Appendix A: Environmental Assessment

Muscatatuck

National Wildlife Refuge

Environmental Assessment

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ENVIRONMENTAL ASSESSMENT FOR the IMPLEMENTATION OF a COMPREHENSIVE CONSERVATION PLAN FOR MUSCATATUCK NATIONAL WILDLIFE REFUGE

Abstract: The U.S. Fish and Wildlife Service is proposing to implement a Comprehensive Conservation Plan (CCP) for the Muscatatuck National Wildlife Refuge (Refuge) in south-central Indiana. This Draft Environmental Assessment (EA) considers the biological, environmental and socioeconomic effects that implementing the CCP (the preferred alternative is the proposed action) and three other alternatives would have on the issues and concerns identified during the planning process. The purpose of the proposed action is to establish the management direction for the Refuge for the next 15 years. The management action will be achieved by implementing a detailed set of goals, objectives, and strategies described in a CCP.

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Chapter 1: Purpose and Need

1.1 Background

The Muscatatuck National Wildlife Refuge (NWR), established in 1966, manages 7,802 acres in Jackson, Jennings, and Monroe Counties of Indiana (Figure 1). The Refuge also administers nine conservation easements, totaling 130.5 acres in five Indiana counties. The Refuge consists of wetland, grassland and woodland communities. The Refuge provides habitat for many avian species including ducks, geese, non-game grassland and forest birds including many neo-tropical migrants, shorebirds, wading birds, birds of prey and wild turkey. A wide variety of reptiles and mammals including the copperbelly water snake, Kirtland's snake, the federally listed endangered Indiana bat, river otter, and white-tailed deer, many fish species and a broad range of terrestrial and aquatic invertebrates also inhabit the refuge. Included among the diverse assortment of wildlife found on the Refuge are several federally listed species and many more state-listed species.

1.2 Purpose

The purpose of the proposed action is to specify a management direction for Muscatatuck National Wildlife Refuge (NWR) over the coming 15 years. The purpose of the Environmental Assessment is to select a management direction for the Refuge that best achieves the Refuge's purposes, vision and goals; contributes to the mission of the National Wildlife Refuge System; is consistent with principles of sound fish and wildlife management; and addresses relevant mandates and major issues developed during scoping. The management direction will be described in detail through a set of goals, objectives, and strategies in a Comprehensive Conservation Plan (CCP).

1.3 Need for Action

The action is needed because adequate long-term management direction does not currently exist for the Refuge. Management is now guided by various general policies, short-term plans, and a 25-year old Master Plan, which does not reflect current conditions or recent scientific knowledge. The action is also needed to address current management issues and to satisfy the legislative mandates of the National Wildlife Refuge System Improvement Act of 1997, which requires the preparation of a CCP for all national wildlife refuges in the United States.

This EA presents four management alternatives for the future of Muscatatuck NWR. The preferred alternative will be selected based on its ability to meet identified goals. These goals may also be considered as the primary need for action. Goals for the Refuge were developed by the planning team and encompass all aspects of Refuge management, including wildlife, habitat, and people. Each of the management alternatives described in this EA will be able to, at least minimally, achieve the following Refuge goals.

Habitat: A dynamic mosaic of vegetation that includes an expanse of upland and floodplain deciduous forest similar to that historically present along with lakes, marshes, and moist soil units.

Wildlife: Support the maximum sustainable breeding and post-breeding populations of cavity-nesting waterfowl, neotropical migratory birds, Indiana bats, and a diversity of migratory, rare wetland, and resident species.

People: Visitors understand and appreciate the natural environment and its processes through participation in high quality, wildlife-dependent interpretation, recreational and educational opportunities.

1.4 Decision Framework

The Regional Director for the Midwest Region (Region 3 of the U.S Fish and Wildlife Service) will need to make two decisions based on this EA: (1) select an alternative for the Refuge, and (2) determine if the selected alternative is a major Federal action significantly affecting the quality of the human environment, thus requiring preparation

Figure 1: Location of Muscatatuck NWR

of an Environmental Impact Statement (EIS). The planning team has recommended Alternative C ("Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses") to the Regional Director. The Draft CCP was developed for implementation based on these recommendations.

1.5 Authority, Legal Compliance, and Compatibility

The National Wildlife Refuge System includes federal lands managed primarily to provide habitat for a diversity of fish, wildlife and plant species. National wildlife refuges are established under many different authorities and funding sources for a variety of purposes. Muscatatuck National Wildlife Refuge is a part of the Refuge System and the authority and purposes are derived from several federal statutes.

The Migratory Bird Conservation Act established a Migratory Bird Conservation Commission to approve areas of land or water recommended by the Secretary of the Interior for acquisition as reservations for migratory birds. Consultation with state and local government is required prior to acquisition. The acquired lands are for use "as an inviolate sanctuary, or for any other management purpose, for migratory birds."

The mandate for FmHA Easements and Fee title transfers "…for conservation purposes..." is codified in 7USC2002.

Appendix E of the Draft CCP contains a list of the key laws, orders and regulations that provide a framework for the proposed action.

1.6 Scoping of the Issues

The planning process for this CCP began in March 2007. Initially, members of the regional planning staff and Muscatatuck NWR staff identified a list of issues and concerns that were associated with the management of the Refuge. These preliminary issues and concerns were based on staff knowledge of the area and contacts with citizens in the community.

The official notice of the intent to develop a CCP for the Refuge was published in the Federal Register on May 16, 2007. Refuge staff and Service planners then asked Refuge neighbors, organizations, local government units, and interested citizens to share their thoughts in an open house and through written comments. In May 2007, people were invited to an open house at the Refuge's visitor center through local papers and a project update sent to the Refuge's mailing list of 1,132. Twenty-five people attended the open house. Comments were received from approximately 35 individuals during the comment period, which ended June 30, 2007. Following the public comment period, an additional meeting was held in the Fish and Wildlife Service Regional Office to review the public comments and identify concerns from subject specialists.

A biological review of Refuge programs held June 20-21, 2007 helped clarify the habitat and wildlife issues. The biological review team included scientists from the U.S. Geological Survey, universities, and the State of Indiana, Regional Office representatives, Indiana state and U.S. Department of Agriculture managers, and Refuge staff. A visitor services review report of the Refuge dated August, 2006 helped clarify visitor services issues and provided potential actions to consider in formulating alternatives. The visitor services review team included regional and Refuge visitor services specialists and Refuge staff.

The following list of issues and concerns was compiled from internal Refuge scoping, public open house sessions and program reviews:

1.6.1 Habitat and Wildlife

There is a need to prioritize wildlife species of management concern and their habitats and, within budget constraints and other limitations, manage according to those priorities. A strategic management direction is needed for wetlands, grasslands, forests, croplands, and the conversion of open lands to forests. Visitors see the current diversity of habitat as valuable because it provides an opportunity to see a large number of bird and resident wildlife species.

1.6.2 Visitor Services

Visitors and staff recognize a tremendous potential in wildlife-dependent recreation, a popular and valued use of the Refuge. There is a need to weigh the delivery of visitor services within the

wildlife mission of the Refuge and seek creative means for expanding wildlife-dependent recreation opportunities, outreach, and education.

1.6.3 Refuge Roads

The public recognizes the value of Refuge roads for access. There is a wide spectrum of opinion on how the roads should be maintained. Some like the roads as they are now; others would like to see improvements in the roads and associated facilities such as parking lots and wildlife overlooks.

1.6.4 Recreational Issues

Some individuals would like to see recreational opportunities expand on the Refuge to include dog training, an archery range, and horseback riding. These activities typically do not occur on refuges and many are not wildlife-dependent in nature. The planning process presents an opportunity to evaluate the requests and reach a decision on their appropriateness and compatibility.

1.6.5 Threats and Conflicts

The public and staff recognize the challenges that increasing development around the perimeter of the Refuge will create for Refuge management and wildlife conservation in the area. There is also recognition of the need for aggressive management of invasive species.

1.6.6 Support

There is wide support for the Refuge and its management among visitors. They note the value of the Friends Group, volunteer, and intern programs.

Chapter 2: Description of the Alternatives

2.1 Formulation of Alternatives

The CCP planning team developed management alternatives for the Refuge based on the issues, concerns and opportunities raised during the CCP scoping process. The issues that are discussed came from individuals, local citizens and officials, cooperating agencies, conservation organizations and Refuge staff. Summaries of the four alternatives are provided in Table 1 on page 101. The management alternatives were developed to generally fit within the current Refuge budget. The alternatives were formulated under the assumption that a large budget increase for operations is unlikely during the life of the plan. The alternatives vary through the reallocation of existing fiscal and staff resources to emphasize different aspects of Refuge programs. The alternatives also consider the possibility of new private resources (volunteers, grant funds, etc.) and a modest Refuge program and/or staff funding increase over the next 15 years.

The concerns facing the planning team related to habitat and wildlife, visitor services, Refuge roads, recreational issues, threats and conflicts, and support of the Refuge. The team acknowledged that the Refuge benefits a broad diversity of wildlife and plants in addition to the migratory birds that are central to its purpose. The team also recognized the close ties of the community to the land and the Refuge, the emerging relationship to Sandhill Cranes, and the importance of the Refuge to the recreational experiences of visitors.

Despite its focus on waterfowl, throughout its existence the Refuge has been recognized as benefiting species other than waterfowl. During the CCP process the benefits have begun to be stated more explicitly, and the value of the Refuge in providing a diversity of habitat for a diversity of wildlife acknowledged. The team also recognized that some past investments in infrastructure have not been maintained and managed in an optimum manner. After years of experience at the Refuge and at other Refuges, the team acknowledged that the costs and challenges of effectively managing moist soil units and greentree reservoirs are greater than anticipated when the units were constructed.

The planning team evaluated the current management of the Refuge and thought about how management might change as a function of attention to other species, a re-evaluation of the constructed management units, and the variety of demands and rewards related to public use. The team's evaluation of current management was that the Refuge, given its resources, can be better managed through a fresh evaluation of what has or has not worked in the past and what might be the focus of activities in the coming years given newer scientific knowledge. So, the team's challenge was to craft alternatives to management that considered the possible reallocation of resources to include other outcomes and what might be gained with a modest increase in resources over the next 15 years.

The following sections describe the current management and three alternatives crafted by the planning team. Chapter 4 of this environmental assessment describes the consequences that would likely result from the actions in each alternative.

2.1.1 Elements Common to All Alternatives

Under all alternatives federally-listed threatened and endangered species would be protected and their populations monitored on Refuge lands.

Under all alternatives the Refuge would coordinate its objectives and activities with the Indiana DNR. The Refuge would consider known populations of state-listed species in management actions under every alternative.

Under all alternatives visitors would feel safe and the Refuge's resources would be protected through sharing regional law enforcement resources and partnering with Indiana DNR Conservation Officers and other enforcement authorities.

Under all alternatives the Refuge Manager would, during early planning, provide the Regional Historic Preservation Officer (RHPO) a description and location of all undertakings (projects, activities, routine maintenance and operations that affect ground and structures, and requests for permitted uses); and of alternatives being considered. The RHPO would analyze these undertakings for their potential to affect historic properties and enter into consultation with the State Historic Preservation Officer and other parties as appropriate. The Refuge Manager would notify the public and local government officials to identify their concerns about potential impacts by the undertaking; this notification will be at least equal to the public notification accomplished for NEPA and compatibility.

2.2 Alternative A: Current Management Direction (No Action)

Under this alternative the activities of the Refuge would continue as in the past with current staffing and resources.

2.2.1 Habitat

With the goal of providing an expanse of upland and bottomland forest, management of existing forest would consist primarily of allowing natural processes to occur with little active manipulation. Conversion of former cropland to forest would occur through natural succession with a limited amount of tree planting. Under this alternative, 670 acres of former cropland would be allowed to succeed to forest. Bottomland forest in the two greentree reservoirs and Moss Lake would continue to be managed as they have been in the past. Greentree units would be managed empty, except for natural flooding, during the summer months to allow for tree growth and then flooded after leaf drop, usually in mid-November, to allow for resting and feeding areas for ducks in migration and then drawn down to empty in early March.

Open water, notably that in Stanfield and Richart lakes and larger ponds as depicted in Figure 2, would be maintained under this alternative. The lakes provide habitat for broods and migrant birds and serve as a water supply for other managed wetland units on the Refuge. The lakes (Stanfield, Richart, Sheryl, Linda) and ponds (Persimmon, Sand Hill, Mallard and Display) are also fishing areas for visitors.

The 383 acres of seasonally flooded impoundments that are managed as moist soil units would continue to be managed as they have been. Water levels would be manipulated to provide Wood Duck habitat and mudflats for shorebirds. Variations in water levels among units provide an increased area and time for feeding by waterfowl, marsh birds, and shorebirds. The variation also increases moist soil plant foods for fall migrants. About 575 acres of Moss Lake would continue to be seasonally flooded with benefits similar to the moist soil units on a portion of that acreage.

Habitat in an early successional stage that occurs on the Refuge where farmland is reverting to more natural conditions would continue to be allowed to succeed through natural processes. Some tree planting would occur in these areas to encourage a more rapid succession to forest with species native to the area.

The 250 acres of agricultural land that are currently in crop rotation would continue to be farmed under this alternative. Invasive plant species would be addressed by continuing to treat approximately 220 acres each year. There would be a continuing attempt to move water away from the Seep Springs Research Natural Area as time and resource were available. The Restle Unit would continue to be managed to maintain the 30 acre seasonally flooded impoundment and 48 acres of bottomland hardwood forest. Active management of the forest on the Restle Unit would not occur.

2.2.2 Wildlife

Wildlife related activities on the Refuge consist primarily of surveys and studies. Little direct management of wildlife occurs. Under this alternative the current surveys would continue and studies, principally initiated by others, would occur sporadically. Species surveyed would include cavity-nesting waterfowl, neotropical migratory birds, migratory waterbirds, fish and other aquatic species.

2.2.3 People

The current wildlife-dependent recreational opportunities and services available to visitors (Figure 3) would continue under this alternative. Hunting, fishing, wildlife observation and

Figure 2: Future Land Cover Under Alternative A (Current Management), Muscatatuck NWR

Figure 3: Visitor Services Facilities Under Alternative A, Muscatatuck NWR

photography, interpretation, and environmental education activities would continue as in the past with incremental improvement in the programs. The Refuge would continue to be open from sunrise to sunset, and entry to the Refuge would remain free. The work of the Refuge would continue to be supported by The Muscatatuck Wildlife Society and volunteers. Nine miles of public roads and two public entrances would continue to provide access to the Refuge. Public access would only be limited in the 770 acres of closed areas associated with the waterfowl sanctuary area and the Refuge shop and quarters areas. Outreach activities would continue and include representation at off-site events, newsletters, and a website.

2.3 Alternative B: Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses

Under this alternative the Refuge would increase the size of its forests and manage fewer acres of constructed wetlands and increasingly rely on natural processes to provide wildlife habitat (Figure 4). There would be increased attention to surveys, monitoring and habitat restoration, and a portion of the Refuge would be treated as more remote and primitive. A biological technician would be added to the staff to accomplish increased survey and monitoring activities, and 1 FTE Equipment Operator would be required to support habitat restoration efforts and control invasive plants.

2.3.1 Habitat

With the goal of providing an expanse of upland and bottomland forest, management of existing forest would consist of restoring forest to more closely resemble historic conditions and to allow succession to occur through natural processes. Active forest management could include timber stand improvement activities of thinning, site preparation for natural reproduction, removal of undesirable tree species and release cutting or killing of undesirable older, over topping trees. Active management could also include small and larger changes to the topography within the forest to re-establish ephemeral wetlands that would have occurred historically. Conversion of former cropland to forest would occur through natural succession with a limited amount of tree planting. Under this alternative 920 acres of former cropland would be allowed to succeed to forest. The two greentree reservoirs would be reconnected to the river and water allowed to flood and ebb with the river's flow. Active forest management of timber stand improvement and topography changes could also be used in the bottomland forests. Moss Lake would be managed to recreate a more naturalistic and dynamic hydrological regime, which consists of seasonal and annual variation of water levels, structured within the framework of the cyclical climatic patterns. This process would restore the natural pulsing hydrology and introduce periodic drawdown to the management regimen. Such changes would increase productivity within the unit from increases in emergent plant and invertebrate production. Water would no longer be impounded in the surrounding forested areas, but would be influenced by more natural flood events. The depth, duration, and frequency of flooding of the forest perimeter would be greatly reduced. Currently, the Moss Lake impoundment is managed in a fairly static state with prescription flood and drawdown dates; flooding is fairly constant and extended and drawdown of the unit has not been pursued.

Open water, except for Stanfield and Richart Lakes, as depicted in Figure 4, would be allowed to gradually revert to forested wetlands under this alternative, although this may take a century to occur. Stanfield and Richart Lakes provide habitat for migrant birds, and to some degree broods, and serve as a water supply for other managed wetland units on the Refuge. The lakes are also fishing areas for visitors. By returning the smaller ponds to forest and forested wetlands, the area will more closely approximate what existed historically and will likely benefit the local herpetofuana.

Moist soil units 7, 8, 9, and 10 would be allowed to succeed to bottomland forest after removal of dikes that created them. The intent would be to return these units to a more naturally functioning system and increase the variability of water levels compared to the controlled management of the past. These changes are expected to benefit Wood Ducks, Indiana bats, copperbelly watersnakes and neotropical migrants by creating more bottomland forest acreage. The 123 acres of Units 1-6 would continue to be managed as moist soil units. Water levels would be manipulated to provide annual food crops for migratory waterbirds, Wood Duck brood habitat and mudflats for shorebirds. Variations in

Figure 4: Land Cover Under Alternative B, Increased Restoration, Muscatatuck NWR

water levels among units would provide an increased area and time for feeding by waterfowl, marsh birds, and shorebirds. The variation also increases moist soil plant foods for fall migrants.

Habitat in an early successional stage that occurs on the Refuge where farmland is reverting to more natural conditions would be more actively converted in this alternative compared to Alternative A. Activities that could be employed include timber stand improvement of thinning, site preparation for natural reproduction, removal of undesirable tree species and release cutting or killing of undesirable older over topping trees. Tree planting would be used to encourage a more rapid succession to forest with species native to the area. Natural succession would be allowed to occur on sites where desirable results could be obtained within a reasonable time.

There would be no farming on the Refuge under this alternative. The 250 acres of agricultural land that are currently in crop rotation would be converted to forested habitat that would have been present historically. Invasive plant species would be addressed more completely than in Alternative A. There would be a comprehensive inventory of all invasive plants within 5 years. The guiding principle for attacking new invasive plants would be early detection and rapid response protocol. There would be an attempt to maintain optimum hydrology for the Seep Springs Research Natural Area, which would require a detailed hydrological study. The Restle Unit would continue to be managed to maintain the 30-acre seasonally flooded impoundment and 48 acres of bottomland hardwood forest. Under this alternative a water management plan would be developed to support water bird feeding, resting, and breeding through cycles in moist soil management. Active management of the forest on the Restle Unit would not occur.

2.3.2 Wildlife

Wildlife surveys on the Refuge would be expanded from current levels under this alternative. More attention would be devoted to Indiana bats, cavity-nesting waterfowl, neo-tropical migratory birds, marsh birds, and shorebirds under this alternative with the intention of documenting the effect of reforestation and management over the long-term. Migratory waterbirds, fish, and other aquatic species would continue to be surveyed. Under this alternative there would be more direct management of wildlife than under Alternative A. An objective for deer management would be to maintain the population between 15 and 25 deer per square mile. The objective of this level would be to strike a balance between successful forest regeneration, which is depressed by high deer numbers, and quality hunting. Monitoring of the deer population and habitat would occur to determine if the population objective is being achieved and the desired habitat results obtained. Beaver and muskrat numbers would be monitored and controlled to facilitate water management under this alternative. And, the raccoon population would be monitored and controlled to facilitate greater Wood Duck production.

2.3.3 People

A portion of the current wildlife-dependent recreational opportunities and services available to visitors would continue or be expanded under this alternative (Figure 5). Another portion of wildlife-dependent recreational opportunities would change as vehicle access to sections of the Refuge would be reduced. South of Stanfield Lake, public access would be limited to foot traffic and bicycles on service roads. Developed trails would only be maintained in areas accessible by vehicles. The intent of this change would be to offer an opportunity that is wilder and more natural, away from the sights and sounds of vehicles. The change in access would also reduce the disturbance to wildlife in the southern part of the Refuge. In addition, the disturbance to migrating waterfowl on Units 1-6 would be reduced by limiting public access during peak duck use periods.

Under this alternative an entrance fee would be charged, which would be a change from the current condition. Admission would be gained through a daily fee, an annual pass, a current Duck Stamp, or the interagency "America the Beautiful – National Parks and Federal Recreational Lands Pass." Collections from the entrance fee would help support the operations of the Refuge. The west entrance to the Refuge from U.S. Highway 31 would be closed. The Refuge would be open 1 hour before sunrise to 1 hour after sunset.

Under this alternative, the duration of early archery deer hunting would be expanded to run from the Saturday after National Wildlife Refuge Week in October to the end of the State early archery season in late November. The season would increase by approximately 3-4 weeks and could vary annually due to the scheduling of National Wildlife Refuge Week and the Indiana early archery season

Figure 5: Visitor Services Under Alternative B, Muscatatuck NWR

for deer. In addition, the special permit draw for early archery would be phased out to create an open hunt. This management transition would be gradual, and closely monitored by Refuge staff. Overlapping the deer hunting seasons, squirrel, rabbit, and quail hunting would continue to be permitted in the southeast portion of the Refuge and would follow their respective State seasons. This would provide squirrel, rabbit, and quail hunters with approximately 5 additional weeks of hunting opportunities. A muzzleloader hunt for deer would occur by special permit drawing during the State season. Late Archery hunting would begin at the end of the muzzleloader season, continue until the end of the State season, and be an open hunt with no special permit draw required. A hunt for turkey would occur by special permit drawing during the state spring season. There would be no waterfowl hunting, nor hunting of any kind in the waterfowl sanctuary, the northeast portion of the Refuge, within 100 yards of any structure, or the closed area around the Refuge maintenance buildings. Hunter orange would be required for all hunts except turkey.

Year-round fishing by state regulations would continue under this alternative on designated lakes and ponds, which include Stanfield and Richart Lakes, Lakes Sheryl and Linda, Persimmon, and Sand Hill Ponds. Non-motorized boat access would continue on Stanfield Lake. Additional accessible fishing sites at current fishing locations would be developed to supplement the existing three facilities, two of which would be unreachable due to road closures (Lake Linda and Sand Hill Pond, south). The quality of fishing areas would be improved through increased management effort.

Periodic fish surveys would be instituted; information from lake surveys would form the foundation of Refuge fisheries management activity. This would yield long-term information on fish population size and structure, reproductive success, species abundance, growth and movement, and habitat conditions.

Where feasible, water management could be altered to create spawning and nursery habitat to provide refuge from predators, and to increase invertebrate and prey fish species abundance. Sedimentation has greatly reduced available spawning habitat in many Refuge lakes; spawning habitat improvement projects need to be undertaken. Nesting boxes for bass will be considered and should be modeled after a successful spawning habitat improvement project design. Logs may be submerged to increase crappie spawning habitat. Gravel may be used in some areas to create bluegill spawning habitat.

The Refuge may institute experimental fishing regulations to promote selective harvest; such regulations would be based on scientific data derived from fisheries surveys. Bag limit reductions may be necessary in years following changes in regulation if significant fisheries are developed and public fishing pressure drastically increases.

Many lakes at Muscatatuck NWR have a need for long-term solutions to reduce the influx of non-point source pollution such as sediment and other nutrients from runoff.

The annual kids' fishing event would continue.

Access for wildlife observation and photography would be altered under this alternative compared to Alternative A. The auto tour route would remain as would vehicle access to Stanfield Lake. South of Stanfield Lake, Refuge roads would be limited to Service vehicles with public access limited to foot traffic and bicycles on the roads. Trails south of Stanfield Lake would not be maintained and allowed to revert back to forest. The two annual photo contests and annual migratory bird day activities would continue. The observation platform at the Restle Unit would be maintained.

Interpretation under this alternative would continue the present programs of the Refuge. The Visitor Center exhibits would be maintained, interpretive programs would be delivered at the current level. Interpretive signs would be present on the auto tour route, Chestnut Ridge Trail, and Myers Cabin. Brochures and the Refuge's website would continue to be improved and upgraded. The Refuge would continue to host the annual Conservation Field Days for Jackson and Jennings County third-graders.

The current activities with the special group at Hayden School would continue under this alternative and the annual internship programs would be sustained. The Refuge would continue to host the annual Indiana Junior Duck Stamp Program and contest. The environmental education program would be administered to satisfy the Service's description of environmental education as described in 605 FW 6 and current policy.

The work of the Refuge would continue to be supported by The Muscatatuck Wildlife Society and volunteers under this alternative. In addition, the Refuge would seek to increase its partnerships with non-governmental organizations and expand its volunteer program as staff and resources permitted. Outreach activities would continue as in Alternative A and include representation at off-site events, programs, newsletters, and through a website.

2.4 Alternative C: Balance Natural Processes and Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)

Under this alternative the Refuge would increase the size of its forests and manage fewer acres of constructed wetlands and increasingly rely on natural processes to provide wildlife habitat. There would be increased attention to surveys, monitoring and habitat restoration. There would be increased attention to raising the quality of wildlife-dependent recreation opportunities. Two biological technicians would be added to the staff and one existing but vacant equipment operator position would be filled to accomplish increased survey and monitoring activities and increased habitat management demands under this alternative.

2.4.1 Habitat

With the goal of providing an expanse of upland and bottomland forest, management of existing forest would consist of restoring forest to more closely resemble historic conditions and to allow succession to occur through natural processes (Figure 6). Active forest management could include timber stand improvement activities of thinning, site preparation for natural reproduction, removal of undesirable tree species and release cutting or killing of undesirable older over topping trees. Active management could also include small and larger changes to the topography within the forest to re-establish ephemeral wetlands that would have occurred historically. Archaeological investigations would be conducted prior to any earth moving. Conversion of former cropland to forest would occur through natural succession and tree planting. Under this alternative 670 acres of former cropland would progress to forest through natural succession and tree planting. The two greentree reservoirs would be reconnected to the river and water allowed to flood and ebb with the river's flow, and reforestation would also occur in these units. Active forest management of timber stand improvement and topography changes could also be used in the bottomland forests. Moss Lake would be managed to recreate a more naturalistic and dynamic hydrological regime, which consists of seasonal and annual variation of water levels, structured within the framework of the cyclical climatic patterns. This process would restore the natural pulsing hydrology and introduce periodic drawdown to the management regimen. Such changes would increase productivity within the unit from increases in emergent plant and invertebrate production. Water would no longer be impounded in the surrounding forested areas, but would be influenced by more natural flood events. The depth, duration, and frequency of flooding would be greatly reduced in the forested perimeter. Currently, the Moss Lake impoundment is managed in a fairly static state with prescription flood and drawdown dates; flooding is fairly constant and extended and drawdown of the unit has not been pursued. This management strategy is the same as that proposed under Alternative B.

Open water would be allowed to revert to forested wetlands under this alternative, except for Stanfield Lake and existing fishing areas, as depicted in Figure 6. Management of Richart Lake would vary and the effects would be closely monitored. The deepwater section closest to the dike would be maintained, while the shallow northeastern portion of the lake would be adjusted by management to increase wetland or woodland habitat. Stanfield Lake, Richart Lake, Lake Sheryl, Lake Linda, Persimmon Pond, and Sand Hill Pond would remain fishing areas for visitors. Display and Mallard Ponds would be closed to fishing. Stanfield and Richart Lakes provide habitat for broods and migrant birds and serve as a water supply for other managed wetland units on the Refuge. By returning most of the ponds to forest and forested wetlands, the area will more closely approximate historical conditions.

Moist soil units 8, 9, and 10 would be allowed to succeed to bottomland forest after removal of the dikes that created them. The intent would be to

Figure 6: Land Cover Under Alternative C, Balance Natural and Constructed, Muscatatuck NWR

return these units to a more naturally functioning system and increase the variability of water levels compared to the controlled management of the past. These changes are expected to benefit Wood Ducks, Indiana bats, copperbelly watersnakes and neotropical migrants by creating more bottomland forest acreage. Moist soil unit 7 would be more intensively monitored and managed to provide water level control and flow through. The 123 acres of Units 1-6 would continue to be managed as moist soil units. Water levels would be manipulated to provide annual food crops for migratory waterbirds, Wood Duck habitat and mudflats for shorebirds. Variations in water levels among units would provide an increased area and time for feeding by waterfowl, marsh birds, and shorebirds. The variation would also increase moist soil plant foods for fall migrants.

Habitat in an early successional stage that occurs on the Refuge where farmland is reverting to more natural conditions would be more actively converted in this alternative compared to Alternative A. Activities that could be employed include timber stand improvement of thinning, site preparation for natural reproduction, removal of undesirable tree species and release cutting or killing of undesirable older over topping trees. Tree planting would be used to encourage a more rapid succession to forest with species native to the area. Natural succession would be allowed to occur on sites where desirable results could be obtained within a reasonable time. The 108-acre Endicott area would be kept open as dry herbaceous habitat to benefit bird viewing. An area of 180 acres would also be kept open as dry herbaceous habitat to benefit Sandhill Cranes and other species. Open areas would be maintained by mowing, haying, or prescribed fire.

There would be no farming on the Refuge under this alternative. A portion of the 250 acres of agricultural land that are currently in crop rotation would be managed as part of the aforementioned 180 acres that will be kept open and the remaining acreage would be converted to forested habitat that would have been present historically. Invasive plant species would be addressed more completely than in Alternative A. There would be a comprehensive inventory of all invasive plants within 5 years. The guiding principle for attacking new invasive plants would be early detection and rapid response protocol. There would be an attempt to maintain optimum hydrology for the Seep Springs Research Natural Area, which would require a detailed hydrological study. The Restle Unit would continue to be managed to maintain the 30-acre seasonally flooded impoundment and 48 acres of bottomland hardwood forest. Under this alternative a water management plan would be developed to support water bird feeding, resting, and breeding through cycles in moist soil management. Active management of the forest on the Restle Unit would not occur.

2.4.2 Wildlife

Wildlife surveys on the Refuge would be expanded from current levels under this alternative. More attention would be devoted to Indiana bats, cavity-nesting waterfowl, neo-tropical migratory birds, marsh birds, and shorebirds under this alternative with the intention of documenting the effect of reforestation and management over the long-term. Migratory waterbirds, fish, and other aquatic species would continue to be surveyed. Under this alternative there would be more direct management of wildlife than under Alternative A. An objective for deer management would be to maintain the population between 15 and 25 deer per square mile. The objective of this level would be to strike a balance between successful forest regeneration, which is depressed by high deer numbers, and quality hunting. Monitoring of the deer population and habitat would occur to determine if the population objective is being achieved and the desired habitat results obtained. Beaver and muskrat numbers would be monitored and controlled to facilitate water management under this alternative. The raccoon population would be monitored and controlled to facilitate greater Wood Duck production.

2.4.3 People

Wildlife-dependent recreational opportunities and services available to visitors would continue or be expanded and facilities improved under this alternative (Figure 7). The auto tour route would be paved, and the west entrance to the Refuge would be closed. Some trails (East and West River Trails) would not be maintained and allowed to revert to natural land cover. In addition, the disturbance to migrating waterfowl on moist soil units 1-6 would be reduced by limiting public access during peak duck use periods. The overall intent of the changes would be to prioritize visitor services and improve selected components to improve the quality of selected opportunities. The Refuge would be open 1 hour before sunrise to 1 hour after sunset.

Figure 7: Visitor Services Facilities Under Alternative C, Muscatatuck NWR

Under this alternative the duration of early archery deer hunting would be expanded to run from the Saturday after National Wildlife Refuge Week in October to the end of the State early archery season in late November. The season would increase by approximately 3-4 weeks and could vary annually due to the scheduling of National Wildlife Refuge Week and the Indiana early archery season for deer. In addition, the special permit draw for early archery would be phased out to create an open hunt. This management transition would be gradual, and closely monitored by refuge staff. Overlapping the deer hunting seasons, squirrel, rabbit, and quail hunting would continue to be permitted in the southeast portion of the Refuge and would follow their respective State seasons. This would provide squirrel, rabbit, and quail hunters with approximately 5 additional weeks of hunting opportunities. A muzzleloader hunt for deer would occur by special permit drawing during the State season. Late Archery hunting would begin at the end of the muzzleloader season, continue until the end of the State season, and be an open hunt with no special permit draw required. A hunt for turkey would occur by special permit drawing during the state spring season. There would be no waterfowl hunting, nor hunting of any kind in the waterfowl sanctuary, the northeast portion of the Refuge, within 100 yards of any structure, or the closed area around the refuge maintenance buildings. Hunter orange would be required for all hunts except turkey.

Year-round fishing by state regulations would continue under this alternative on designated lakes and ponds, which include Lakes Stanfield and Richart, Lakes Sheryl, Linda and Persimmon, and Sand Hill Ponds. A pond would be designated as a kids-only fishing pond with the restriction of catch-and-release only.

The annual kids' fishing event would continue.

Mallard and Display Ponds would be closed to fishing to eliminate the costs associated with dike maintenance and providing public access at these locations and to consolidate and reduce overall user impacts to Refuge wetlands.

Gasoline motors would be prohibited from use or possession while on the water, but electric trolling motors would be allowed on Stanfield Lake.

Additional accessible fishing sites at current fishing locations would be developed to supplement the existing three facilities. Improvements would be made to shoreline topography to augment fish habitat and fishing opportunities. The take of fish would be monitored and more closely managed through regulations to ensure a sustainable, healthy population. Periodic fish surveys would be instituted; information from lake surveys would form the foundation of Refuge fisheries management activity. This would yield long-term information on fish population size and structure, reproductive success, species abundance, growth and movement, and habitat conditions. Where feasible, water management could be altered to create spawning and nursery habitat to provide refuge from predators and to increase invertebrate and prey fish species abundance. Sedimentation has greatly reduced available spawning habitat in many Refuge lakes and reduced the quality of bank fishing; spawning habitat improvement projects need to be undertaken. Nesting boxes for bass would be considered and should be modeled after a successful spawning habitat improvement project design. Pine trees may be submerged to increase crappie spawning habitat. Gravel may be used in some areas to create bluegill spawning habitat. The Refuge may institute experimental fishing regulations to promote selective harvest; such regulations would be based on scientific data derived from fisheries surveys. Bag limit reductions may be necessary in years following changes in regulation if significant fisheries are developed and public fishing pressure drastically increases. Many lakes at Muscatatuck NWR have a need for long-term solutions to reduce the influx of non-point source pollution such as sediment and other nutrients from runoff. An educational program on the topic of fishing ethics would be established.

Access for wildlife observation and photography would be altered under this alternative compared to Alternative A. The auto tour route would be paved with asphalt to reduce dust on the route. Maintenance of existing gravel roads and parking lots would be improved. The west entrance to the Refuge would be closed. The East and West River Trails would not be maintained and allowed to revert back to forest. The surface of the remaining trails would be improved. Bicycling would be permitted only on paved or gravel roads. Trails would be closed to bicycles. A wildlife observation structure would be built near the shop area to facilitate viewing of wildlife using the open area. Species that would be expected to be seen from the structure include deer, Wild Turkey, Sandhill Crane, and varieties of Canada Geese. The Hackman

Overlook structure would be evaluated in a visitor services step-down plan for potential modification or removal. The two annual photo contests and annual migratory bird day activities would continue. The observation platform at the Restle Unit would be maintained.

Interpretation under this alternative would continue the present programs of the Refuge. The Visitor Center exhibits would be maintained, interpretive programs would be delivered at the current level. Interpretive signs would be present on the auto tour route, Chestnut Ridge Trail, and Myers Cabin. Brochures and the Refuge's website would continue to be improved and upgraded. The Refuge would continue to host the annual Conservation Field Days for Jackson and Jennings County third-graders.

The current activities with the special group at Hayden School would continue under this alternative and the annual internship programs would be sustained. The Refuge would continue to host the annual Indiana Junior Duck Stamp Program and contest. The environmental education program would be administered to satisfy the Service's description of environmental education as described in 605 FW 6 and current policy.

The work of the Refuge would continue to be supported by The Muscatatuck Wildlife Society and volunteers under this alternative. In addition, the Refuge would seek to increase its partnerships with non-governmental organizations and expand its volunteer program as staff and resource permitted. Outreach activities would continue as in Alternative A and include representation at off-site events, programs, newsletters, and through a website. There would be an expanded effort to appeal to under-represented populations through outreach. The intent of the outreach efforts would be to increase participation in Refuge activities, environmental stewardship, and volunteer participation.

2.5 Alternative D: Intensified Management of Constructed Units; Expanded Priority General Public Uses

Under this alternative the Refuge would increase the size of its forests and manage its constructed wetlands more intensively. There would be increased attention to surveys and monitoring. A biological technician, an equipment operator, and a park ranger (interpretation) would be added to the staff to accomplish increased survey and monitoring activities, the more intensive management of moist soil units, and expanded public use activities.

2.5.1 Habitat

With the goal of providing an expanse of upland and bottomland forest, management of existing forest would consist of restoring forest to more closely resemble historic conditions and to allow succession to occur through natural processes (Figure 8). Active forest management could include timber stand improvement activities of thinning, site preparation for natural reproduction, removal of undesirable tree species and release cutting or killing of undesirable older over topping trees. Active management could also include small and larger changes to the topography within the forest to re-establish ephemeral wetlands that would have occurred historically. Conversion of former cropland to forest would occur through natural succession with a limited amount of tree planting. Under this alternative, 853 acres of former cropland would be allowed to succeed to forest and would be assisted by tree planting. Water on the two greentree reservoirs and Moss Lake would be more effectively managed through control of muskrats and beaver, maintenance of dikes, and structure modifications. Reforestation would also occur in these units.

Open water as depicted in Figure 8 would be sustained with more active management of structures and increased maintenance under this alternative. The lakes provide habitat for broods and migrant birds and serve as a water supply for other managed wetland units on the Refuge. The lakes are also fishing areas for visitors.

Figure 8: Land Cover Under Alternative D, Intensified Management, Muscatatuck NWR

All moist soil units would be managed more intensively following accepted management guidelines for this type of unit. The intent would be to fully return these units to their designed functional capacity. Water levels would be manipulated to provide annual food crops for migratory waterbirds and may provide limited Wood Duck habitat and mudflats for shorebirds. Variations in water levels among units would provide an increased area and time for feeding by waterfowl, marsh birds, and shorebirds. The variation also increases moist soil plant foods for fall migrants. Vegetation in the units would be manipulated with occasional disking or other disturbance. The level of water in Moss Lake would be managed as a brood marsh and a green tree unit.

Habitat in an early successional stage that occurs on the Refuge where farmland is reverting to more natural conditions would be more actively converted in this alternative compared to Alternative A. Activities that could be employed include timber stand improvement of thinning, site preparation for natural reproduction, removal of undesirable tree species and release cutting or killing of undesirable older over topping trees. Tree planting would be used to encourage a more rapid succession to forest with species native to the area. Natural succession would be allowed to occur on sites where desirable results could be obtained within a reasonable time. The 108-acre Endicott area would be kept open to benefit bird viewing. An area of 180 acres would also be kept open to benefit Sandhill Crane and other species. Open areas would be maintained by mowing, haying, or prescribed fire.

There would be approximately 350 acres of agricultural land in crop rotation on the Refuge under this alternative. The agricultural land would benefit wildlife viewing and provide Sandhill Crane habitat, and wildlife food. Invasive plant species would be addressed more completely than in Alternative A. There would be a comprehensive inventory of all invasive plants within 5 years. The guiding principle for attacking new invasive plants would be early detection and rapid response protocol. There would be an attempt to maintain optimum hydrology for the Seep Springs Research Natural Area, which would require a detailed hydrological study. The Restle Unit would continue to be managed to maintain the 30-acre seasonally flooded impoundment and 48 acres of bottomland hardwood forest. Under this alternative a water management plan would be developed to support water bird feeding, resting, and breeding through cycles in moist soil management. Active management of the forest on the Restle Unit would not occur.

2.5.2 Wildlife

Wildlife surveys on the Refuge would be expanded from current levels under this alternative. More attention would be devoted to Indiana bats, cavity-nesting waterfowl, neo-tropical migratory birds, marsh birds, and shorebirds under this alternative with the intention of documenting the effect of reforestation and management over the long-term. Migratory waterbirds, fish, and other aquatic species would continue to be surveyed. Under this alternative there would be more direct management of wildlife than under Alternative A. An objective for deer management would be to maintain the population between 15 and 25 deer per square mile. The objective of this level would be to strike a balance between successful forest regeneration, which is depressed by high deer numbers, and quality hunting. Monitoring of the deer population and habitat would occur to determine if the population objective is being achieved and the desired habitat results obtained. Beaver and muskrat numbers would be monitored and controlled to facilitate water management under this alternative. And, the raccoon population would be monitored and controlled to facilitate greater Wood Duck production.

2.5.3 People

Wildlife-dependent recreational opportunities and services available to visitors would be expanded and facilities improved under this alternative (Figure 9). All Refuge roads would be paved and the two entrances to the Refuge would be maintained. All trails would be retained and their surfaces improved. The overall intent of the changes would be to maximize visitor services and their quality.

Under this alternative an entrance fee would be charged, which would be a change from the current condition. Admission would be gained through a daily fee, an annual pass, a current Duck Stamp, or the interagency "America the Beautiful – National Parks and Federal Recreational Lands Pass." Collections from the entrance fee would help support the operations of the Refuge. The Refuge would be open 1 hour before sunrise to 1 hour after sunset.

Figure 9: Visitor Services Facilities Under Alternative D, Muscatatuck NWR

Under this alternative the duration of early archery deer hunting would be expanded to run from the Saturday after National Wildlife Refuge Week in October to the end of the State early archery season in late November. The season would increase by approximately 3-4 weeks and could vary annually due to the scheduling of National Wildlife Refuge Week and the Indiana early archery season for deer. In addition, the special permit draw for early archery would be phased out to create an open hunt. This management transition would be gradual, and closely monitored by Refuge staff. Overlapping the deer hunting seasons, squirrel, rabbit, and quail hunting would continue to be permitted in the southeast portion of the Refuge and would follow their respective State seasons. This would provide squirrel, rabbit, and quail hunters with approximately 5 additional weeks of hunting opportunities. A muzzleloader hunt for deer would occur by special permit drawing during the State season. Late Archery hunting would begin at the end of the muzzleloader season, continue until the end of the State season, and be an open hunt with no special permit draw required. A hunt for turkey would occur by special permit drawing during the state spring season. There would be no waterfowl hunting, nor hunting of any kind in the waterfowl sanctuary, the northeast portion of the Refuge, within 100 yards of any structure, or the closed area around the refuge maintenance buildings. Hunter orange would be required for all hunts except turkey.

Year-round fishing by State regulations would be permitted under this alternative on all available waters excluding the waterfowl sanctuary and seasonally flooded impoundments.

Electric trolling motors would be allowed on Stanfield Lake and canoes would be allowed on all floatable water bodies, which would include the development of at least one new boat access.

A pond would be designated as a kids-only fishing pond with the restriction of catch-and-release only. The annual kids' fishing event would continue.

Additional accessible fishing sites at current fishing locations would be developed to supplement the existing three facilities. The quality of fishing areas would be improved through increased management effort.

Periodic fish surveys would be instituted; information from lake surveys would form the foundation of Refuge fisheries management activity. This will yield long-term information on fish population size and structure, reproductive success, species abundances, growth and movement, and habitat conditions.

Where feasible, water management could be altered to create spawning and nursery habitat, to provide refuge from predators, and to increase invertebrate and prey fish species abundance.

Sedimentation has greatly reduced available spawning habitat in many Refuge lakes and spawning habitat improvement projects need to be initiated.

Nesting boxes for bass would be considered and should be modeled after a successful spawning habitat improvement project design. Pine trees may be submerged to increase crappie spawning habitat. Gravel may be used in some areas to create bluegill spawning habitat.

The Refuge may institute experimental fishing regulations to promote selective harvest; such regulations would be based on scientific data derived from fisheries surveys. Bag limit reductions may be necessary in years following changes in regulation if significant fisheries are developed and public fishing pressure drastically increases.

Many lakes at Muscatatuck NWR have a need for long-term solutions to reduce the influx of non-point source pollution such as sediment and other nutrients from runoff.

Access for wildlife observation and photography would be altered under this alternative compared to Alternative A.

The Refuge roads would be paved with asphalt to reduce dust. Maintenance of parking lots would be improved. The surface of the Refuge trails would be improved. Bicycling would be permitted only on paved roads. Trails would be closed to bicycles.

A wildlife observation structure would be built near the shop area to facilitate viewing of wildlife using the open area. Species that would be expected to be seen from the structure include deer, Wild Turkey, Sandhill Crane, and varieties of Canada Geese. The Hackman Overlook structure would be evaluated in a visitor services step-down plan for potential modification or removal.

The two annual photo contests and annual migratory bird day activities would continue. The observation platform at the Restle Unit would be maintained.

Interpretation under this alternative would continue the present programs of the Refuge. The visitor center exhibits would be maintained, interpretive programs would be delivered at the current level. Interpretation would be present on the auto tour route, Chestnut Ridge Trail, and Myers Cabin. Brochures and the Refuge's website would continue to be improved and upgraded. The Refuge would continue to host the annual Conservation Field Days for Jackson and Jennings County third-graders.

Current environmental education activities would continue under this alternative with the partnership with the special group at Hayden School and the annual internship programs sustained. The Refuge would continue to host the annual Indiana Junior Duck Stamp Program and contest. The environmental education program would be administered to satisfy the Service's description of environmental education as described in 605 FW 6 and current policy.

The work of the Refuge would continue to be supported by The Muscatatuck Wildlife Society and volunteers under this alternative. In addition, the Refuge would seek to increase its partnerships with non-governmental organizations and expand its volunteer program as staff and resources permitted. Outreach activities would continue as in Alternative A and include representation at off-site events, programs, newsletters, and through a website. There would be an expanded effort to appeal to under-represented populations through outreach. The intent of the outreach efforts would be to increase participation in Refuge activities, environmental stewardship, and volunteer participation.

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Goal 1: Habitat – Maintain a dynamic mosaic of vegetation that includes an expanse of upland and floodplain deciduous forest similar to that historically present along with lakes, marshes, and moist soil units.				
Upland Hardwood Forest	Conversion of former cropland to forest through natural succession and limited tree planting. (670 acres)	Conversion of former and current cropland to forest through natural succession and limited tree planting. (920 acres) Active forest management that might include timber stand improvement, restoring hydrology and micro/ macrotopography	Same as Alt. B with acreage changed to 670 acres.	Conversion of most of former cropland into forest with 67 additional acres returning to agriculture. Active forest management that might include timber stand improvement, restoring hydrology and micro/ macrotopography.
Bottomland Hardwood Forest Natural Constructed	Water control on two greentree reservoirs and Moss Lake.	Convert greentree reservoirs to naturally flowing. Manage for more naturalistic hydrology to Moss Lake, (more variation in water level). Active forest management that might include timber stand improvement, restoring hydrology and micro/ macrotopography.	Same as Alt. B.	More effective control of water on two greentree reservoirs and Moss Lake. Includes reforestation, control of muskrats and beavers.
Open Water	Maintain current acreage as depicted in Figure 2.	Except for Stanfield and Richart Lakes, allow or assist open water areas to naturally revert to forested wetlands or other/same habitat adjacent to them.	Maintain Stanfield Lake and the deepwater portion of Richart Lake, and existing fishing areas, except for Mallard and Display Ponds, which will be closed to fishing. Water levels in some areas of Richart Lake may vary. Allow all other ponds to revert to forested wetlands.	Maintain current acreage as depicted in Figure 8 with more active management of structures and higher maintenance.

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Seasonally Flooded Constructed Impoundments	383 acres under moist soil management, which includes water and vegetation manipulation. 576 acres in Moss Lake.	Fewer acres under moist soil management through conversion of moist soil units 7, 8, 9, and 10 to bottomland forest through removal of dikes. Moist soil units 1-6 are managed. Also, McDonalds North and South, Sue, and Endicott North and South are managed as seasonally flooded impoundments. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.	Same as Alt. B, but retain moist soil unit 7, if possible, to keep dual function of control and flow through.	Manage all current moist soil units more intensively. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.
Reconverting Farmland/ early successional habitat	Allow natural succession and planting trees for conversion to forests.	Active conversion through planting, timber stand improvement, and natural succession.	Same as Alt. B. Endicott area (108 acres), kept open to benefit bird viewing. Area in 180-acre wildlife viewing area also kept open to benefit cranes and other species.	Same as Alt C plus return approx. 67 acres into crop rotation for wildlife viewing, crane habitat, and wildlife food.
Agricultural	250 acres in rotation.	No acres in agriculture.	Same as Alt. B. Use mowing, haying, or prescribed fire to maintain open acres for wildlife viewing and crane habitat.	Approximately 350 acres in rotation for crane habitat and wildlife viewing.
Invasive Plant Species	Approximately 220 acres treated per year.	Comprehensive inventory of all invasive plants within 5 years of plan approval. Employ early detection and rapid response protocol for responding to new invasives. Development of an IPM or section of HMP. Requires additional annual funding and possibly a biological technician FTE.	Same as Alt. B	Same as Alt. B

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Seep Springs Research Natural Area	No change in management, (some attempt to move water from area as time and resources permit)	Maintain optimum hydrology for the community. Requires detailed hydrological study.	Same as Alt. B	Same as Alt. B
Restle Unit	Maintain 30 acres of seasonally flooded impoundment and 48 acres of bottomland hardwood forest. Closed to all public use	Alternative A plus: Develop water management plan to support water bird feeding, resting, and breeding through cycles in moist soil mgt.	Same as Alt. B	Same as Alt. B
Goal 2: Wildlife – Support the maximum sustainable breeding and post-breeding populations of cavity-nesting waterfowl, neotropical migratory birds, Indiana bats, and a diversity of migratory, rare wetland, and resident species.				
Federally-listed Threatened and Endangered Species ***Indiana bat***	Intermittent surveys initiated by others.	Indiana bat: Conduct baseline survey and study of habitat use patterns. Follow with monitoring at regular intervals. Develop partnerships and seek grants to fund monitoring studies.	Same Alt. B	Same Alt. B
Cavity-nesting waterfowl	Annual brood surveys to estimate production. Cavity surveys were conducted in 1984-5 and 2006.	Monitor number of cavities after 15 years of implementation of plan. Conduct brood counts on managed units and Moss Lake every 3 years. Monitor brood habitat every year.	Same Alt. B	Same Alt. B
Neotropical migratory birds	May Day count annually for presence-absence data. These counts satisfy public interest.	May Day count annually for presence-absence data. These counts satisfy public interest. Point counts every 5 years to more systematically document the effect of reforestation.	Same Alt. B	Same Alt. B

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Secretive marsh birds and shorebirds	Limited study in past.	Marsh survey every 5 years to determine presence-absence, and distribution of species, with observations integrated into Annual Water Management Plan. Monitor shorebirds numbers and diversity spring through fall.	Same as Alt. B	Same as Alt. B
Rare wetland species	Periodic surveys of rare wetland species (examples include copperbelly watersnake, Kirtland's snake, four-toed salamander, and state-listed plants including rare orchid) by cooperators and volunteers.	Same as Alt. A with effort to improve protocols	Same as Alt. A with effort to improve protocols	Same as Alt. A with effort to improve protocols
Migratory waterbirds	Weekly waterfowl count from Labor Day through March. Provide data to state. Mid-winter waterfowl count to satisfy request of Service. Conduct surveys for Great Blue Herons every 5 years. Conduct annual Sandhill Crane surveys as requested by partners.	Same as Alt. A	Same as Alt. A	Same as Alt. A
Native resident and other wildlife	Variety of studies being conducted	Same as Alt. A.	Same as Alt. A	Same as Alt. A
Fish and other aquatic species	Periodic surveys to monitor diversity of species.	Same as Alt. A Monitor diversity, distribution and rough abundance on a 10-year cycle.	Same as Alt. B	Same as Alt. B

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Deer	No objective specified.	Maintain deer population between 15 and 25 per sq mi to balance between forest regeneration and quality hunting. Monitor deer population and habitat to determine if population level is achieved and not harmful to Refuge habitat.	Same as Alt. B	Same as Alt. B
Beaver, muskrat, raccoon	No objectives specified.	Control raccoon population as prescribed by monitoring to facilitate Wood Duck production. Beaver and muskrat are monitored and controlled to facilitate water management. Identify, monitor for and control any other species that is identified to be causing damage due to its high population level.	Same as Alt. B	Same as Alt. B
Heavy metal contamination in fish	Surveys conducted in 2006, results pending.	Fish will be used as indicator species. Conduct first survey within 5 years. Monitor at 10-15 year intervals.	Same as Alt. B	Same as Alt. B
Goal 3: People – Visitors understand and appreciate the natural environment and its processes through participation in high quality, wildlife dependent recreation and educational opportunities.				
Hunting ***(continued on next page)***	Hunt rabbit, quail, squirrel, turkey, and deer (Portions of the state season; portions of the Refuge). No waterfowl hunting allowed. No hunting of any kind in the Waterfowl Sanctuary.	Same as Alt. A., and: Expand hunt times for rabbit, quail, squirrel, and archery deer hunting. Hunting program will be monitored for biological and safety effects. (continued next page)	Same as Alt B., and: Offer state youth hunts in conjunction with cooperators in addition to current program. Also with partners, recruit under-represented populations to participate in hunting programs.	Same as Alt. C.

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Hunting (continued)		Early archery by State season starting after National Wildlife Refuge Week. Squirrel, rabbit, and quail hunts continue during deer hunts. Late Archery following closure of muzzleloader season for the remainder of the State season. Muzzleloader by special permit drawing during State Season. Hunter orange required for all hunts except turkey. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.		
Fishing	Year round fishing by state regulations on designated lakes and ponds –Richart and Stanfield Lakes, Lakes Sheryl, Linda, and Sand Hill, and Persimmon, Mallard and Display Ponds. Boating allowed on one lake. No motors allowed. Float tubes allowed in all fishing areas. Three accessible fishing facilities. Kids' fishing event once a year.	Same as Alt. A, except that Mallard and Display Ponds would be removed from the fishing program. Additionally, create more accessible sites around current fishing locations. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods. Improve quality of fishing areas.	Same as Alt. B, and: Designate a kid's only fishing pond with catch and release only. Allow electric trolling motors on Stanfield Lake after several years of monitoring of fish populations to d evelop baseline population values, but no gasoline powered engines may be attached to boats. Develop regulations to manage take based on monitoring. (ex.: Slot limits, aggregate creel limits). Establish fishing ethics educational program.	Fish all available waters excluding waterfowl sanctuary, and seasonally flooded impoundment units. Allow electric trolling motors, but no gasoline-powered engines may be attached to boats, and permit canoes etc. on all other floatable water bodies – would include development of an additional boat access point. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.

Table 1: Summary of Draft Management Alternatives for Muscatatuck NWR

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Observation & Photography	Auto tour route (4 miles). Seven hiking trails. Observation deck at Endicott Marsh. Overlook structure on Richart Lake. Nine miles of roads. Two annual photo contests. Annual migratory bird days. Refuge week activities. Maintain observation platform at Restle Unit with the rest of the unit closed to all public uses. Bicycling is permitted only on gravel/paved roads. Riding on hiking trails is prohibited.	Developed trails limited to area north of the intersection at Stanfield Lake. Vehicle access maintained to Stanfield Lake. South of Stanfield Lake Refuge roads limited to service vehicles. Public access limited to foot traffic and bicycles. East and West River Trails not maintained and allowed to revert back to habitat. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods. Maintain observation platform at Restle Unit with the rest of the unit closed to all public uses. Bicycling is permitted only on gravel/paved roads. Riding on hiking trails is prohibited.	East and West River Trails not maintained and allowed to revert back to habitat. Improve surfacing of all remaining trails. Blacktop auto tour route (contingent on funding). Build an observation structure to facilitate wildlife viewing near the shop area. Modify or remove Hackman Overlook structure. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods. Maintain observation platform at Restle Unit with the rest of the unit closed to all public uses. Bicycling is permitted only on gravel/paved roads. Riding on hiking trails is prohibited.	Same as Alt. C, and: Retain East and West River Trails in program and blacktop all Refuge roads. Build an observation structure to facilitate wildlife viewing near the shop area. Modify or remove Hackman Overlook structure. Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods. Maintain observation platform at Restle Unit with the rest of the unit closed to all public uses. Bicycling is not allowed on trails.
Interpretation	Provide 25 interpretive programs per year to schools and the public. Interpretation on auto tour route and Chestnut Ridge Trail. Myers Cabin interpretation. Keep six brochures updated and stocked at visitor contact points.. Maintain an accurate website.	Same as Alt. A.	Same as Alt. A, and: Improve quality of interpretation at all current facilities and throughout all media. Improve website to higher currency.	Same as Alt. C.

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Environmental Education	Partnership with special group at Hayden School and annual internship program. Host annual Indiana Junior Duck Stamp Program and contest. Host annual Conservation Field Days for Jackson and Jennings County Schools' third-graders.	Same as Alt. A and: Modify current program to satisfy the Service's definition of environmental education.	Same as Alt. B	Same as Alt. B and: Expand current program to additional school(s) (additional staff required).
Recreational fees	None.	Entrance fee collection with an iron ranger. Admission with daily fee, an annual pass, a current Duck Stamp, or an interagency pass. Daily admission fee of $5. Restle Unit exempt.	None.	Same as Alt. B.
Coop Association/ Friends	One active Friends Group, The Muscatatuck Wildlife Society. Membership based. 400 members. Other partnerships include the National Wild Turkey Federation, Ducks Unlimited, and the Audubon Society.	Same as Alt. A and: Expand partnerships to include other non-government organizations.	Same as Alt. B.	Same as Alt B.
Volunteer Program	Approximately 11,000 hours contributed by 200 volunteers.	Same as Alt. A and: Continue support and expand programs as staff and resources permit	Same as Alt. B	Same as Alt. A and: Expand participation from additional groups and audiences. (additional staff required)
Law Enforcement	One shared position with Big Oaks and Patoka River NWRs. Cooperative support from state police, sheriff's departments, and IDNR. Additional support through zone resources.	Same as Alt. A	Same as Alt. A	Same as Alt. A with possible funded cooperation with Indiana DNR.

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Public Access / Roads	Open from sunrise to sunset. All acres open except closed areas. Nine miles of roads with two public entrances.	Open 1 hour before sunrise to 1 hour after sunset. Limit vehicle traffic to roads north of intersection. Close west entrance. West Entrance may have to remain open, or be reopened to use during the Highway 50 widening project, which will begin sometime during the period covered by this CCP.	Same as Alt. A, plus: Open 1 hour before sunrise to 1 hour after sunset. Close west entrance. Blacktop auto tour route. Improve maintenance of gravel roads and parking lots. West Entrance may have to remain open, or be reopened to use during the Highway 50 widening project, which will begin sometime during the period covered by this CCP.	Same as Alt. A, plus: Open 1 hour before sunrise to 1 hour after sunset. Blacktop Refuge roads. Close west entrance. West Entrance may have to remain open, or be reopened to use during the Highway 50 widening project, which will begin sometime during the period covered by this CCP.
Outreach	Maintain a website. Staff a booth at the annual FFA Career Fair. Refuge newsletter published three times a year. Staff provide a limited number of off-site programs to schools and organizations.	Same as Alt. A	Same as Alt. A and: Expand appeal to under-represented populations. Improved website. (Purpose is increased participation and environmental stewardship—attendance and volunteers)	Same as Alt. C
Cultural Resources Management	Meet Service Regulations	Same as Alt. A	Same as Alt. A	Same as Alt. A
Implementation Requirements				
Staffing	No change.	One additional biological science technician. Fill existing vacant tractor operator position.	Two biological science technicians. Fill existing vacant tractor operator position.	Additional biological technician. Park ranger for interpretation. Fill existing vacant tractor operator position.

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Facilities	No change.	Dikes removed from Moist Soil Units 7, 8, 9 and 10. Roads south of Stanfield Lake and east of the auto tour loop would be maintained for Service vehicle access only. The west entrance to the Refuge would be closed. Additional accessible fishing sites would be developed at ponds and lakes with public road access.	Dikes would be removed from Moist Soil Units 8, 9 and 10. The auto tour route would be paved. Existing gravel roads and parking lots would be improved. The west entrance to the Refuge would be closed. The East and West River Trails would not be maintained and would revert to natural land cover. The surface of the remaining trails would be improved. A wildlife observation structure would be built near the Refuge shop area. The Hackman Overlook structure would be evaluated for modification or removal. Additional accessible fishing sites would be developed at current fishing locations to supplement the existing facilities.	Maintenance of water control structures would increase. All Refuge roads would be paved and parking lots improved. Both Refuge entrances would be maintained. All trails would be maintaind and trail surfaces improved. A wildlife observation structure would be built near the shop area. The Hackman Overlook structure would be evaluated for modification or removal. Additional accessible fishing sites would be developed at current fishing locations to supplement the existing facilities.

Chapter 3: Affected Environment

This chapter contains an overview of the affected environment of Muscatatuck NWR. More detail is contained in Chapter 3 of the CCP.

3.1 Introduction

The Muscatatuck NWR manages 7,802 acres in Jackson, Jennings, and Monroe Counties of Indiana. The Refuge also administers nine conservation easements, totaling 130.5 acres in five Indiana counties.

3.2 Geographic/Ecosystem Setting

Historically, the Refuge was a part of the expansive, contiguous deciduous hardwood forest that covered most of the central and southern part of the state. Lindsey (1997) listed oak-hickory and beech-maple as the dominant pre-settlement forest types. Prior to European settlement of the area, the Muscatatuck River Basin was an old lake basin of deciduous forest. This area is generally wet or moist most of the year.

The land of the future Refuge was cleared for farms in the mid 1800s as the state was settled by Europeans. When the Service purchased the land most of the area had been altered from its original forest cover type. Since the Service has managed the land, the cover has changed away from agriculture to managed wetlands and trees. Fire was likely a part of the forces shaping the forest prior to European settlement as indigenous populations used fire as a management tool in forested areas. Fire has been suppressed at in the Muscatatuck NWR area for much of the last century, except for some areas that were treated with fire as a management tool in the 1990s.

Today the more common species in the bottomland hardwood forest are pin oak, swamp white oak, swamp chestnut oak, sweet gum, green ash, river birch, silver and red maple and shellbark hickory.

The Refuge lies in a predominantly agricultural landscape. Farm land constitutes 63.5 percent of the land area in Jackson County and 59.1 percent in Jennings County (FedStats 2002). Within this predominantly agricultural landscape, the developed area of Seymour to the west of the Refuge is a notable exception. There are forested lands and woodlots scattered among the agricultural lands. Based on 2001 national land cover data developed by the Multi-Resolution Land Characteristics Consortium, the area within a 6-mile distance of the Refuge is 61.8 percent agricultural, 10.8 percent developed, and 26.4 percent forested (U.S. Geological Survey 2001). (Figure 10)

The Refuge contributes to the goals and objectives of various regional, national, and international conservation plans and initiatives, including the North American Waterfowl Management Plan and Partners in Flight.

The State of Indiana, other federal agencies, and non-governmental conservation organizations own and manage lands and recreation access sites within a 50-mile radius of the Refuge (Figure 11). Local governments also own and manage community parks in the area. Conservation easements also apply to a significant amount of land in the surrounding area.

3.3 Socioeconomic Setting

Muscatatuck NWR is located in Jackson and Jennings Counties. These two counties are less racially and ethnically diverse than the State of Indiana as a whole. The population in the counties has a lower average income and a lower percentage of high school and college graduates than the state's population as a whole. The population estimate for the two counties was 70,664 in 2005. In 2004 manufacturing was the largest of the major economic sectors in both counties accounting for 25.8 percent of the jobs in Jackson County and 19.3 percent of the jobs in Jennings County. Retail trade, transportation, and warehousing were also notable sectors (STATS Indiana 2007).

Figure 10: Land Cover in the Vicinicty of Muscatatuck NWR

Figure 11: Conservation Lands Surrounding Muscatatuck NWR

3.4 Climate

The Refuge experiences a continental climate of warm, humid summers and moderately cold winters. The area receives moisture from the Gulf of Mexico as air masses move up the Mississippi and Ohio River Valleys. January is the coldest month with a mean normal temperature of 28 degrees Fahrenheit. July is the warmest month with a mean normal temperature of 74.5 degrees Fahrenheit. The frost and freeze dates for a 32 degrees Fahrenheit with a 50 percent probability are April 20 and October 12. The normal annual precipitation is about 46 total inches. Normal precipitation is distributed relatively evenly across the months of the year with a low normal of 2.84 inches in February and a high normal of 5.01 inches in May (Source: National Climatic Data Center).

3.5 Geology and Soils

The Refuge lies within the Scottsburg lowland physiographic division of Indiana. The lowland has resulted from the greater erosion of shales compared to the underlying limestones and siltstones of adjacent uplands. Thick glacial deposits, which are older than Wisconsin glacial deposits, cover the area with little variation in topography (Wayne 1956). More specifically, Muscatatuck NWR's geology includes the combination of underlying bedrock strata and the unconsolidated soils material deposited by glacial action. The glacial material is dominantly stratified sands and clays that have been blanketed with a mantle of wind blown silt (loess). Hydric soils cover approximately 38 percent of the Refuge.

3.6 Hydrology and Water Quality

The Refuge lies within a flat, relatively well drained portion of the Wabash River Basin. Water flows away from the Refuge down the Vernon Fork of the Muscatatuck River. Three small streams, Sandy Branch, Mutton Creek, and Storm Creek, flow through the Refuge and enter the Vernon Fork soon after leaving the Refuge. The subwatersheds of Upper- and Lower- Mutton Creek and Upper- and Lower-Storm Creek, which cover 30,100 acres above the Refuge, flow into the Refuge. Approximately 8,525 acres of the Mutton Creek-Sandy Branch subwatershed, which includes the eastern portion of Seymour, also flows into the Refuge. The annual floodplain of the Vernon Fork extends 2,000 to 3,500 feet into the Refuge along its southern border. Annual floods inundate approximately 2,700 acres of the Refuge.

Agriculture is the primary land use in the watershed. Run-off from crop fields, pastureland, and feedlots contributes to non-point source pollution. In addition to agriculture, the rapid urban development of the area surrounding the Refuge has led to increases in flow rates, erosion, and amount of particles, sediment, and other substances reaching the Refuge.

3.7 Refuge Habitats and Wildlife

3.7.1 Wetlands

Wetlands cover 38 percent of the Refuge, and approximately 36 percent of that land floods annually.

The majority of wetland habitat is bottomland hardwood forest (4,142 acres) and managed water units that include moist soil units, brood marshes, greentree impoundments and Stanfield, Moss and Richart Lakes (1,264 acres). The Refuge also has over 70 other small ponds and wetland areas. These were constructed by former land owners to be stock ponds or ponds near residences and are utilized by migratory birds and wildlife. Several seeps exist on the Refuge. One, an acid seep spring designated as a research natural area, is extremely rare in Indiana having been documented in only seven other locations in the state. Wildlife that use the wetlands include Wood Ducks and Hooded Mergansers, which nest in the bottomland hardwoods, American Bald Eagle, copperbelly watersnake, river otter and many other species from all faunal assemblages.

3.7.2 Forests

Approximately 66 percent (5,302 acres) of the Refuge is covered by forests. Approximately 77 percent of the forested area (4,076 acres) is classified as a type of bottomland hardwood forest – a cold-deciduous forest that is temporarily or seasonally flooded and occurs on wet soils and in floodplains. American beech and a variety of maple and oak species dominate bottomland forests. Ash, sweetgum, river birch and sycamore are also present. The remaining 22 percent of the forested

area (1,226 acres) is classified as upland hardwood forest – a cold-deciduous forest type that primarily occurs in lowland or submontane habitats on soils that are unaffected by seasonal flooding. Varieties of oaks and maples dominate, and these forests can also include American beech and eastern red cedar along with other species (Sieracki et al. 2002).

Trees commonly found on the Refuge include:

- pin oak
- swamp white oak
- swamp chestnut oak
- sweet gum
- green ash
- river birch
- silver and red maple
- shellbark hickory
- white oak
- red oak
- white ash
- tuliptree
- American beech

Mammals that use the forests include:

- white-tailed deer
- eastern gray squirrel
- eastern fox squirrel
- southern flying squirrel
- groundhog
- Indiana Bat

Forest bird species include:

- Wood Duck
- Hooded Merganser
- Red-shouldered Hawk
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- American Redstart
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

3.7.3 Grasslands

Some areas of grasslands are mowed for wildlife viewing along the auto tour route. The majority of these fields contain non-indigenous species such as fescue, timothy, orchard grass, and clover. The remaining dominant grassland vegetation includes native broadleaves, bluegrass, bluegrass-fescue, alfalfa-brome, and panic grass. Fescue is the dominant species over much of the non-cultivated open area. Wildlife that use the grasslands include various mice and vole species, eastern cottontail rabbit, white-tailed deer, coyote, black king snake, black rat snake, eastern garter snake, Red-tailed Hawk, Northern Harrier, Sedge Wren, Grasshopper Sparrow, Henslow's Sparrow, Song Sparrow, Indigo Bunting, Dickcissel, Red-winged Blackbird, Eastern Meadowlark, and Bobolink.

3.7.4 Birds

More than 279 bird species have been reported on the Refuge and 120 of those are considered nesting species. A rich diversity of waterfowl, raptors, and songbirds is commonly observed on the Refuge. Wood Duck broods are common sightings in the spring and summer months. Waterfowl use days during the winter and spring migrations number in the thousands. A Bald Eagle nest has been active since 2002 and winter migrants are commonly seen. Muscatatuck NWR is also known for the spring and summer migration of songbirds especially warblers in May. The Refuge was designated a Continentally Important Bird Area in June 1998. The designation was based on Christmas bird count data and the Refuge's wintering numbers of Canada Geese from the James Bay population. The Refuge was a stopover site for the Whooping Crane Eastern Partnership (WCEP) ultralight-led Whooping Cranes annually from the fall of 2001 through the fall of 2007. A complete list of bird species and a general guide to their seasonal occurrence and status on the Refuge can be found in Appendix C.

3.7.5 Mammals

Thirty-eight species of mammals are known to occur on the Refuge. The mammals include the federally-listed endangered Indiana bat, the State-listed endangered Evening bat, and the white-tailed deer, a species popular for hunting and wildlife viewing. Occurrence of the Indiana bat, including lactating females, on the Refuge was confirmed in 1995 and reaffirmed in 2007 by telemetry studies that found that the Indiana bat is a summer resident on the Refuge (Whittaker 1995; Carter 2007), and it may be more abundant than was generally thought. These bats are also known to form maternity colonies on the Refuge; one maternity roost was studied and its coordinates recorded in 2007, (Carter 2007). River otters, once extirpated from the State of Indiana, were reintroduced to the Refuge beginning in January 1995. The first otter litters were produced on the Refuge in 1996. The reintroduction in Indiana has been successful and river otters are no longer considered state-listed endangered (Johnson et al. 2007). A complete list of mammal species that occur on the Refuge can be found in Appendix C.

3.7.6 Amphibians and Reptiles

Forty-one species of amphibians and reptiles are known on the Refuge. They include the state-listed endangered four-toed salamander, copperbelly watersnake, Kirtland's snake, and the rough green snake, an Indiana Species of Special Concern. As of November 1996, under the provisions of the Copperbelly Watersnake Conservation Agreement and Strategy, scientists began to better understand the life history patterns of the copperbelly watersnake. Telemetry work at the Refuge has proven valuable in clarifying the ecological requirements of this species and observational data collected since 1992 and tracking/locating data collected in 1997 through 2000 revealed the species' dependence on both palustrine emergent and floodplain forest habitats. Indiana University Professor Dr. Meretsky discovered the state-listed endangered four-toed salamander during her work on the Refuge. The salamander is associated with mature forests containing wetlands with mossy edges. Records of the species from central and southern Indiana appear to be based upon very small isolated colonies, some of which may no longer exist. Thus, the Refuge population is a significant find. A complete list of the amphibians and reptiles that occur on the Refuge is provided in Appendix C.

3.7.7 Fish

Fifty-four species of fish were collected during a 2007 survey on the Refuge. The species collected are presented in Appendix C. The most diverse families represented were the minnow and darter families that included 11 species each. Fishing for largemouth bass, bluegill, redear sunfish, crappie, and channel catfish is popular with an estimated 15,000 fishing visits per year at the Refuge.

3.7.8 Invertebrates

An intensive survey of aquatic macroinvertebrates was conducted concurrently with the fish survey during the spring of 2007. Fifty samples were collected from a variety of creeks, streams, and lake outlets. The results of this survey are still pending; however, five species of crayfish were collected including the paintedhand mudbug, Great Plains mudbug, northern crayfish, Sloan's crayfish, and rusty crayfish (Simon et al. 2008).

Thirty-five dragonfly species have been recorded on the Refuge, including the Beaverpond baskettail, eastern pondhawk, and shadow darner. The Refuge, where many photographs were taken to illustrate the book Dragonflies of Indiana, is known as a good location to observe dragonflies (Curry 2001). The beaverpond baskettail dragonfly is considered a rare species in the State of Indiana. Butterfly surveys have been conducted since 2002 by volunteers using a protocol established by the North American Butterfly Association, and 60 species have been identified to date including the cabbage white, an exotic species. A complete listing of dragonfly and butterfly species documented on the Refuge can be found in Appendix C.

At least 24 species of mollusks have been documented on the Refuge (Harmon 1996, Fisher 2007). A total of eight sites were sampled in 2007 for live, fresh dead, and weathered dead shells. Harmon's (1996) study documented 20 species present on the Refuge; the 2007 inquiry yielded three new species from the Vernon Fork – elephantear, flutedshell, and deertoe. The little spectaclecase was found in both the 1996 and the 2007 surveys. However, only fresh dead specimens were encountered in 2007. This species is a species of special concern in Indiana and is listed as imperiled (S2) within the state. The Asiatic clam, a non-native invasive species, is markedly abundant on the Refuge, especially within the Vernon Fork of

the Muscatatuck River. A complete listing of mollusk species documented on the Refuge can be found in Appendix C.

3.7.9 Threatened and Endangered Species

3.7.9.1 Threatened/Endangered/Candidate Species (Federally Listed)

Least Tern, Whooping Crane, Indiana bat, and copperbelly watersnake use the Refuge. Whooping Cranes from the "Operation Migration" project have used the Refuge as a stopover on their annual trip down to Florida, and free ranging or direct release birds are routinely seen within 20 miles of the Refuge. There is substantial documentation of the copperbelly watersnake's use of the Refuge.

The federally-listed Endangered Indiana bat was confirmed on the Refuge in 1995 and reaffirmed in 2007. Surveys indicate that the Indiana bat roosts on the Refuge during the summer and that maternity colonies are present.

3.7.9.2 State-listed/Candidate Species

A total of 61 state-listed endangered and special concern species have been documented on the Refuge with five more suspected to occur on the property. State status, including state-listed or special concern, is noted in the species lists contained in Appendix C.

3.8 Threats to Resources

3.8.1 Invasive/Exotic/Pest Species

Invasive, exotic, and noxious weeds are common throughout most of the Refuge's habitat types. Although research quality distribution and abundance estimates are lacking, it is evident to anyone traveling on Refuge roads that autumn olive, garlic mustard, reed canary grass, multiflora rose, crown vetch and many other species dominate certain portions of the landscape. Japanese stiltgrass, multiflora rose, autumn olive, tree-of-heaven, and kudzu threaten the diversity and health of the bottomland and upland hardwoods while other species, such as reed canary grass, compete with native vegetation in riparian corridors, moist soil units, and other wetland types. Many of the invasive species have the capability of producing solid monocultures shading out native vegetation, which reduces overall plant and animal diversity.

Invasives, exotics, and pest species found on the Refuge are:

- purple loosestrife
- Autumn olive
- Canada thistle
- Johnson grass
- multiflora rose
- moneywort
- common carp
- Asian clams
- Japanese stiltgrass
- oriental bittersweet
- garlic mustard
- kudzu
- reed canary grass
- Asian ambrosia beetle
- Asian ladybugs
- European Starling
- Brown-headed Cowbirds
- House Sparrows
- mosquito fish
- gypsy moths

There was an account of a gypsy moth in 1995, but subsequent traps have not revealed any moths. It is not considered a major problem.

3.8.2 Contaminants

Contaminants may be entering the Refuge via the Vernon Fork of the Muscatatuck River (VFMR) and its tributaries. Contaminants are also likely to be entering the Refuge from a wide variety of other sources such as:

- atmospheric deposition
- crop and livestock runoff
- septic system failures
- surface runoff from the city of Seymour and adjacent highways and roads
- discharge from National Pollutant Discharge Elimination System (NPDES) sites
- underground storage tanks
- accidental spills

- power substations
- Crown Central Petroleum (refinery)

Agriculture is the primary land use in the watershed. Run-off from crop fields, pastureland, and feedlots contributes to non-point source pollution. Erosion, nutrient and sediment loading, and contamination from application of pesticides, herbicides, and fertilizers all introduce contaminants into the watershed and Refuge system. Many of these substances, such as organo-chlorines and organo-phophates, are known to be toxic to fish and wildlife via direct exposure, bioaccumulation, and bio-magnification.

In addition to agriculture, the rapid urban development of the area surrounding the Refuge has had detrimental impacts on the watershed. As more land is cleared and paved, there are increases in flow rates, erosion, and amount of particles, sediment, and other substances reaching the Refuge. The Refuge is within a mile or less of three major highways, all of which cross at least one of the three primary tributaries that enter the Refuge. This creates sources of run-off containing salts, fuel, and other petroleum products. In addition, the construction of homes and businesses has put a strain on waste water treatment facilities and septic systems which could result in nutrient and bacterial problems within the watershed. There is also potential for accidental spills to occur.

Atmospheric deposition of heavy metals is a concern worldwide and the Refuge falls under the same general fish advisory as most of the waters in the State of Indiana. This advisory establishes recommendations for fish consumption based on elevated mercury levels with the fish in Indiana. The problems associated with heavy metal contamination may be compounded at the Refuge due to the impoundment of water and trapping of sediment, collection, and concentration of runoff from a large watershed, and the wetting and drying cycles that contribute to the methylation of mercury.

3.9 Archeological and Cultural Values

The Myers Cabin is a restored family log cabin at the south end of the Refuge that was built between 1870-1890 by Louis Myers. The barn behind the cabin was built in 1900 and is an excellent example of "hand-pegged" construction. Carl Myers, a son of Louis, was in the plant nursery business and developed (or found) some seedless persimmon trees, which he sold commercially from his house adjacent to Myers Cabin. A small grove of the seedless persimmon trees still remain close to the cabin. The cabin was continuously occupied by the Myers family and the barn was in use until they were purchased by the Fish and Wildlife Service around 1966. Both structures are in very good condition and have been restored and maintained by the Muscatatuck Wildlife Society.

The Barkman Cemetery is located along County Line Road and was in use at the time of the Refuge establishment. A path to the cemetery is maintained for ease of access from a small parking lot. There are more than 30 headstones, and many have been repaired by volunteers. The cemetery is maintained by Refuge and volunteer staff and is regularly visited by family members.

The Myers Cemetery is a small site located along the East River Hiking Trail, and has only about seven head-stones. It is in the woods and does not require mowing. A marker for an unknown civil war soldier was apparently stolen from the cemetery in the early 1980s.

The Refuge has two national register archaelogical sites, the Low Spur site and the Sand Hill site. The Sand Hill site and most of the Refuge area was scoured by collectors long before the Refuge was purchased. More than 73 archaelogical sites have been documented on the Refuge by professional archaeologists. Recovered artifacts indicate that the Refuge area was intensively occupied in the Archaic (10,000-1,000 B.C.) and Woodland (1,000 B.C.-A.D. 1200) time periods with Late Archaic and Woodland components particularly well represented. Early Archaic sites were found on upland ridge and bluff tops and both Early and Late Archaic sites were found on ridge spurs and lowland terraces. Large multi-component sites were located on a variety of landforms. Many of the sites have been interpreted as short-term temporary campsites, perhaps seasonal extractive camps (like hickory-nut processing) or sites occupied for part of the year. Fire-cracked rock, chert flakes, projectile points, and pieces of pottery were commonly excavated finds and are curated at the Glenn Black Museum in Bloomington.

3.10 Other Management Areas

3.10.1 Research Natural Area

The Muscatatuck Seep Springs Research Natural Area (MSS-RNA) occupies a 97-acre portion of the Refuge. It is one of only seven acid seep springs documented in Indiana. The cold, acidic groundwater yields a unique assemblage of plant species. Many of the plants that occur here are restricted to these exact environmental conditions. These conditions are extremely uncommon in the landscape, especially in southern Indiana. This community is also ranked G3 (Globally Rare) in the Natural Heritage system, an international network of biological and conservation data base, coordinated by the Nature Conservancy. State-listed plant species found here are: American ginseng, club spur orchid, southern tubercled orchid, bog bluegrass, Walter's St. Johnswort, smooth white violet. Also found here are the state-listed endangered four-toed salamander and the state-listed endangered copperbelly watersnake.

3.10.2 Restle Unit

The Restle Unit of Muscatatuck NWR is a 78-acre parcel in Monroe County, northwest of Bloomington, Indiana, donated to the National Wildlife Refuge System in 1990. It has a 30-acre emergent wetland that was repaired by a Maintenance Action Team in September 2005. The rest of the remaining acreage is bottomland hardwoods. It is a palustrine floodplain forest with swamp white oak, pin oak, swamp cottonwood, sycamore and silver maple.

Historically the area was a part of a large forested area called the Central Hardwood Region. The GLO original survey notes of 1811 and 1815 refer to forests comprised of beech, burr oak, maple, water oak, poplar, hickory, elm, and ash (Slusher and Welch 2001). The land was cleared for agriculture in the mid-1800s as the state was settled and tile drainage began in the late 1800s, and an extensive system of ditches was put in place in order to control the hydrology for farming.

The Restle Unit lies within the outer margin of the floodplain on the north side of Bean Blossom Creek. Steep uplands with intermittent streams form a border north of the property. The unit is relatively flat and has a low gradient and is seasonally flooded. It is located in the south central part of the state, in a region known as the Mitchell Karst Plain Section of the Highland Rim Natural Region, as classified by the Indiana Natural Heritage program. The major soil types are Zipp, silty clay loam which is frequently flooded, and Burnside silt loam which is occasionally flooded.

The Restle Unit provides habitat for a diversity of wildlife including Wood Ducks, Canada Geese, Hooded Mergansers, Mallards, and other waterfowl. At least 80 bird species have been identified using the unit including Bald Eagle, Osprey, Northern Harrier, Black-crowned Night-Heron, Great Egret, and Great Blue Herons.

Mammals seen on the Refuge include beaver, muskrats, white-tailed deer, eastern fox squirrel, raccoon, red fox, opossum, and eastern mole are mammals that have been seen.

Amphibians and reptiles seen in the Unit include: Cricket frog, green frog, spring peeper, southern leopard frog, painted turtle, snapping turtle, northern banded water snake, and ribbon snake.

The federally-listed endangered Indiana bat has not been confirmed on the Unit, but is suspected to be present because the habitat provided matches its requirements; however no studies have occurred to find them. An IDNR radio collared bobcat was tracked using the Restle Unit in June and July 2002.

The Restle Unit is surrounded by a complex of protected land called the Bean Blossom Bottoms that includes acreage owned by Sycamore Land Trust and Wetland Reserve Program land. A total of 708 acres are protected. At least 109 bird species including Prothonotary Warbler, Wood Thrush, Cerulean Warbler, Red-headed Woodpecker, American Woodcock, Willow Flycatcher, Prairie Warbler, Henslow's Sparrow, Virginia Rail, and King Rail all have been reported from the Bean Blossom Bottoms area and the area is recognized as an Indiana Important Bird Area (IBA) by the Audubon Society. These lands support a Bald Eagle nest, a Great Blue Heron rookery, the state-listed endangered Kirtland's snake and northern crayfish frog (last confirmed in 1998).

The Unit is included in the Audubon-designated Beanblossom Bottoms Important Bird Area (IBA). State-listed species seen are Bald Eagle, Northern Harrier, Barn Owl, Osprey, Black-crowned Night-Heron, and Black Tern. State species of concern include Great Egret, Red-shouldered Hawk, and

Sandhill Crane. Twenty three bird species of Conservation Concern were listed on the IBA nomination form (Cole 2007).

Invasive, exotic species and noxious weeds seen at the Unit include reed canary grass, Asian bush honeysuckle and European Starling. Inventory work has not yet been done.

Management of the Unit as stated in the Restle donation document is "grantee shall perpetually manage the real estate as a wetland habitat for native wildlife and plant enhancement and protection." There are some deed restrictions to the management of the property (Appendix E of the Draft CCP).

The 30-acre wetland area will be managed for migrant and nesting waterfowl and, when appropriate, mudflats may be exposed for shorebird use. The bottomland hardwood forest will continue to grow.

The Restle Unit was donated with the restriction that "no general access of the public to the area shall be permitted." An observation deck overlooking the Unit with a parking area on Bottom Road was constructed in 1998 and is available for the public to use.

Chapter 4: Environmental Consequences

4.1 Effects Common to All Alternatives

Specific environmental and social impacts of implementing each alternative are examined in this chapter. A summary of the impacts of each alternative is provided in Table 2 on page 133. Several potential effects will be very similar under each alternative, and they are summarized in this section.

4.1.1 Air Quality

None of the management alternatives would have appreciable, long-term impacts on ambient air quality. Prescribed fire would not be used as a habitat management strategy under Alternatives A and B; however, it may be used under Alternatives C and D as an option to maintain the wildlife viewing areas and to control invasives, manage moist soil units forests, and grasslands. Tailpipe emissions from operation of Refuge equipment and from visitation to the Refuge by the motoring public are negligible in comparison with overall regional emissions.

4.1.2 Environmental Justice

Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" was signed by President Clinton on February 11, 1994. Its purpose was to focus the attention of federal agencies 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 directed federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and 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 access to public information and participation in matters relating to human health or the environment.

None of the management alternatives would disproportionately place any adverse environmental, economic, social, or health impacts on minority and low income populations. Public use activities that would be offered under each of the alternative would be available to any visitor regardless of race, ethnicity or income level. The new, proposed entrance fee in Alternatives B and D would be small and would not be a prohibitive expense to any motorist visiting the Refuge.

4.1.3 Climate Change Impacts

The U.S. Department of the Interior issued an order in January 2001 requiring federal agencies, under its direction, that have land management responsibilities to consider potential climate change impacts as part of long range planning endeavors.

The increase of carbon dioxide (CO2) within the earth's atmosphere has been linked to the gradual rise in surface temperature commonly referred to as global warming. In relation to comprehensive conservation planning for national wildlife refuges, carbon sequestration constitutes the primary climate-related impact to be considered in planning. The U.S. Department of Energy's "Carbon Sequestration Research and Development" defines carbon sequestration as "...the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere."

Vegetated land is a tremendous factor in carbon sequestration. Terrestrial biomes of all sorts – grasslands, forests, wetlands, tundra, and desert – are effective both in preventing carbon emission and acting as a biological "scrubber" of atmospheric CO2. The Department of Energy report's conclusions noted that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere.

Conserving natural habitat for wildlife is the heart of any long-range plan for national wildlife refuges. The actions proposed in this CCP would conserve or restore land and habitat, and would thus retain existing carbon sequestration on the Refuge. This in turn contributes positively to efforts to mitigate human-induced global climate change.

Overall, there will be a minimal postive net change in the amount of carbon sequestered on the Refuge from any of the proposed management alternatives. Further discussion of potential concerns and uncertainties related to climate change are included in the CCP.

4.1.4 Cultural Resources

The Service is responsible for managing archeological and historic sites found on national wildlife refuges. Undertakings accomplished on the Refuge have the potential to impact cultural resources. The consequences for cultural resources would be the same under each management alternative. Although the presence of cultural resources, including historic properties, cannot stop a Federal undertaking, the undertakings are subject to Section 106 of the National Historic Preservation Act and sometimes other laws. Thus, the Refuge Manager, during early planning, provides the Regional Historic Preservation Officer a description and location of all projects, activities, routine maintenance and operations that affect ground and structures; requests for permitted uses; and alternatives being considered. The RHPO analyzes these undertakings for potential to affect historic properties and enters into consultation with the State Historic Preservation Officer and other parties as appropriate. And, the Refuge Manager asks the public and local government officials to identify concerns about impacts caused by the undertaking in a notification that is at least equal to, and preferably with, the public notification carried out for NEPA and compatibility.

4.1.5 Other Common Effects

None of the alternatives would have more than negligible or at most minor effects on soils, topography, noise levels, transportation, waste management, human health and safety, or visual resources.

4.2 Management Alternatives

4.2.1 Alternative A: Current Management Direction (No Action)

Under this alternative the activities of the Refuge would continue as in the past with current staffing and resources.

Under Alternative A, the conversion of former cropland to upland forest would continue through natural succession and limited tree planting to provide for forest nesting birds, neo-tropical migrants, and Indiana bats. It is expected that habitat benefits would continue to accrue for these species under Alternative A. And, the Refuge's bottomland forest would be managed as in the past to benefit cavity nesting waterfowl. The projected increase in the block sizes of upland and bottomland forests would be beneficial to area sensitive species.

The acreage of open water on the Refuge would be maintained as would the current benefits to broods and migrant birds.

The constructed impoundments, which are seasonally flooded, would be managed as in the past under this alternative. The manipulation of water levels and vegetation management would be less than the design potential of the units. The units would support fewer waterfowl and shorebirds than possible under optimum management.

Former farmland would be allowed to proceed through natural succession and early successional habitat would develop, which would benefit grassland and shrubland bird species such as:

- Blue-winged Warbler
- Golden-winged Warbler
- Yellow-breasted Chats
- American Woodcock
- Bob-white Quail
- Prairie Warbler
- Field Sparrow
- Henslow's Sparrow
- Grasshopper Sparrow
- Dickcissel
- Bobolink

- Sedge Wren
- Black-billed Cuckoo

Many woodland nesting bird species utilize shrublands as post-fledging habitat. Upon maturity of these habitats, as shrubs are replaced by larger trees, a variety of forest dwelling species would begin to experience benefits. Species that might be expected to benefit include: white-tailed deer, eastern gray squirrel, eastern fox squirrel, southern flying squirrel, woodchuck, and Indiana bat.

Forest birds that might benefit include:

- Wood Duck
- Hooded Merganser
- Red-shouldered Hawk
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- American Redstart
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

A wide range of reptiles and amphibians could be expected to benefit from habitat conditions under Alternative A. The current acreage in farming rotation would continue and benefit wildlife viewing of many species including Wild Turkey, deer, raptors such as Rough-legged Hawks and Northern Harriers, Sandhill Cranes, geese and other waterfowl will be seen by the public. Limited herbicide application would likely continue to be necessary to ensure efficient crop production; removing land from agriculture greatly reduces the need for herbicide application which then is only necessary in the case of invasive plant control. The negative impacts to water quality, amphibians, invertebrates etc. would consequently be locally reduced if agricultural production ceased. However, maintaining agricultural lands allows for the retention of terrestrial edge habitats within the Refuge which is extremely valuable for many species. This habitat type will be limited if all agriculture acreages were allowed to revert to forested habitats and edge species would suffer the consequences.

The diversity of habitat on the Refuge is what makes this a top birding spot in the state. The Refuge is a "Continentally Important Bird Area." Therefore, large scale or drastic changes in the way the Refuge is managed could have a negative impact on the diversity of habitat and consequently on the number of species of birds and their abundance. Small mammals associated with agriculture and grasslands are another suite of species that would likely suffer negative impacts as former cropland and grasslands are converted to forested habitats, however, small mammals native to bottomland forest habitat should increase in abundance. This alternative is the current management alternative.

For a birder, seeing 100 or more species in a day is a goal that usually involves driving hundreds of miles by car to visit the varied habitats required to achieve this goal. The variety of habitat on the Refuge in this alternative has made the goal possible. The ability to visit forest, grassland, shrub/scrub, marsh and other wetland habitats in a rather small area makes Muscatatuck NWR a remarkable place for bird watchers.

The treatment and control of invasive plant species using a variety of methods would have the beneficial result of slowing the spread of these species, which tend to supplant native flora and reduce habitat value for wildlife. Under Alternative A, there would be control on about 220 acres each year and limited monitoring of invasive species.

This alternative would support a number of species on the Region's Regional Conservation Priority Species list.

Under this alternative the wildlife-dependent opportunities available on the Refuge would continue at the present level. Volunteer and partnership participation would continue, as would the current level of contact with the community. The result would be that visitor numbers, visitor satisfaction, and public support of Refuge would continue at current levels.

4.2.2 Alternative B: Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses

Under Alternative B, the restoration of historical land cover and processes would benefit forest nesting birds, neo-tropical migrants, and Indiana bats. It is expected that wildlife benefits would be greater than under Alternative A. The Refuge's bottomland forest would be managed as in the past to benefit cavity nesting waterfowl. The projected increase in the block sizes of upland and bottomland forests would be beneficial to area sensitive species such as Cerulean Warbler and Wood Thrush. The acreage of open water on the Refuge would be decreased. Benefits to broods and migrant birds may be slightly reduced; however, benefits would accrue across a wide array of herpetofaunal assemblages, which in turn will benefit species that prey on these reptiles and amphibians. It can be expected that frog and salamander species would increase in abundance under this alternative as these areas revert and as the habitats become less suitable for the fish species that negatively impact their longevity and reproductive success.

Fewer constructed impoundments, which are seasonally flooded, would be managed under this alternative compared to Alternative A. This would result in a small reduction in the acreage of available brood habitat. However, it is estimated that the Refuge already has underutilized brood habitat in the water units that would be retained and managed. A large reduction in the acreage of habitat available to migrant waterfowl, shorebirds, and wading birds is expected to transpire; however, these losses are expected to be offset by increases in the quality of habitat and native plant food production on the remaining impoundments. A broad range of reptiles and amphibians are expected to benefit as impoundments influenced by the Vernon Fork and Moss Lake flood waters tend to harbor an abundance of fish that negatively impact longevity and reproductive success of these species. Fish are not only detrimental to the herpetofauna but sizeable large mouth bass can also negatively impact Wood Duck duckling survival through predation losses. The increases in bottomland forested habitat will benefit breeding Wood Ducks and other cavity nesting species, migrant waterfowl, neotropical migrants, and several mammal species. Specifically, the following species would be expected to respond well to the changes under this alternative:

- white-tailed deer
- eastern gray squirrel
- eastern fox squirrel
- southern flying squirrel
- woodchuck
- Indiana bat

Forest birds expected to respond well to changes resulting from this alternative include:

- Red-shouldered Hawk
- Long-eared Owl
- Chuck-will's-widow
- Whip-poor-will
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

Former farmland would be actively converted to habitat in later stages of succession, which would benefit early successional species, including grassland and shrubland birds, for several decades before eventually giving way to benefits solely to forest species. Bird species that would benefit from converting former farmland, including many woodland nesting bird species that use shrublands as post-fledging habitat, include:

- Blue-winged Warbler
- Golden-winged Warbler
- Yellow-breasted Chat
- American Woodcock
- Bob-white Quail
- Prairie Warbler

- Field Sparrow
- Henslow's Sparrow
- Grasshopper Sparrow
- Dickcissel
- Bobolink
- Sedge Wren
- Black-billed Cuckoo

As these habitats mature and shrubs are replaced by larger trees, a variety of forest dwelling species will begin to experience benefits.

Mammal species include:

- white-tailed deer
- Eastern gray squirrel
- Eastern fox squirrel
- Southern flying squirrel
- Indiana bat

Forest birds likely to benefit include:

- Wood Duck
- Hooded Merganser
- Red-shouldered Hawk
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- American Redstart
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

Species expected to benefit also include a wide range of reptiles and amphibians.

The current acreage in farming rotation would be discontinued and converted to forested habitat following an extended period of grassland/shrubland habitat. The species benefited will mirror those benefited by conversion of the former farmland to forested habitats. Drastic reductions in edge habitat will ensue under this alternative, eventually negatively impacting abundance and density of a wide range of edge species. However, species that are closely tied to agricultural lands are not expected to be severely impacted on a local or regional scale because of the abundance of agriculture in the surrounding landscape. Brown-headed Cowbirds would likely be negatively impacted, which would benefit forest and shrubland birds. Increases in small mammal populations and furbearer species could be expected in the short-term with only long-term benefits procured for forest species such as white-tailed deer, eastern gray squirrel, eastern fox squirrel, southern flying squirrel, woodchuck, and the Indiana bat. Some reptiles and amphibian species can be expected to benefit as well.

Agricultural practices create monotypic stands of vegetation and reduce overall productivity of many sites and are directly responsible for the mortality of many small mammal, reptile, amphibian, and bird species. Direct mortality from machinery, loss of habitat, nest destruction, and health problems associated with herbicides are expected to be reduced under this alternative and elimination of farming and the associated agricultural practices is presumed to have more positive benefits than negative.

Diversity of habitat at the Refuge level will be reduced, although this will not be true at the field level as increases in vegetative diversity should follow within crop fields where monocultures were promoted. Edge habitat will be reduced eventually, however, during the early stages of conversion of cropland to forest an abundance of early successional habitat will be produced leading to short-term increases in diversity of habitat. Such gains in diversity would be temporary and, as early successional habitat is replaced by maturing forest, diversity of habitat would be drastically reduced.

The control of invasive plant species using a variety of methods would have the beneficial result of slowing the spread of these species. Under this alternative, good information would guide control efforts and invasive species would be more effectively controlled than under Alternative A.

This alternative would support a number of species on the Region's Regional Conservation Priority Species (RCPS) list in the short-term. The

species expected to benefit during the early stages of forest development include:

- Northern Harrier
- American Woodcock
- Short-eared Owl
- Loggerhead Shrike
- Bell's Vireo
- Blue-winged Warbler
- Golden-winged Warbler
- Prairie Warbler
- Field Sparrow

Support for many more species on the RCPS list would be long-term if not perpetual. These species include:

- copperbelly watersnake
- Indiana bat
- Wood Thrush
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- Louisiana Water Thrush
- Kentucky Warbler
- Canada Warbler
- Rusty Blackbird
- Wood Duck
- Long-eared Owl
- Chuck-will's-widow
- Whip-poor-will
- Red-headed Woodpecker
- Northern Flicker
- Olive-sided Flycatcher
- Acadian Flycatcher

Four species on the RCPS list are expected to benefit in both the long and short terms: Black-billed Cuckoo, Bewick's Wren, and the Orchard Oriole.

This alternative differs from Alternative A in a couple of ways. The reduction in openings within the forested landscapes is hypothesized to result in lower abundances of Brown-headed Cowbirds, which negatively influence the nest success of many of the aforementioned bird species. Also both the long-term and the short-term species previously mentioned are supported to a greater extent under this alternative owing to the conversion of a larger acreage than under Alternative A.

The recreation fees collected under this alternative would help generate revenue needed to support visitor services. The new recreation fees would require an adjustment period until visitors become informed of the program.

Under this alternative the wildlife-dependent recreation opportunities available on the Refuge would change. The miles of road open to the public would be reduced from 8.41 miles to 5.56 miles in Alternative B. Refuge entrances would be reduced from two to one. Length of maintained trails would be reduced from 9.93 miles to 3.79 miles.

Visitors seeking easy access to the Refuge would experience fewer opportunities. Visitors seeking an experience further from their vehicle and encountering fewer other visitors would have more opportunities under this alternative.

Successful deer hunters would have farther to travel on average to bring their deer to a vehicle. The average distance from the area open to deer hunting to an open road in Alternative A is 1,765 feet and in Alternative B is 2,742 feet. The maximum distance in Alternative A is 1.16 miles and in Alternative B is 1.75 miles. There would be approximately 2 more weeks open to deer hunting under this alternative compared to Alternative A.

Persons with mobility challenges would have more fishing opportunities as more accessible sites are developed at existing fishing locations under this alternative. Some ponds would be more difficult to reach for fishing, which would offer the opportunity of fishing with fewer people present. The change in road and trail access would reduce fishing opportunities for visitors who did not want to walk or bicycle to the more remote ponds.

The type of opportunities for wildlife observation and photography would change under this alternative compared to Alternative A. Less diversity of habitat and fewer species would likely be seen by visitors due to the reduced miles of roads available. Visitors seeking observation and photography experiences characterized by the presence of fewer people, experiencing nature, and exploration would find more and higher quality opportunities under this alternative.

Interpretation and environmental education under this alternative would be expected to promote resource stewardship, conservation and public understanding of natural resources and increase public appreciation of America's natural resources to the same degree as in Alternative A.

Volunteer and partnership participation would increase slightly and the level of contact with the community would be maintained in this alternative . The result would be that visitor numbers, visitor satisfaction, and public support of the Refuge should increase slightly above current levels.

4.2.3 Alternative C: Balance Natural Processes and Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alternative)

Under Alternative C the restoration of historical land cover and processes and the projected increase in the block sizes of upland and bottomland forests would be beneficial to area sensitive species such as: nesting birds, neo-tropical migrants, and Indiana bats. It is expected that wildlife benefits would be greater than under Alternative A. The Refuge's bottomland forest would be managed as in the past to benefit tree nesting water birds that include Wood Ducks, Hooded Mergansers, Green Herons, and Yellow-crowned Night-herons.

The acreage of open water on the Refuge would be decreased. Benefits to Wood Ducks, and waterbirds may be slightly reduced in the areas. However, benefits would accrue across a wide array of herpetofaunal assemblages which in turn would benefit species that prey on these reptiles and amphibians. It can be expected that frog and salamander species would increase in abundance under this alternative as these areas revert and as the habitats become less suitable for the fish species that negatively impact their longevity and reproductive success. Bird species that are expected to benefit include: Yellow-crowned Night-Heron, Barred Owl, Solitary Sandpiper, Northern Waterthrush, and Louisiana Waterthrush. The benefits to these species would be greater than in Alternative A and equal to or slightly less than in Alternative B.

Fewer acres within constructed impoundments, which are seasonally flooded, would be managed under this alternative compared to Alternative A. This will result in a small reduction in the acreage of available brood habitat and the acreage of habitat available to migrant waterfowl, shorebirds, and wading birds. However, these losses are expected to be offset by increases in the quality of habitat and native plant food production on the remaining impoundments. A broad range of reptiles and amphibians are expected to benefit as impoundments influenced by the Vernon Fork and Moss Lake flood waters tend to harbor an abundance of fish that negatively impact longevity and reproductive success of these species. Fish are not only detrimental to the herpetofauna but sizeable large mouth bass can also negatively impact Wood Duck duckling survival through predation losses. The increases in bottomland forested habitat will benefit breeding Wood Ducks and other cavity nesting species, migrant waterfowl, neotropical migrants, and several mammal species. Specifically, the following mammal species are likely to benefit under this alternative:

- white-tailed deer
- Eastern gray squirrel
- Eastern fox squirrel
- southern flying squirrel
- Indiana bat

Forest birds that are likely to benefit include:

- Wood Duck
- Hooded Merganser
- Red-shouldered Hawk
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- American Redstart
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

Former farmland would be actively converted to habitat in later stages of succession, which would benefit early successional species, including grassland and shrubland birds, for several decades before eventually giving way to benefits solely to forest species. Bird species such as Blue-winged Warbler, Golden-winged Warbler, Yellow-breasted Chat, American Woodcock, Bob-white Quail, Prairie Warbler, Field Sparrow, Henslow's Sparrow, Grasshopper Sparrow, Dickcissel, Bobolink, Sedge Wren and Black-billed Cuckoo would benefit as well as many woodland nesting bird species that use shrublands as post-fledging habitat. As these habitats mature and shrubs are replaced by larger trees, a variety of forest dwelling species would begin to experience benefits. Mammals expected to benefit from this management alternative include: White-tailed deer, eastern gray squirrel, eastern fox squirrel, southern flying squirrel, and Indiana bat. Forest birds that would benefit include:

- Wood Duck
- Hooded Merganser
- Red-shouldered Hawk
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- American Redstart
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

A wide range of reptile and amphibian species are also likely to benefit from this management direction.

The current acreage in farming rotation would be discontinued and converted to forested habitat following an extended period of grassland/shrubland habitat. The species benefited will mirror those benefited by conversion of the former farmland to forested habitats. Drastic reductions in edge habitat will ensue under this alternative, eventually negatively impacting abundance and density of a wide range of edge species. However, species that are closely tied to agricultural lands are not expected to be severely impacted on a local or regional scale because of the abundance of agriculture in the surrounding landscape. Brown-headed Cowbirds would likely be negatively impacted to the benefit of forest and shrubland birds. Increases in small mammal populations and furbearer species could be expected in the short-term with only long-term benefits procured for forest species such as: white-tailed deer, eastern gray squirrel, eastern fox squirrel, southern flying squirrel, woodchuck, and Indiana bat. Some reptiles and amphibian species can be expected to benefit as well.

Agricultural practices create monotypic stands of vegetation and reduce overall productivity of many sites and are directly responsible for the mortality of many small mammals, reptiles, amphibians, and birds. Direct mortality from machinery, loss of habitat, nest destruction, and health problems associated with herbicides are expected to be reduced under this alternative and elimination of farming and the associated agricultural practices is presumed to have more positive benefits than negative.

Diversity of habitat at the Refuge level will be reduced, although this will not be true at the field level as increases in vegetative diversity should follow within crop fields where monocultures were promoted. Edge habitat will be reduced eventually, however, during the early stages of converting cropland to forest, an abundance of early successional habitat will be produced leading to short-term increases in diversity of habitat. Such gains in diversity will be temporary and, as early successional habitat is replaced by maturing forest, diversity of habitat will be drastically reduced.

The control of invasive plant species using a variety of methods would have the beneficial result of slowing the spread of these species. Under this alternative, good information would guide control efforts and invasive species would be more effectively controlled than under Alternative A.

This alternative would support a number of species on the Region's Regional Conservation Priority Species list and has identical benefits as Alternative B. The species expected to benefit during the early stages of forest development include: Northern Harrier, American Woodcock,

Short-eared Owl, Loggerhead Shrike, Bell's Vireo, Blue-winged Warbler, Golden-winged Warbler, Prairie Warbler, and the Field Sparrow.

Support for many more species on the RCPS list would be long-term if not perpetual. These species include:

- copperbelly watersnake
- Indiana bat
- Wood Thrush
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- Louisiana Water Thrush
- Kentucky Warbler
- Canada Warbler
- Rusty Blackbird
- Wood Duck
- Long-eared Owl,
- Chuck-will's-widow
- Whip-poor-will
- Red-headed Woodpecker
- Northern Flicker
- Olive-sided Flycatcher
- Acadian Flycatcher

Four species on the RCPS list are expected to benefit in both the long-term and short-term; these species include Black-billed Cuckoo, Bewick's Wren, and the Orchard Oriole. This alternative differs from Alternative A in a couple of ways. The reduction in openings within the forested landscapes is hypothesized to result in lower abundances of Brown-headed Cowbirds, which negatively influence nest success of many of the aforementioned bird species. Also both the long-term and the short-term species previously mentioned are supported to a greater extent under this alternative owing to the conversion of a larger acreage than under Alternative A.

Under this alternative the wildlife-dependent recreational opportunities available on the Refuge would change. Refuge entrances would be reduced from two to one. Some people would be inconvienced by the loss of one entrance and an existing shortcut to the highway. People living in houses along County Road 400 N (West Entrance) would benefit from decreased traffic. Length of maintained trails would be reduced from 9.93 miles to 4.62 miles.

Visitors seeking easy access to the Refuge would experience a more developed auto tour route. Visitors seeking an experience further from their vehicle and encountering fewer other visitors would have more opportunities under this alternative than under Alternative A, but less than Alternative B.

Successful deer hunters would have the same distance to travel on average to bring their deer to a vehicle as in Alternative A. There would be approximately 3 more weeks open to deer hunting under this alternative compared to Alternative A. There would be more opportunities for youth to hunt.

Persons with mobility challenges would have more fishing opportunities as more accessible sites are developed at current fishing locations under this alternative. Because electric motors would be allowed on Stanfield Lake, visitors would have easier access to all parts of the lake, which may expand opportunities for persons who find it difficult to row or paddle. A sustainable fishery and better management would result in a more consistent chance of success for anglers from year to year. Over the long-term, less resource impacts and a higher quality experience among fisherman is expected as a result of a fishing ethics educational program.

The setting for viewing and photographing wildlife from a vehicle would be improved under this alternative compared to Alternative A as a result of paving the auto tour route, which would reduce dust in the air. A diversity of habitat would be maintained and, therefore, a continued diversity of wildlife would be available for viewing in the long-term. Visitors seeking observation and photography experiences characterized by easy access would find higher quality opportunities under this alternative.

Interpretation and environmental education under this alternative would be expected to promote resource stewardship, conservation and public understanding of natural resources and increase public appreciation of America's natural resources to the same degree as in Alternative A. Visitors would experience increased quality of interpretive and educational experiences as these programs are incrementally improved.

Volunteer and partnership participation would increase slightly and the level of contact with the community would be maintained in this alternative. The result would be that visitor numbers, visitor satisfaction, and public support of the Refuge would increase slightly above current levels.

4.2.4 Alternative D: Intensified Management of Constructed Units; Expanded Priority General Public Uses

Under Alternative D the restoration of historical land cover would benefit forest nesting birds, neo-tropical migrants, and Indiana bats. It is expected that wildlife benefits would be greater than under Alternative A. The Refuge's bottomland forest would be managed as in the past to benefit cavity nesting waterfowl broods. The projected increase in the block sizes of upland and bottomland forests would be beneficial to area sensitive species such as Cerulean Warbler and Wood Thrush.

The acreage of open water on the Refuge would be maintained. Benefits to broods and migrant birds would be the same as in Alternative A. Benefits would not accrue across a wide array of herpetofaunal assemblages which in turn will not benefit species that prey on reptiles and amphibians. It can be expected that frog and salamander species will not increase in abundance under this alternative as these areas are not reverted back to forest and as the habitats remain suitable for the fish species that negatively impact their longevity and reproductive success. Under this alternative, fish will receive the benefit of protection from habitat degradation as the ponds will be protected from reverting back to shallow forested wetlands.

Intensive management of water impoundments, under this alternative, would benefit all three major waterbird guilds – migrating waterfowl, shorebirds, and wading birds – more than Alternative A. This will result in a small reduction in the acreage of available brood habitat as units are put back into moist soil production and consequently receive periodic vegetion and soil disturbances to set back succession. However, it is estimated that the Refuge already has a surplus of available brood habitat, so the loss is not expected to impact cavity nesting species overall. The acreage of suitable habitat available to migrant waterfowl, shorebirds, and wading birds is expected to increase. Native plant and seed production coupled with increased amphibian and invertebrate production will increase food supplies for a broad spectrum of wetland species from waterfowl to raccoons. Amphibians are expected to benefit as impoundments influenced by flood waters tend to harbor an abundance of fish, which negatively impact longevity and reproductive success of these species. Fish are not only detrimental to the herpetofauna but sizeable large mouth bass can also negatively impact Wood Duck duckling survival through predation losses. Several species of rails may benefit from increased management also.

Former farmland would be actively converted to habitat in later stages of succession, which would benefit early successional species, including grassland and shrubland birds, for several decades, eventually giving way to benefits solely to forest species. Bird species such as Blue-winged Warbler, Golden-winged Warbler, Yellow-breasted Chat, American Woodcock, Bob-white Quail, Prairie Warbler, Field Sparrow, Henslow' Sparrow and Grasshopper Sparrow, Dickcissel, Bobolink, and Sedge Wren would benefit as well as many woodland nesting bird species that use shrublands as post-fledging habitat. When these habitat mature and shrubs are replaced by larger trees, a variety of forest dwelling species will begin to experience benefits. Species likely to benefit include:

- White-tailed deer
- Eastern gray squirrel
- Eastern fox squirrel
- Southern Flying Squirrel
- Indiana bat
- Wood Duck
- Red-shouldered Hawk
- Red-headed Woodpecker
- Northern Flicker
- Acadian Flycatcher
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- American Redstart
- Louisiana Waterthrush
- Kentucky Warbler
- Rusty Blackbird

- Yellow-billed Cuckoo
- Wood Thrush

A wide range of reptiles and amphibians would also be expected to benefit.

The current acreage in farming rotation would be increased, which would provide more crane habitat and wildlife food which will benefit white-tailed deer, eastern Wild Turkey, Canada Goose, raptors such as Rough-winged Hawks and Northern Harriers, Sandhill Crane, Mallard, raccoon, opossum, and some squirrel and other small rodents, such as voles and mice. Brown-headed Cowbirds could be expected to benefit at the detriment of neotropical migrants, grassland and forested bird species. Retention of edge habitat will ensue under this alternative which will have positive impacts on abundance and density of a wide range of edge species. However, species that are closely tied to agricultural lands are not expected to be boosted on a local or regional scale because of the abundance of agriculture in the surrounding landscape and the relatively small acreage increases in this alternative.

Controlling of invasive plant species using a variety of methods would slow the spread of these species. Under this alternative, good information would guide control efforts and invasive species would be more effectively controlled than under Alternative A.

This alternative would support a number of species on the Region's Regional Conservation Priority Species list and differs from Alternative A in several respects. There would be less benefit to songbirds than there would be under other alternatives. Increases in agriculture would likely enable higher densities of brown-headed cowbirds to use the Refuge resulting in less benefit to neotropical, grassland, and forest bird species that are regional priority species. Also, the increases in farmed acreage would reduce the overall acreage converting to forested habitat compared to Alternative A consequently reducing benefits to the early successional species in the short term and forest species in the long term including Indiana bat and copperbelly watersnakes. The following species would still be expected to benefit from increases in forest acreage, but at reduced levels than in other alternatives.

Habitat during the early stages of forest development would be suitable for:

- Northern Harrier
- American Woodcock
- Short-eared Owl
- Loggerhead Shrike
- Bell's Vireo
- Blue-winged Warbler
- Golden-winged Warbler
- Prairie Warbler
- Field Sparrow

Support for many more species on the RCPS list would be long-term if not perpetual. These species include:

- copperbelly watersnake
- Indiana bat
- Wood Thrush
- Cerulean Warbler
- Prothonotary Warbler
- Worm-eating Warbler
- Louisiana Water Thrush
- Kentucky Warbler
- Canada Warbler
- Rusty Blackbird
- Wood Duck
- Long-eared Owl
- Chuck-will's-widow
- Whip-poor-will
- Red-headed Woodpecker
- Northern Flicker
- Olive-sided Flycatcher
- Acadian Flycatcher

Four species on the RCPS list are expected to benefit in both the long-term and short-term. These species include: Black-billed Cuckoo, Bewick's Wren, and the Orchard Oriole. The reduction in openings within the forested landscapes is hypothesized to result in lower abundances of Brown-headed Cowbirds, which negatively influence nest success of many of the previously mentioned bird species. Some increases will occur owing to increased agriculture, as previously

mentioned. The following Regional conservation priority species all have the potential to be positively benefited under this alternative:

- American Bittern
- Least Bittern
- Black-crowned Night-Heron
- Trumpeter Swan
- Wood Duck
- American Black Duck
- Mallard
- Blue-winged Teal
- Northern Pintail
- Canvasback
- Lesser Scaup
- Bald Eagle
- Northern Harrier
- Yellow Rail
- King Rail
- Common Moorhen
- Whooping Crane
- Upland Sandpiper
- Short-billed Dowitcher
- Wilson's Phalarope

The benefit will be greater for these species under this alternative than all other alternatives due to increased intensity of management within moist soil units, no reductions in moist soil unit acreages, increases in agriculture, and maintenance of all open water areas.

The recreation fees collected under this alternative would help generate revenue needed to support visitor services. The new recreation fees would require an adjustment period until visitors became informed about the program.

Under this alternative, the wildlife-dependent recreation opportunities available on the Refuge would be maximized within the constraints of compatibility. Both Refuge entrances would be maintained. Length of maintained trails would remain at 9.93 miles.

Visitors seeking easy access to the Refuge would experience increased opportunities as all Refuge roads were paved and trails developed to a higher standard.

Successful deer hunters would have the same distance to travel on average to bring their deer to a vehicle as in Alternative A. There would be about three more weeks open to deer hunting under this alternative compared to Alternative A. There would be more opportunities for youth to hunt.

Persons with mobility challenges would have more fishing opportunities under this alternative as more accessible sites are developed at current fishing locations. Because electric motors would be allowed on Stanfield Lake, visitors would have easier access to all parts of the lake, which may expand opportunities for persons who find it difficult to row or paddle. More surface acres of water would offer increased fishing opportunities as a result of permitting non-powered craft on all floatable waters. A sustainable fishery and better management would result in a more consistent chance of success for anglers from year to year. Over the long-term, less resource impacts and a higher quality experience among anglers is expected as a result of a fishing ethics educational program.

Opportunities for viewing and photographing wildlife from a vehicle would be better compared to Alternative A because all roads would be paved under Alternative D, reducing the amount of dust in the air. A diversity of habitat would be maintained and, therefore, a continued diversity of wildlife would be available for viewing in the long-term. Visitors seeking observation and photography experiences characterized by easy access would find higher quality opportunities under this alternative.

Interpretation and environmental education under this alternative would be expected to promote resource stewardship, conservation and public understanding of natural resources and increase public appreciation of America's natural resources to the same degree as in Alternative A. Visitors would experience increased quality of interpretive and educational experiences as these programs are incrementally improved.

Volunteer and partnership participation would increase slightly and the level of contact with the community would be maintained in this alternative.

Table 2: Summary of Impacts

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alt.)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Impacts Associated with Habitat Management				
Waterfowl Productivity	Continue at present level.	Remain stable	Remain stable	Increase
Grassland-dependent migratory birds	Decrease steadily through time to lower level.	Decrease steadily, but more rapidly than Alt. A to lowest level among alternatives.	Decrease to lower, but sustained presence.	Decrease to lower, but sustained presence.
Forest dependent migratory birds	Steady increase through time.	Steady, but more rapid than in Alt. A, increase through time.	Steady, but more rapid than in Alt. A, increase through time.	Steady, but more rapid than in Alt. A, increase through time.
Other Migratory Birds	Continue at present level.	Increase in shorebird use.	Increase in shorebird use. Increase in fall migrant waterfowl use.	Same as Alt. C.
Reptiles and Amphibians	Remain stable, possible slow decline in acid seep area.	Possible wider fluctuations, but long-term stability.	Same as Alt B, plus: Populations fluctuate as moist soil unit vegetation manipulated.	Populations fluctuate as moist soil unit vegetation manipulated.
Threatened and Endangered Species	Remain stable	Remain stable	Remain stable	Remain stable
Impacts Associated with Wildlife				
Biological Inventories and Monitoring	Continued lack of adequate data to accomplish adaptive management.	Increased long-term understanding concerning wildlife presence and success of management.	Same as Alt B	Same as Alt B
Resident Wildlife	Continue at present level.	Deer population decrease to a stable lower number.	Same as Alt B	Same as Alt B
Invasive Species	Slow spread of invasive species.	Increased treatment as a result of more knowledge.	Same as Alt B	Same as Alt B
Impacts Associated with Public Use				
Road Access	8.412 miles of roads; two entrances	5.561 miles of gravel roads; one entrance	4.625 miles of asphalt paved roads, 3.787 miles of improved maintenance gravel roads: one entrance	8.412 miles of asphalt paved roads; two entrances

Table 2: Summary of Impacts

Topic	**Alternative A** Current Management Direction (No Action)	**Alternative B** Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	**Alternative C** Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alt.)	**Alternative D** Intensified Management of Constructed Units; Expanded Priority General Public Uses
Trail Access	9.930 miles of trails with existing surfaces	3.785 miles of trails with existing surfaces	4.623 miles of trails with improved surfaces	9.930 miles of trail with improved surfaces
Entrance Fee	None	Modest increased cost to visitors.	Same as Alt. A	Same as Alt. B
Hunting ***(Season days based on 2007-2008)***	75 percent (5,394) acres open to deer and Wild Turkey hunting. 25 percent (1,896 acres) open to squirrel, rabbit, and quail hunting Days for hunting: deer – 43 Wild Turkey – 18 squirrel – 169 rabbit – 98 quail – 67	Same as Alt. A, plus: additional hunting days. Days for hunting: Deer – 64 Wild Turkey – 18 squirrel – 204 rabbit – 133 Bob-white Quail – 102	Same as Alt. B with increased opportunities for youth and under-represented populations.	Same as Alt. C
Fishing	216 water surface acres open to fishing	197 water surface acres open to fishing	197 water surface acres open to fishing	216 water surface acres open to fishing
Observation and Interpretation	Continuation of present opportunities. A large diversity of birds available for viewing, however, waterbirds are not concentrated. Area sensitive species may not be present or if present not in appreciable numbers.	Higher satisfaction among visitors seeking fewer people farther from motor vehicles. Decreased opportunities for visitors viewing wildlife from automobiles. Reduction in edge habitat, grasslands, and shrubland will eventually lead to declines in diversity of birds available for viewing. Increased management of remaining moist soil units should increase use and concentrate waterbirds along the auto tour route for visitors.	A broader array of opportunities available. Reduction in edge habitat, grasslands, and shrubland will eventually lead to declines in diversity of birds available for viewing. Increased management of remaining moist soil units should increase use and concentrate waterbirds along the auto tour route for visitors.	Higher satisfaction among visitors seeking to view wildlife from automobiles in a more developed setting. A large diversity of birds available for viewing waterbirds are not concentrated but more intense moist soil management should result in more use.

Table 2: Summary of Impacts

Topic	Alternative A Current Management Direction (No Action)	Alternative B Increased Restoration of Natural Processes; Maintain Focus on Priority General Public Uses	Alternative C Balance Natural Processes & Constructed Units; Increased Focus on High Quality Priority General Public Uses (Preferred Alt.)	Alternative D Intensified Management of Constructed Units; Expanded Priority General Public Uses
Education and Interpretation	Continuation of present benefits to Hayden School students and Junior Duck Stamp participants.	Same as Alt. A	Same as Alt. A	Benefits expanded to additional students in area schools.
Wildlife Disturbance	Remain stable	Decrease	Slight decrease	Slight increase
Impacts Associated with Friends, Volunteers, and Outreach Activities				
Community support for Refuge's mission	Continuation of present support.	Short-term reduced support by some advocates until new base formed.	Increased support in the near and long term by community.	Increased support among visitors and community.

The result would be that visitor numbers, visitor satisfaction, and public support of the Refuge would increase slightly above current levels.

4.3 Cumulative Impacts Analysis

"Cumulative environmental impacts" refer to effects that result from the incremental impact of the proposed action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. In this section, the cumulative impact of each alternative is discussed in terms of hardwood forest and hunting.

All four alternatives would have similar and negligible to minor cumulative impacts on wildlife species and Refuge programs and facilities.

4.3.1 Hardwood Forests

Indiana's forests were severely reduced in the 19th and 20th centuries. Since 1950, Indiana's forest land has increased, but with smaller forest parcels. The Refuge's reforestation program would contribute to the cumulative increase in forest land for Indiana and minimally counter the trend toward smaller forest parcels (Woodall et al. 2005).

All four alternatives would contribute to additional reforestation. Alternative B would reforest virtually the entire Refuge that is not open water or marsh. The other alternatives would also contribute additional forest area to this cover type.

4.3.2 Hunting

4.3.2.1 Anticipated Impacts on Wildlife Species

Resident Big Game – White-tailed Deer

Deer hunting does not have regional population impacts due to the restricted home ranges of white-tailed deer. The Refuge provides excellent habitat for Indiana's only big game species, the white-tailed deer. Bottomland forest, agricultural fields, idle/scrub lands, wetlands and upland forest provides the habitat diversity necessary for abundant food, protective cover, and reproductive activities. Because of the area's abundant deer population, deer hunting is a popular activity for local and visiting sportsmen. The continuing high numbers of deer is evidence that hunting on the Refuge and

neighboring lands has not had a cumulative negative impact on deer abundance and distribution. Given the absence of natural predators in southern Indiana, it is important to keep deer numbers in check by some means to avoid an exponential increase that would damage natural habitats, increase automobile accidents and safety risks to motorists, and damage vegetable and flower gardens, horticulture, and agricultural crops.

Resident Small Game

Small game hunted on the Refuge includes rabbits, squirrels, quail, and turkey. No new hunts for small game are proposed under any of the alternatives. Indiana DNR regulates small-game hunting, which is controlled from year to year as necessary to avoid any long-term population declines.

Non-Game Wildlife

Non-game or non-hunted wildlife would include non-hunted migratory birds such as songbirds, wading birds, raptors, and woodpeckers; small mammals such as rodents, the opossum, small carnivores and bats; reptiles and amphibians such as snakes, skinks, turtles, lizards, salamanders, frogs and toads; and invertebrates such as butterflies, moths, other insects and spiders. Except for migratory birds and some species of migratory bats, butterflies and moths, these species have very limited home ranges and hunting could not affect their populations regionally. Therefore, only local effects will be discussed.

Disturbance to non-hunted migratory birds could have regional, local, and flyway effects. Regional and flyway effects would not be applicable to species that do not migrate such as most woodpeckers and some songbirds including cardinals, titmice, wrens, chickadees, etc. The cumulative effects of disturbance to non-hunted migratory birds under the proposed action are expected to be negligible for the following reasons. Hunting season would not coincide with the nesting season. Long-term future impacts that could occur if reproduction was reduced by hunting are not relevant for this reason. Disturbance to the daily wintering activities of birds, such as feeding and resting, might occur. Disturbances to birds by hunters would probably be commensurate with that caused by non-consumptive users. The cumulative effects of disturbance to non-hunted migratory birds under the proposed action are expected to be negligible for the above reasons.

With regard to other wildlife, disturbance would be unlikely for the following reasons. Small mammals, including bats, are less active during the fall and winter months when the primary hunting season occurs. Many of these species are also nocturnal. Both of these qualities make hunter interactions with small mammals very rare. Hibernation or torpor by cold-blood reptiles and amphibians also limits their activity during the hunting season when temperatures are low. Hunters would rarely encounter reptiles and amphibians during most of the hunting season. Encounters with reptiles and amphibians in the early fall are few and should not have cumulative negative effects on reptile and amphibian populations. Invertebrates are also not active during cold weather and would have few interactions with hunters during the hunting season. Refuge regulations further mitigate possible disturbance by hunters to non-hunted wildlife. Vehicles are restricted to roads and the harassment or taking of any wildlife other than the game species legal for the season is not permitted.

Although ingestion of lead-shot by non-hunted wildlife could be a cumulative impact, it is not relevant to Muscatatuck NWR because the use of lead shot is only permitted in upland areas away from open water.

Some species of bats, butterflies and moths are migratory. Cumulative effects to these species at the "flyway" level should be negligible. These species are in torpor or have completely passed through Indiana by peak hunting season in November-January. Some hunting occurs during September and October when these species are migrating; however, hunter interaction would be commensurate with that of non-consumptive users.

Threatened and Endangered Species

Federally listed threatened or endangered species occur at Muscatatuck NWR. The proposed action would likely have a positive long-term effect on the primary threatened and endangered species on the Refuge, the Indiana bat, by expanding forested acres in all alternatives. Whooping Cranes could also benefit in the future as free-ranging animals increase in number and re-inhabit their former range, using open space/grassland/cropland that will be on the Refuge. Hunters are unlikely to encounter threatened and endangered species. An

Intra-Service Section 7 evaluation under the Endangered Species Act will be completed as a part of the CCP process, which will evaluate hunting and all proposed actions of the CCP relative to threatened and endangered species.

4.3.2.2 Anticipated Impacts on Refuge Programs

Refuge Programs

As public use levels on the Refuge grow over time, unanticipated conflicts between user groups may occur. The Refuge's visitor use programs would be adjusted as needed to eliminate or minimize each problem and provide quality wildlife-dependent recreational opportunities. Experience on many National Wildlife Refuges has proven that time and space zoning (e.g., establishment of separate use areas, use periods, and restrictions on the number of users) is an effective tool in eliminating conflicts between user groups. Overall, the cumulative impact of hunting on other wildlife-dependent recreation would be negligible to minor.

Refuge Facilities

The Service defines facilities as: "Real property that serves a particular function(s) such as buildings, roads, utilities, water control structures, raceways, etc." Those facilities most used by hunters are roads, parking lots, and trails. Maintenance or improvement of existing facilities would cause minimal short-term impacts to localized soils and waters and may cause some wildlife disturbances and damage to vegetation. The facility maintenance and improvement activities described are periodically conducted to accommodate daily Refuge management operations and general public uses such as wildlife observation and photography. These activities would be conducted at times (seasonal and/or daily) to cause the least amount of disturbance to wildlife. Siltation barriers will be used to minimize soil erosion, and all disturbed sites will be restored to as natural a condition as possible. Overall, the cumulative impact of hunting on Muscatatuck NWR's facilities would be negligible.

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