sturgeon.</p>	<p>Restoration of additional forest habitat under this alternative will result in added roost habitat and buffer for bald eagles.</p> <p>Emphasis on restoration of tidal marsh will provide additional potential for forage and nursery habitat for shortnose sturgeon.</p> <p>Increased visitation could potentially result in added off-trail usage impacts and disturbance as a result of use. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use or added disturbance that might influence nesting.</p>	<p>Conversion of grasslands and 15 acres of nonnative poplar forest to shrub-scrub habitat would result in a minor loss of potential roost habitat as compared to alternative B.</p> <p>Delayed restoration of any tidal marsh would postpone any net benefits to the shortnose sturgeon that may utilize the refuge.</p> <p>Increased visitation could potentially result in added off-trail usage impacts and disturbance as a result of use. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use or added disturbance that might influence nesting.</p>
<p>We would continue to implement public access restrictions to protect the nesting American bald eagles through closure of the nesting sites and would offset the inconvenience to some visitors by completing installation of a webcam at the nesting site.</p> <p>Remediation of Folcroft Landfill, restoration of refuge habitats, continued land acquisition and protection and associated protection of vegetation and water resources all benefit water quality on refuge and to a minimal extent off refuge. Improved water quality provides minimal benefits to shortnose sturgeon in the Delaware River.</p> <p>We will continue to coordinate with PGC and PADCNr on information sharing and decisionmaking recommendations to maintain partnerships in protection of endangered species.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Landbirds</p>	<p>Continue forest management with an existing focus on control of invasive species already established in forested habitats.</p> <p>Seasonal drawdowns of water levels within the 145-acre impoundment may affect osprey and eagle foraging. The concentration of fish as a result of drawdowns may have a net neutral or positive effect.</p>	<p>Minimal habitat manipulation of forest habitat would maintain distribution and quality for forest dwelling birds.</p> <p>Short-term, temporary impacts result from human presence on trails, research, and the presence of dogs; however, the requirement to stay on trails and on leash would minimize the extent and duration of impacts.</p> <p>Increased knowledge and understanding of bird populations resulting from various surveys and inventories would help us better quantify effects on birds on the refuge.</p> <p>Initiation of deer management efforts through the use of wildlife control specialists would result in improvements in forest structure and vegetation diversity, which would improve the available cover and forage for landbirds over time.</p> <p>Conversion of the 15 acres of nonnative poplar forest to coastal plain or floodplain forest will result in short-term losses of forest bird habitat, although forest composition and structure will be improved as a result of long-term restoration.</p> <p>Conversion of 14 acres of grasslands to coastal plain or floodplain forest will result in expanded acreage of forest habitats and species, along with a corresponding loss of grassland habitat and suitable stopover habitat for associated species.</p> <p>Increased visitation could potentially result in added off-trail usage impacts and disturbance as a result of use. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use or added disturbance that might influence nesting.</p> <p>Added public use infrastructure proposed under alternative B such as boardwalks and kiosks would not be constructed near known nesting areas.</p>	<p>Similar to alternative B, except:</p> <p>Considering installation of sound barriers next to interstate I-95 could lead to noise abatement measures that would improve breeding and rearing success.</p> <p>Initiation of deer management efforts would result in improvements in forest structure and vegetation diversity, which would improve the available cover and forage for landbirds over time. Under this alternative, we would anticipate those benefits taking longer to develop as a result of the combination of specialized hunts and wildlife control specialists.</p> <p>Conversion of the 15 acres of nonnative poplar forest to shrub-scrub habitat will result in losses of forest bird habitat, although development of early successional habitat would create a habitat type currently unavailable on the refuge. In particular, short-eared owls nesting in the nonnative poplar forest would experience greater displacement in nesting opportunities under alternative C due to the single large-scale clearing of the entire 15-acre area.</p> <p>Conversion of 14 acres of grasslands to shrub-scrub habitat will result in reductions of forest habitats and species, along with a corresponding increase in early successional habitat and suitable stopover habitat for associated species.</p> <p>Increased visitation could potentially result in added off-trail usage impacts and disturbance as a result of use. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use or added disturbance that might influence nesting.</p>

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
Effects on Landbirds (cont.)	<p>Continue to maintain breeding, foraging, and stopover habitat for State-listed and regional priority landbird species as part of refuge wetland, grassland, and forest management.</p> <p>Continue to restrict access and management activities when and where appropriate near known nesting sites and continue breeding success monitoring.</p> <p>We will continue to coordinate with PGC and PADCNR on information sharing and decisionmaking recommendations to maintain partnerships in protection of endangered species.</p> <p>Landbirds will continue to be impacted by disturbance as a result of the presence of humans in portions of the habitats present at the refuge.</p> <p>We will continue to not manage feral cat populations on the refuge. 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 landbird species.</p>		

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Open Water and Wetland Bird Species</p>	<p>Continue manipulating water levels within the 145-acre impoundment in order to provide seasonal migration stopover habitat for various bird groups such as waterfowl, wading waterbirds, and shorebirds. Areas of freshwater tidal marsh, along with open waters of Darby Creek and the Delaware River would also continue to provide available nesting, foraging, and stopover habitat for water birds.</p>	<p>Alternative B would provide long-term expansion of open water and wetland habitats through the restoration of additional freshwater tidal marsh, which would increase nesting, foraging, and migratory stopover habitat for waterfowl, shorebirds, and wetland wading birds.</p> <p>Restoration of up to half of the impoundment would add to the benefits provided by freshwater tidal marsh. More detailed comparison of use of freshwater tidal marsh and the 145-acre impoundment by birds on the refuge would be evaluated further under this alternative to ensure that the most beneficial array of marsh and open water habitat is provided.</p> <p>Expanded restoration of freshwater tidal marsh, including portions of the 145-acre impoundment, would allow us to improve our education and interpretation about the importance of tidal marsh habitat, habitat restoration, and wildlife conservation.</p> <p>The conversion of up to half of the 145-acre impoundment would result in a loss of nontidal open water habitat from the refuge. However, the adverse effects on wildlife as a result of this would likely be negligible, since most waterfowl, wetland wading birds, and shorebirds readily utilize freshwater tidal marsh and open waters and mudflats which are available elsewhere on the refuge.</p> <p>Construction of restoration projects proposed would result in short-term disturbances to soils, vegetation, hydrology, and soundscapes of localized portions of habitat used by open water and wetland birds. We would undertake considerations during our construction and its timing to minimize these impacts. We anticipate the long-term benefit of this habitat to exceed any minor short-term impact on these species' habitat.</p>	<p>The restoration of the entire 145-acre impoundment to freshwater tidal marsh would improve foraging and nesting habitat for State-listed wetland wading birds such as the American bittern, least bittern, and king rail as well as waterfowl like the American black duck, lesser scaup, and northern pintail. Similar to alternative B, a more detailed comparison of use of freshwater tidal marsh and the 145-acre impoundment by birds on the refuge would be evaluated further under this alternative to ensure that the most beneficial array of marsh habitat is provided.</p> <p>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. Use of existing trails poses minimal potential impact to birds nesting in open water or wetland habitats.</p> <p>Compared to alternatives A and B, there would be more people walking off-trail on the refuge if opened to hunting, increasing potential for disturbance. Since the hunt would be controlled, refuge staff would monitor locations and numbers of hunters and wildlife control specialists to ensure there are no long-term effects on these species.</p>

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Open Water and Wetland Bird Species (cont.)</p>		<p>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. Use of existing trails poses minimal potential impact to birds nesting in open water or wetland habitats.</p> <p>Added public use infrastructure proposed under alternative B such as boardwalks and kiosks would not be constructed near known nesting areas. Construction timing would also be considered where necessary to avoid potential disturbance to sensitive species.</p>	<p>Alternative C also would develop a secondary method of transportation that would allow visitors to gain access to portions of the freshwater tidal marsh either via a tram, shuttle bus, or boat tour. Depending on the frequency, duration, and method of transportation, providing any of these options could pose disturbance to populations of open water or wetland birds on the refuge. We would continue to only pursue a transportation option that minimizes the impact on wildlife and the habitats they utilize.</p>
<p>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. Long term benefits to waterbirds are anticipated through the ongoing management of existing freshwater tidal marsh and the impoundment, primarily in the control and reduction of purple loosestrife and phragmites.</p> <p>The refuge would continue to coordinate with Pennsylvania Game Commission and Department of Conservation and Natural Resources, along with our conservation partners, to ensure that we utilize the best available science in our management decisions related to State-listed species.</p> <p>Waterfowl and shorebirds that are not State-listed, but still of regional conservation priority, would continue to utilize freshwater tidal marsh, open waters and associated mudflats along Darby Creek. Restoration of the 55-acre phragmites-dominated wetland to freshwater tidal marsh, proposed under all alternatives, would add beneficial habitat for many open water and wetland bird species.</p> <p>Some wetland birds may be present during aerial applications of herbicides for phragmites control and may experience direct contact with herbicides if they do not flush ahead of the helicopter flyover, or if spray misses the targeted application patch. The herbicides and surfactants approved for use in marshes are not toxic to birds, and would wet them only temporarily, if at all. We do not expect this as a frequent occurrence, as many marsh birds are not likely to inhabit phragmites stands.</p> <p>Bennett and Zuelke (1999) summarize several studies indicating recreation activities 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. We will take all necessary measures to mitigate those effects, particularly where group educational activities are involved. We will 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, or curtail or discontinue them.</p> <p>Public users of the areas along Darby Creek, the 145-acre impoundment, and tidal marsh 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.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
Effects on Fisheries	Same as <i>Impacts on Fisheries That Would Not Vary by Alternative.</i>	<p>Same impacts as alternative A; plus:</p> <p>Restoring and expanding freshwater tidal marsh within the refuge would increase the available habitat for spawning, year-round food and shelter, and nursery and rearing habitat.</p> <p>Potential impacts from recreational users would also slightly increase over alternative A with expanded fishing opportunities. Increased risk from shoreline erosion or debris and other waste could affect water quality. However, we plan to monitor those sites closely and address any elevated concerns.</p> <p>Installing a network of water quality monitoring equipment along Darby Creek within the refuge and implementing long-term and continuous monitoring would provide additional information to guide management actions in regards to fisheries.</p> <p>Restoration of a portion of the 145 acre impoundment to a freshwater tidal wetland would have a short-term impact on fishing resources. Since finfish are mobile most impacts would be avoided; however some impacts to eggs and larvae may occur.</p> <p>Providing additional fishing access points and expanding fishing programs would provide additional opportunities for fishing. Designated fishing access points would concentrate use and disturbance.</p> <p>Marsh restoration construction projects will result in a short-term, localized, and temporary disturbance during completion of work. Long-term benefits to available habitat will be created as a result of restoration projects.</p>	<p>Fishing impacts are similar to those described under alternative B, except for the restoration of the entire 145-acre impoundment to freshwater tidal marsh.</p> <p>However, the delay of the marsh restoration would postpone potential benefits in creating spawning, nursery, and foraging opportunities for fish.</p> <p>Marsh restoration construction projects will result in a short-term, localized, and temporary disturbance during completion of work. Long-term benefits to available habitat will be created as a result of restoration projects.</p>

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
Effects on Fisheries (cont.)	<p>Protection of the existing freshwater tidal marsh, impoundment, and other open water areas at the refuge protects and supports a number of aquatic species (see Table 2-2), and may also provide habitat for species of conservation concern, such as the federally and State-listed endangered shortnose sturgeon.</p> <p>Completion of the 55-acre marsh restoration will result in short-term, localized, and temporary impacts during completion of work. Long-term benefits will be created to fish spawning, nursery, and forage habitat as a result.</p> <p>Continue enforcement against deliberate introductions of nonnative fish, and outreach and education to explain the impacts of those introductions as well as the accidental introductions of invasive plants, pathogens, and exotic, invasive invertebrates.</p> <p>State regulations would be adhered to, which establish species and harvest limits to ensure no cumulative impact on any fish populations.</p> <p>Support ongoing research and studies for monitoring impacts to fisheries due to contaminants and/or climate change.</p> <p>We would continue to work with the PFBC on outreach, education and law enforcement related to fisheries found at the refuge.</p> <p>We would also continue to coordinate with EPA and other stakeholders to close Folcroft and Clearview Landfill and minimize water quality and fishery impacts related to contaminants associated with these sites.</p>		

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
Effects on Mammals	Lack of deer management would continue to impact other mammal species as a result of the ongoing degradation of habitats including loss of vegetative cover and species diversity.	<p>Implementing a deer management control plan through the use of wildlife control specialists would reduce the deer herd, resulting in the loss of individual deer, while improving the health of remaining individuals. Deer management would also promote natural regeneration of native species, creating added cover and forage for other small mammals.</p> <p>Conversion of 15 acres of nonnative poplar forest to coastal plain or floodplain forest would result in short-term impacts due to removal of vegetation and loss of cover. In the long term this area will reestablish native vegetation and mammal habitat across this site.</p> <p>Infrastructure construction projects, such as boardwalks and facility expansions, will result in minimal and localized disturbance to potential mammal foraging and nesting habitat.</p> <p>Restoration construction projects will result in a short-term, localized, and temporary loss of habitat during completion of work. Long-term benefits will be created to mammal habitat as a result of restoration projects.</p> <p>Increased visitation could potentially result in added off-trail usage and disturbance to individual mammals. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p>	<p>Same as alternative B, except:</p> <p>The delay of the marsh restoration would postpone potential benefits in creating habitat opportunities for small mammals.</p> <p>Initiation of deer management efforts would result in improvements in forest structure and vegetation diversity, which would improve the available cover and forage for mammals over time. Under this alternative, we would anticipate those benefits taking longer to develop as a result of the combination of specialized hunts and wildlife control specialists.</p>
<p>We will continue to coordinate with PGC and PADCNR on information sharing and decisionmaking recommendations to maintain partnerships in protection of mammals utilizing the refuge.</p> <p>Overall, the effects from public use are not likely to have an impact on mammals. Limiting visitors to existing trails prevents unintended disturbance to terrestrial mammals. Rare mammals potentially present such as the marsh rice rat and the river otter, are adequately buffered from human disturbance by the waters of Darby Creek and expanses of freshwater tidal marsh.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Amphibians and Reptiles</p>	<p>Lack of deer management would continue to impact other amphibian and reptile species as a result of the ongoing degradation of habitats including loss of vegetative cover and species diversity.</p>	<p>Implementing a deer management control plan through the use of wildlife control specialists would reduce the deer herd, which would promote natural regeneration of native species, creating added cover and forage habitat for amphibians and reptiles.</p> <p>Conversion of 15 acres of nonnative poplar forest to coastal plain or floodplain forest would result in short-term impacts due to removal of vegetation and loss of cover. Long-term this area will reestablish native vegetation and cover and forage habitat across this site.</p> <p>Added emphasis on marsh restoration projects will result in a short-term, localized, and temporary loss of habitat during completion of work. Long-term benefits will be created to nesting and foraging habitat for both amphibians and reptiles as a result of restoration projects.</p> <p>Increased visitation could potentially result in added off-trail usage and disturbance. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p> <p>Increased knowledge and understanding of amphibian and reptile populations resulting from various surveys and inventories would help us better quantify our effects on amphibian and reptile species on the refuge.</p>	<p>Initiation of deer management efforts would result in improvements in forest structure and vegetation diversity, which would improve the available cover and forage for mammals over time. Under this alternative, we would anticipate those benefits taking longer to develop as a result of the combination of specialized hunts and wildlife control specialists.</p> <p>Conversion of 15 acres of nonnative poplar forest to shrub-scrub would result in short-term impacts due to removal of vegetation and loss of cover. Long-term this area will reestablish native vegetation providing cover and forage habitat.</p> <p>The delay of the marsh restoration would postpone potential benefits in creating habitat opportunities for amphibians and reptiles.</p> <p>Increased visitation could potentially result in added off-trail usage and disturbance. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p> <p>Considering installation of sound barriers next to interstate I-95 could lead to noise abatement measures that would improve breeding and rearing success.</p>
<p>We will continue to coordinate with EPA and other stakeholders to close Folcroft and Clearview Landfill and minimize water quality and amphibian and reptile impacts related to contaminants associated with these sites.</p> <p>We will 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.</p> <p>Completion of the 55-acre marsh restoration will result in short-term, localized, and temporary impacts during completion of work. Long-term benefits will be created for reptile and amphibian habitat as a result.</p> <p>We will continue to sustain the State-threatened red-bellied turtle through protection of hibernation, foraging, basking, and nesting habitat.</p>			

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Invertebrates</p>	<p>Same as impacts identified under effects common to all alternatives below.</p>	<p>Increased knowledge and understanding of invertebrate populations resulting from U.S. Forest Service inventory would help us better quantify the effects on invertebrate species on the refuge.</p> <p>Conversion of 15 acres of nonnative poplar forest to coastal plain or floodplain forest would result in short-term impacts due to removal of vegetation and loss of cover. In the long term this area will reestablish native vegetation and invertebrate habitat across this site.</p> <p>Conversion of 14 acres of grassland to coastal plain or floodplain forest will result in expanded acreage of forest habitats, along with a corresponding loss of grassland habitat.</p> <p>Added emphasis on marsh restoration projects will result in a short-term, localized, and temporary loss of invertebrate habitat during completion of work. Long-term benefits will be created for invertebrates as a result of restoration projects.</p> <p>Implementing a deer management control plan through the use of wildlife control specialists would reduce the deer herd, which would promote natural regeneration of native species, creating an added diversity of species and habitats for invertebrates.</p>	<p>Same as alternative B, except:</p> <p>The conversion of 15 acres of nonnative poplar forest to shrub-scrub, as well as the conversion of 14 acres of grassland to shrub-scrub will result in a change of vegetation cover type. The resulting impact on invertebrates, and whether it would be a net positive or negative impact, is unclear at this time.</p>

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Invertebrates (cont.)</p>	<p>Completion of the 55-acre marsh restoration will result in short-term, localized, and temporary impacts during completion of work. Long-term benefits will be created for invertebrate habitat as a result.</p> <p>Under all alternatives we would continue to monitor and manage invasive species that cause environmental harm such as the decline of native species and disruption of environmental processes. The use of herbicides to complete aspects of invasive species management can cause negative impacts to some invertebrates. However, our attempts to minimize use and application of IPM techniques should minimize any impact on invertebrate populations.</p> <p>The restoration of native plants as a result of invasive species control and other land management would improve vegetation diversity, which in turn would likely improve available habitat for invertebrates.</p> <p>Outdoor lighting at the refuge can create impacts to certain species in the butterflies and moths family. We have minimized the use of outdoor lighting at the refuge and thereby maintain a negligible effect on invertebrates.</p>		

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Public Use and Access</p>	<p>We would maintain the existing five priority public uses (excluding hunting).</p> <p>Hunting would continue to be prohibited on the refuge in compliance with local regulations.</p> <p>Complete ongoing upgrades to meet ADA-accessibility requirements, installation of a webcam at the bald eagle nest, and completion of an outdoor pavilion for environmental education.</p> <p>We predict a slight increase in visitor numbers per year on the refuge, and would expect a commensurate increase in demand for refuge programs.</p>	<p>In the short term, access limitations at restoration sites during or after construction would inconvenience some visitors. In the long term, increased emphasis on restoration would provide additional habitat for wildlife and therefore increased opportunities for compatible, wildlife-dependent recreation.</p> <p>Implementing this alternative would expand existing opportunities for five of the six priority public uses with a focus on offering places, programs, and exhibits that appeal to children and families and that help reconnect them with nature.</p> <p>Providing additional fishing access points, boardwalks, bird and photography blinds would increase opportunities for wildlife observation.</p> <p>Regularly updating and improving interpretation infrastructure such as signage, kiosks, and displays would improve the quality of visitor experiences.</p> <p>Providing more interpretive options such as virtual tours, podcasts, and interactive programs via the refuge Web site or cellphone would engage urban youth and technologically savvy visitors.</p> <p>Increased visitation could potentially result in added off-trail usage and disturbance. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p> <p>Partnering with neighboring marinas and boat launches to institute organized boat tours of Tinicum Marsh would increase wildlife viewing opportunities, particularly for the elderly and families and would attract new visitors.</p>	<p>This alternative would also initiate a deer management control program utilizing a controlled youth hunt in order to assist in reducing the size of the resident deer herd. This would promote natural regeneration of native species and enhance habitat for other wildlife such as birds, amphibians, reptiles, and small mammals.</p> <p>Installation of additional webcams at the refuge would allow refuge visitors to observe wildlife via the internet and virtually explore portions of the refuge they may not normally observe.</p> <p>Under this alternative, the refuge anticipates increased visitation, although slightly less in numbers as compared to alternative B. This increase could potentially result in added off-trail usage and disturbance. Refuge staff will monitor usage to prevent or correct any unauthorized off-trail use.</p>

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
Effects on Public Use and Access (cont.)	<p>Under all alternatives, we would continue to provide quality, compatible wildlife-dependent recreation that allows a diversity of visitors to connect with nature in the outdoors. We would maintain our infrastructure to support those activities, upgrade appropriate facilities to ADA standards, and provide safe access.</p> <p>We would continue to permit dog walking as long as dogs are kept on leash and the activity is restricted to designated access road corridors.</p> <p>We would continue to limit access to ecologically sensitive areas such as nesting sites during breeding seasons and high quality wetlands. We would make efforts to minimize the impact on public use and access to those locations and timeframes necessary for adequate species protection.</p> <p>We would continue to seek qualified researchers and funding to answer refuge specific questions, participate in multi-refuge studies in partnership with USGS, and facilitate appropriate and compatible research.</p>		
Effects on Cultural and Historic Resources	<p>Under all alternatives, we would maintain the existing local natural history exhibits as part of the visitor center displays and maintain the existing natural history educational resource program including web-based lesson plans, loan boxes, and equipment.</p> <p>No archaeological or historic sites or structures are known to exist on the refuge. Given the extent of tidal marsh and the past level of land fill and disturbance in upland areas, it is unlikely that archeological resources would be identified at the refuge in the future. The refuge owns no museum property.</p> <p>While no adverse impacts to cultural or historic resources are anticipated, we will send this draft CCP/EA to the RHPO for review in compliance with section 106 of the NHPA. In all of the alternatives, we will consult with our regional archeologist and the RHPO as needed to ensure compliance with NHPA and other applicable laws and regulations.</p>		

Refuge Resource or Program	Alternative A Current Management	Alternative B Increased Restoration and Improved Visitor Services	Alternative C Delayed Restoration with Increased Focus on Regional Role in Higher Education in Conservation and Research
<p>Effects on Socioeconomic Environment</p>	<p>Continue to contribute minimally to the local and much larger Philadelphia area economy, in terms of refuge staff jobs, income, refuge and visitor expenditures, and the purchase of goods and services for refuge activities.</p> <p>Estimate of total annual refuge visitation of 133,000 contributes up to \$1.5 million to the State or local economy.</p>	<p>Increasing visitation by 54 percent over the next 15 years could contribute annually up to approximately \$2.3 million to the State or local economy.</p> <p>Expanding opportunities for five of six priority public uses.</p> <p>Adding five refuge staff would minimally increase benefits for the local economy in jobs, income, expenditures, and purchases of goods and services for refuge activities.</p> <p>Implementing management actions such as partnership with local cultural attractions, developing marketing materials for hotels, and partnership with regional transportation are specifically designed to take advantage of the regional tourism and increase visitors and their contribution to the local economy.</p> <p>Special construction projects would also contribute to the local economy for labor, materials, and services.</p>	<p>Alternative C proposes similar management actions designed to increase visitation discussed in alternative B and staffing levels. The benefits of increased visitation and visitor expenditures would resemble those in alternative B.</p> <p>Restoration of the entire 145-acre impoundment to freshwater tidal marsh could limit the refuge's ability to manipulate water levels in order to assist neighboring Tinicum Township with flood control.</p>
<p>Of the management activities that would not vary by alternative, the following would benefit or adversely affect the socioeconomic environment of the refuge: protecting land, maintaining facilities, implementing the 55-acre restoration project, supporting research and Friends of Heinz NWR group activities at the refuge, and implementing existing priority public use opportunities.</p>			