

Muscatatuck

National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Assessment

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Chapter 1: Introduction and Background

Introduction

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, 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 and plants found on the Refuge are several federally listed species, including the federally listed endangered Indiana bat, and many more state-listed species. Species lists found in Appendix C note any state and federal designations.

The U.S. Fish and Wildlife Service

Muscatatuck NWR is administered by the U.S. Fish and Wildlife Service (Service). The Service is the primary federal agency responsible for conserving, protecting, and enhancing the nation's fish and wildlife populations and their habitats. It oversees the enforcement of federal wildlife laws, management and protection of migratory bird populations, restoration of nationally significant fisheries, administration of the Endangered Species Act, and the restoration of wildlife habitat such as wetlands. The Service also manages the National Wildlife Refuge System.



Great Blue Heron. Photo credit: U.S. Fish & Wildlife Service

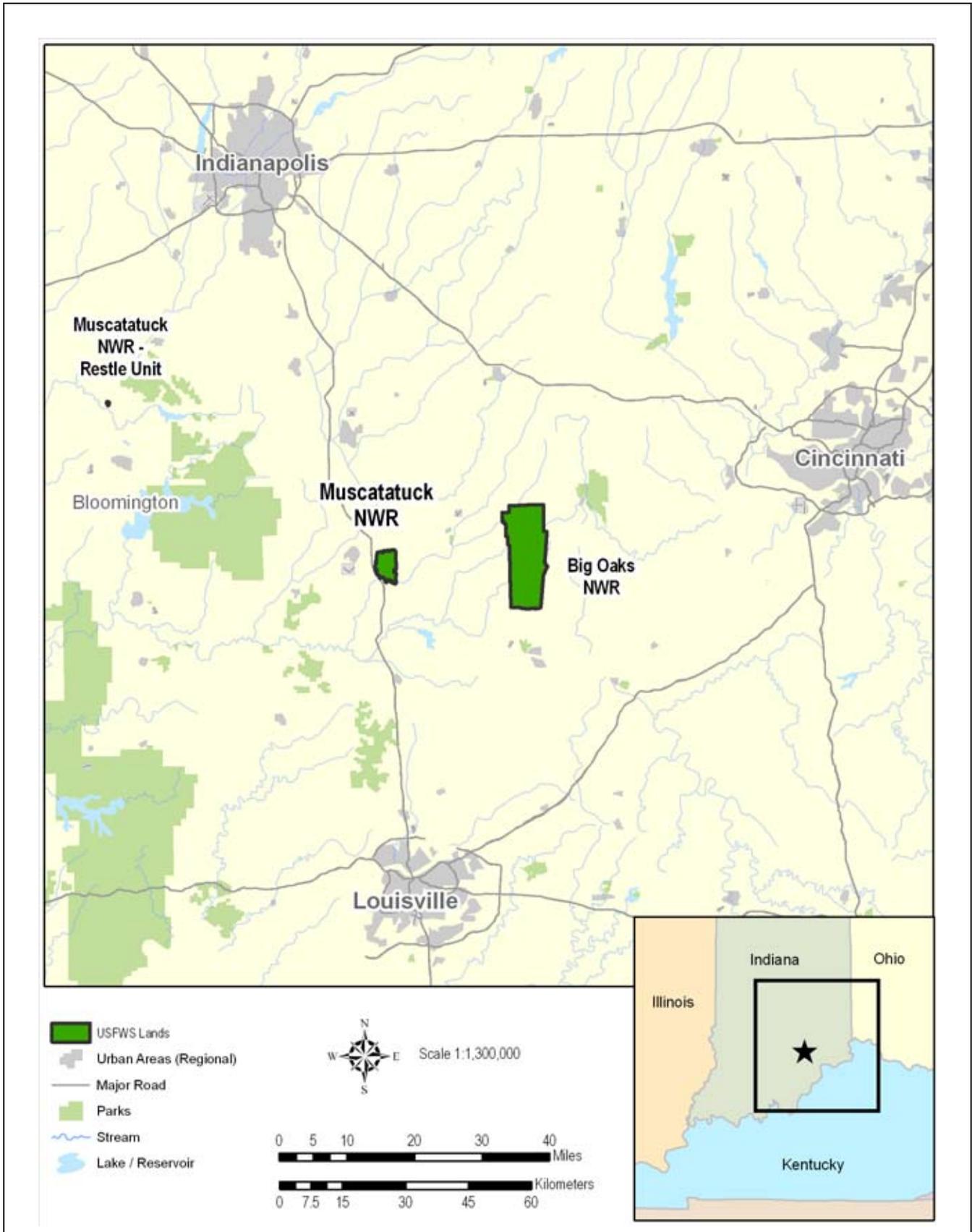
The National Wildlife Refuge System

Refuge lands are part of the National Wildlife Refuge System, which was founded in 1903 when President Theodore Roosevelt designated Pelican Island in Florida as a sanctuary for Brown Pelicans. Today, the System is a network of about 545 refuges and wetland management districts covering about 95 million acres of public lands and waters. Most of these lands (82 percent) are in Alaska, with approximately 16 million acres located in the lower 48 states and several island territories.

The National Wildlife Refuge System is the world's largest collection of lands specifically managed for fish and wildlife. Overall, it provides habitat for more than 5,000 species of birds, mammals, fish, amphibians, reptiles, and insects. As a result of international treaties for migratory bird conservation and other legislation, such as the Migratory Bird Conservation Act of 1929, many refuges have been established to protect migratory waterfowl and their migratory flyways.

Refuges also play a crucial role in preserving endangered and threatened species. Among the most notable is Aransas NWR in Texas, which provides winter habitat for the highly endangered Whooping Crane. Likewise, the Florida Panther Refuge protects one of the nation's most

Figure 1: Location of Muscatatuck NWR



endangered predators. Refuges also provide unique recreational and educational opportunities for people.

When human activities are compatible with wildlife and habitat conservation, refuges are places where people can enjoy wildlife-dependent recreation such as hunting, fishing, wildlife observation, photography, environmental education, and environmental interpretation. Many refuges have visitor centers, wildlife trails, automobile tours, and environmental education programs. Nationwide, approximately 30 million people visited national wildlife refuges in 2004.

The National Wildlife Refuge System Improvement Act of 1997 established several important mandates aimed at making the management of national wildlife refuges more cohesive. The preparation of Comprehensive Conservation Plans (CCPs) is one of those mandates. The legislation directs the Secretary of the Interior to ensure that the mission of the National Wildlife Refuge System and purposes of the individual refuges are carried out. It also requires the Secretary to maintain the biological integrity, diversity, and environmental health of the National Wildlife Refuge System.

The goals of the National Wildlife Refuge System are to:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).



Muscatatuck NWR. Photo Credit: Jon Kauffeld

- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

History and Establishment

In the early 1960s there was interest among the Indiana Department of Conservation, state-wide sportsmen and conservation organizations, and many businessmen and civic leaders in southern Indiana for a national wildlife refuge in the area known as Mutton Creek Bottoms. Their interest was prompted by the recollection of past waterfowl use of the area, the reduction of waterfowl habitat throughout the area by drainage, an anticipated economic stimulus from tourists and sportsmen, and possible educational benefits derived from nature trails and wildlife observations.

With the approval of the Governor and support by local elected representatives, the Service presented the proposal for the Muscatatuck NWR to the Migratory Bird Conservation Commission on June 7, 1966. The Commission approved the acquisition of 7,922 acres to provide duck breeding and migration habitat. Lands for the Refuge were acquired under eminent domain. The Refuge was officially established by the acquisition of the first tracts on October 6, 1966. By April 24, 1973, acquisition was considered complete with 7,724 acres acquired; interest in a remaining in-holding had waned by 1979 because the asking price was too high. The 78-acre Restle Unit in Monroe County was acquired through a donation in 1991.

Refuge Purpose

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act. When proposed as a refuge to the Migratory Bird Conservation Commission in 1966, the area was identified as having good potential for waterfowl with expected increases in production and use during the spring and fall migrations. It was also noted that the Refuge would provide recreation facilities for the people of the vicinity.

The Refuge also manages nine conservation easement areas. The purpose of the easements, “... for conservation ...”, derives from the Consolidated Farm and Rural Development Act. The Service administers the easements as part of the National Wildlife Refuge System.

Refuge Vision

The Refuge staff considered past vision statements and emerging issues and drafted the following vision statement as the desired future state of the Refuge:

As the land of winding waters, treasured for generations, Muscatatuck National Wildlife Refuge honors its heritage and connects visitors with the natural environment by conserving a rich mosaic of sustainable habitat for a diversity of wildlife and plants.

Purpose of the Plan

This CCP articulates the management direction for Muscatatuck NWR for the next 15 years. Through goals, objectives, and strategies, this CCP describes how the Refuge intends to fulfill its purpose and contribute to the overall mission of the National Wildlife Refuge System. Prior to the CCP, Refuge management was guided by a 1982 Master Plan, which is now dated, and other short-term plans of limited scope. There is a need for a broad, long-term look at management direction given changed conditions and scientific information, and over 40 years of on-the-ground experience by the Service managing the Refuge.

Several legislative mandates within the National Wildlife Refuge System Improvement Act of 1997 have guided the development of this plan. These mandates include:

- Wildlife has first priority in the management of refuges.
- Wildlife-dependent recreation activities, namely hunting, fishing, wildlife observation, wildlife photography, environmental education and interpretation are priority public uses of refuges. We will facilitate these activities when they do not interfere with our ability to fulfill the refuges’ purpose or the mission of the Refuge System.
- Other uses of the Refuge will only be allowed when determined appropriate and compatible with Refuge purposes and mission of the Refuge System.

The plan will guide the management of Muscatatuck NWR by:

- Providing a clear statement of direction for the future management.
- Making a strong connection between Refuge activities and conservation activities that occur in the surrounding area.
- Providing neighbors, visitors, and the general public with an understanding of the Service’s management actions.
- Ensuring Refuge actions and programs are consistent with the mandates of the National Wildlife Refuge System.
- Ensuring that Refuge management considers federal, state, and county plans.
- Establishing long-term continuity in Refuge management.
- Providing a basis for the development of budget requests on the Refuge’s operational, maintenance, and capital improvement needs.

Legal Context

In addition to the acquisition authorities of the Refuge, and the National Wildlife Refuge System Improvement Act of 1997, several federal laws, executive orders, and regulations govern its administration. Appendix E contains a partial list of the legal mandates that pertain to Refuge management and guided the preparation of this plan.

Chapter 2: The Planning Process

Meetings and Involvement

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.

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 1,067. 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 Program Review, which is an evaluation of the relevance and direction of the biological program through the collective inputs of professionals among the various fields of ecology and wildlife sciences, began with a 2-day meeting on June 20 and 21 of 2007. The Regional Refuge Biologist facilitated the event, which was attended by 17 individuals with various state, federal, and academic affiliations. Information was presented on the Refuge, the general ecology of the region, establishing legislation and policy directives, current issues facing the Refuge, prior program accomplishments, a report on the current biological inventory and monitoring program, and a draft vision for the future. The meeting was punctuated with field trips to specific sites to stimulate discussion and demonstrate issues of concern. The group discussed management alternatives and



Muscatatuck NWR. Photo Credit: U.S. Fish & Wildlife Service

potential strategies, identified potential biological program priorities, discussed the draft goals and objectives for the various program components and other ideas for the future of the program.

The planning team also considered the recommendations of a Visitors Services Review that was conducted June 19-22, 2006. The review evaluated the services of the Refuge against the minimum visitor services requirements in policy.

Issues

Issues play an important role in planning. Issues focus the planning effort on the most important topics and provide a base for considering alternative approaches to management and evaluating the

consequences of managing under these alternative approaches. The issues, concerns, and opportunities expressed during the first phase of planning have been organized under the following headings.

■ 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.

■ 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.

■ 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.

■ 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.

■ Threats and Conflicts

The public and staff recognize the challenges 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.

■ 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.

Wilderness Review

As part of the CCP process, lands within Muscatatuck NWR were reviewed for wilderness suitability. No lands were considered suitable for Congressional designation as wilderness as defined by the Wilderness Act of 1964. Muscatatuck NWR does not contain 5,000 contiguous acres of roadless, natural lands. Nor does the Refuge possess any units of sufficient size to make their preservation practicable as wilderness. Refuge lands and waters have been substantially altered by humans, especially by agriculture, drain construction, and road-building. Extensive modification of natural habitats and manipulation of natural processes has occurred. Adopting a “hands-off” approach to management at the Refuge would not facilitate the restoration of a pristine or pre-settlement condition, which is the goal of wilderness designation.

Chapter 3: Refuge Environment and Management

Introduction

Muscatatuck National Wildlife Refuge

Muscatatuck NWR manages lands in Jackson, Jennings, and Monroe Counties in south-central Indiana. Management responsibilities also include a 30-county Wildlife Management District, which involves management of U.S. Department of Agriculture's (USDA) Farm Service Agency Conservation Easements and team membership in the Wetland Reserve Program Wetland Evaluation Team with USDA – Natural Resource Conservation Service (NRCS) for the 22-county southeast Indiana area. Although formal management responsibility for the 30-county Partners for Fish and Wildlife private lands district was transferred by agreement to the Indiana State Private Lands Coordinator in 2004, Muscatatuck NWR still assists with past projects completed with MNWR partners, provides coordination and support in six counties, and makes referrals from other counties to the State Private Lands Coordinator.

Ecological Context

Historic Vegetation

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. The Muscatatuck River Basin prior to European settlement of the area was an old lake basin. The forest community has been defined as "Bluegrass till plain flatwoods" by the Indiana Invasive Plant Species Assessment Work Group (Jacquart et al. 2002) and "Southeastern Till Plain



River otter. Photo credit: Dan Kaiser

Beech-Maple Division" by IDNR Division of Nature Preserves (2005). This area is generally wet or moist most of the year.

Information gleaned from the General Land Office (GLO) survey notes from November 1806 is summarized in the following paragraphs. Names in bold are the names as found in the original survey notes and those within parentheses are current interpretations of the species represented (Homoya 2007).

In the Jennings County portion of the Refuge the area is mostly upland flats and moist slopes. The tree species mentioned the greatest number of times is **beech** (American beech; *Fagus grandifolia*). As with today, this species is characteristic of these communities. Three other species mentioned are sugar (sugar maple; *Acer saccharum*), **W. ash** (White ash; *Fraxinus americana*), and **cherry** (black cherry; *Prunus serotina*).

In the western portion of the Refuge (Jackson Co.) most of the same species listed above are mentioned; additional types occur, especially in the floodplains. The list includes: "**Ash**; (green ash; *Fraxinus pennsylvanica*), **maple** (red maple; *Acer rubrum* and/or silver maple; *Acer*

saccharinum), **elm** (American elm; *Ulmus americana*) in the bottoms, **beech** (American beech; *Fagus grandifolia*) and **poplar** (tulip tree; *Liriodendron tulipifera*) on the Highland." These notes were describing a survey line between sections 25 and 26 T. 6 N. R. 6 E. Also mentioned for the floodplain in this region was **ironwood** (probably blue beech; *Carpinus caroliniana*, and not hop hornbeam; *Ostrya virginiana*).

W. oak (white oak; *Quercus alba*) and/or **swamp chestnut oak** (*Quercus michauxii*) and/or **swamp white oak** (*Quercus bicolor*), and **gum** (sweet gum; *Liquidambar styraciflua*) were mentioned in a floodplain just north of the Vernon Fork Muscatatuck River along the section line between sections 35 and 36, T. 6 N. R. 6 E. White oak is not a normal component of wet floodplain forests in Indiana, but does occur in slightly elevated portions of floodplains, (Homoya 2007). There are no references to any open areas or grasslands. There are references to a few swamps in the floodplain; they were forested and probably only ephemerally wet.

In addition to written descriptions of historic vegetation conditions, soil information can be used to understand the vegetation capacity of a landscape. The soils in any given locality are a result of the parent rock material, organisms,



Female Wood Duck and brood. Photo Credit: Mark Trabue

climate, and relief. These factors and the resulting soils limit what overlying native vegetation can inhabit an area. Soil survey data collected over the past century by the USDA's Natural Resource Conservation Service have included written descriptions of native vegetation, which can be tied to the soil unit and mapped. Figure 2 uses data from the Soil Survey Geographic (SSURGO) Database to displays the potential natural vegetation found at Muscatatuck. The dominance of a mixed deciduous forest covertype is consistent with other accounts of the region's native vegetation status.

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 there were 116 private land ownerships, 4,100 acres being farmed, and 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 in the Muscatatuck NWR area for much of the last century, except for some areas of the Refuge 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.

Land Use/Cover

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. Forested lands and woodlots are 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 3)

Figure 2: Potential Natural Vegetation, Muscatatuck NWR

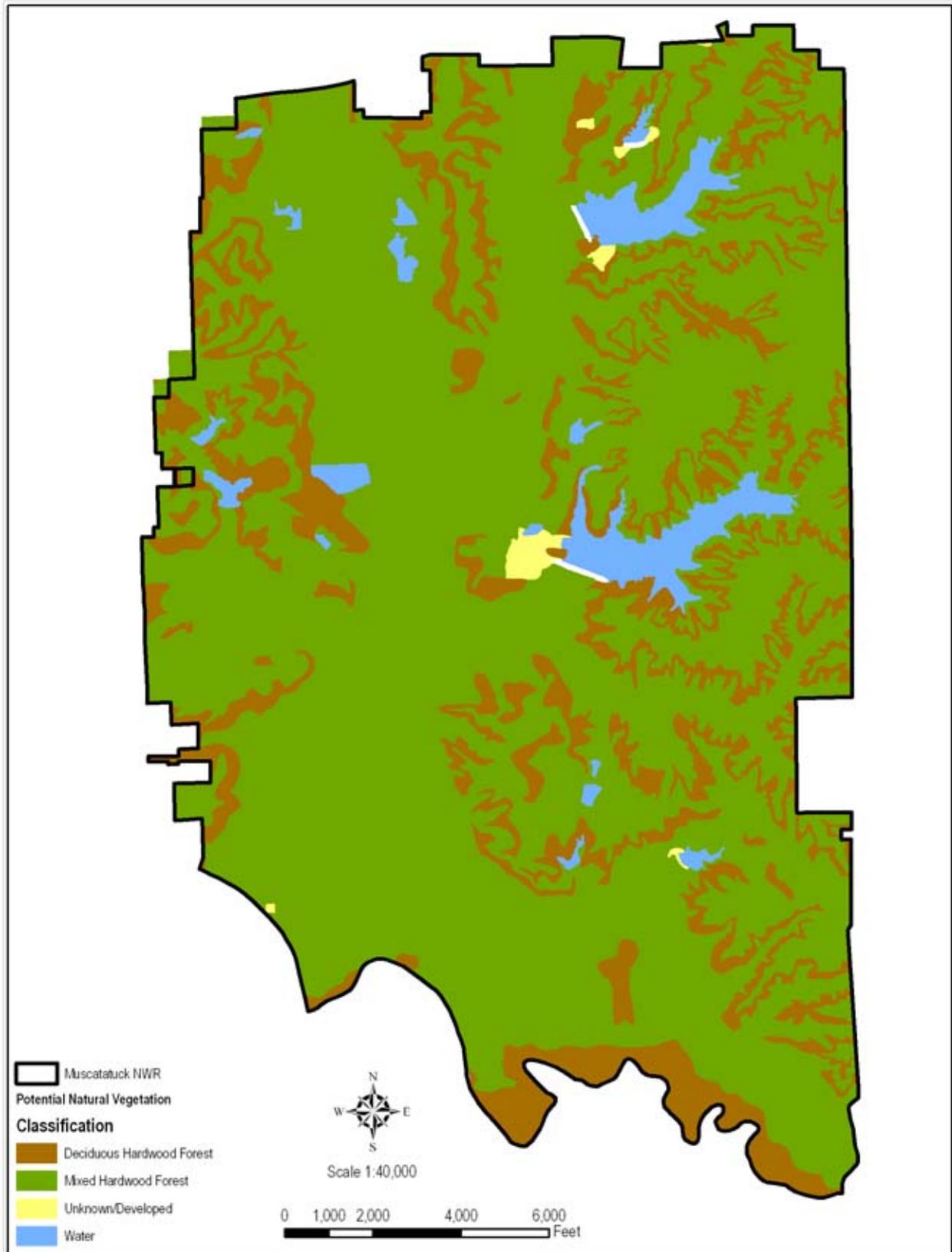
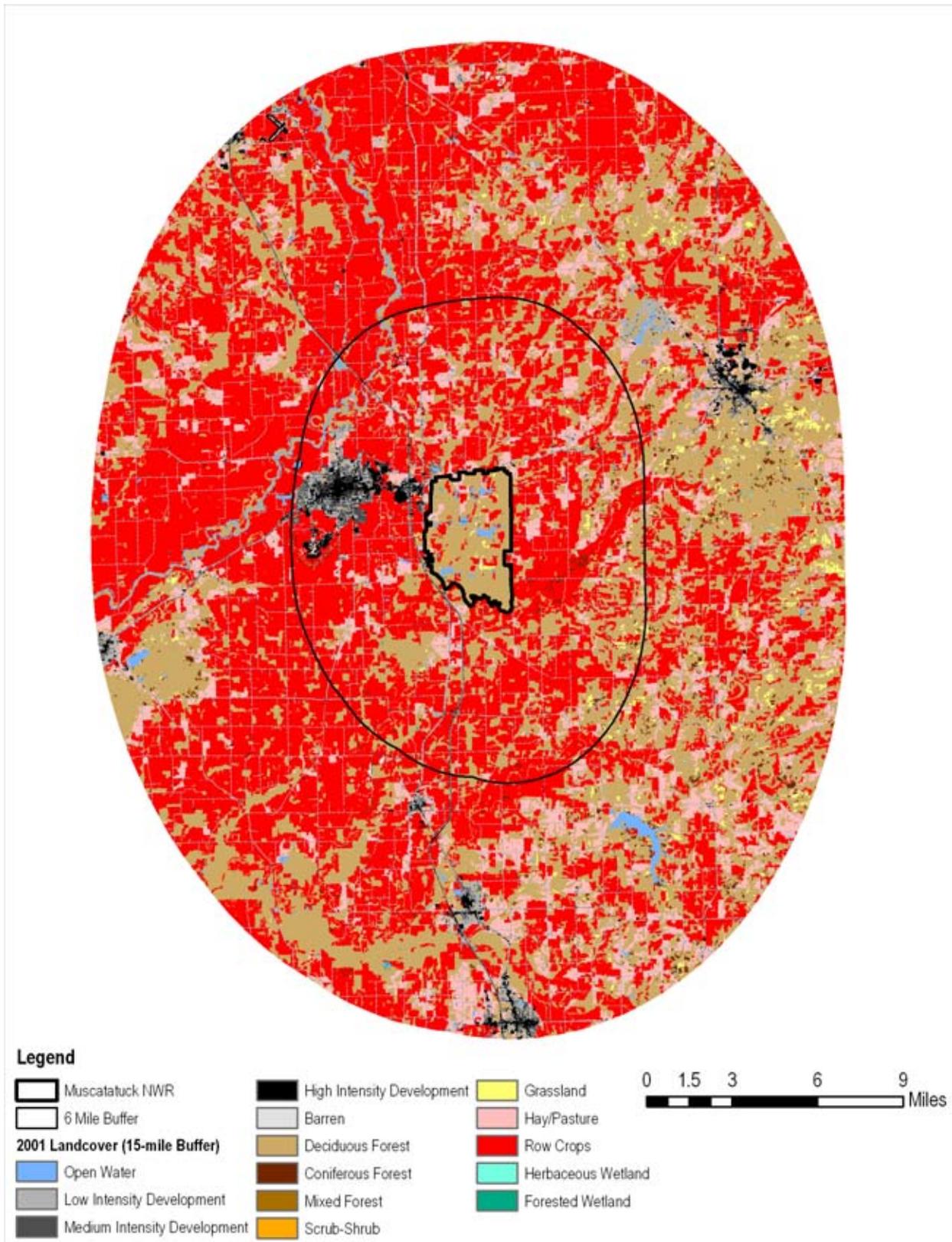


Figure 3: Land Use / Land Cover in the Vicinity of Muscatatuck NWR



Migratory Bird Conservation Initiatives

Several migratory bird conservation plans have been published over the last decade that can be used to help guide management decisions on refuges. Bird conservation planning efforts have evolved from a largely local, site-based orientation to a more regional, even inter-continental, landscape-oriented perspective. Several transnational migratory bird conservation initiatives have emerged to help guide the planning and implementation process. The regional plans relevant to Muscatatuck NWR are:

- The Central Hardwoods Joint Venture Concept Plan
- Upper Mississippi River and Great Lakes Region Joint Venture of the North American Waterfowl Management Plan
- The Upper Mississippi Valley/Great Lakes Regional Shorebird Conservation Plan
- The Upper Mississippi Valley/Great Lakes Regional Waterbird Conservation Plan

Each of the bird conservation initiatives has a process for designating priority species, modeled to a large extent on the Partners in Flight method of computing scores based on independent assessments of global relative abundance, breeding and wintering distribution, and vulnerability to threats, area importance, and population trends. These scores are often used by agencies in developing lists of priority bird species. The Service based its 2001 list of Non-game Birds of Conservation Concern primarily on the Partners in Flight shorebird and waterbird status assessment scores.

Region 3 Fish and Wildlife Conservation Priorities

Every species is important; however the number of species in need of attention exceeds the resources of the Service. To focus effort effectively, Region 3 of the Fish and Wildlife Service compiled a list of Resource Conservation Priorities (U.S. Fish & Wildlife Service 1999). The list includes:

- All federally listed threatened and endangered species and proposed and candidate species that occur in the Region.
- Migratory bird species derived from Service wide and international conservation planning efforts.

- Rare and declining terrestrial and aquatic plants and animals that represent an abbreviation of the Endangered Species program's preliminary draft "Species of Concern" list for the Region.

Appendix D lists 80 Regional Resource Conservation Priority species relevant to the Refuge.

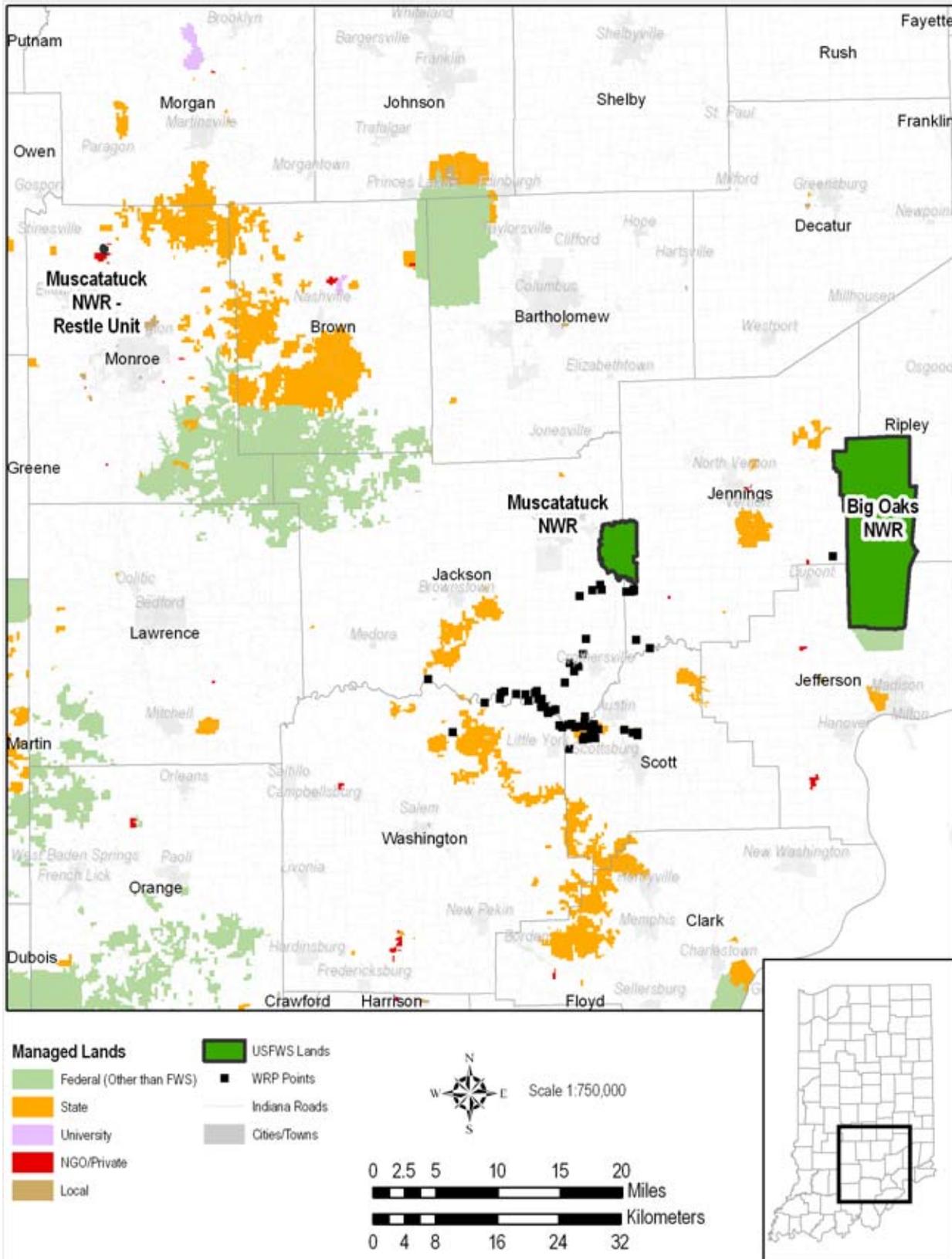
Other Conservation and Recreation Lands in the Area

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 (see Figure 4). The State areas include public access sites, fish and wildlife areas, recreation areas, forests, and nature preserves. The federal areas include Big Oaks National Wildlife Refuge, Hoosier National Forest, and Department of Defense lands. Among non-governmental organizations, The Nature Conservancy is a major land owner and manager. Local governments also own and manage community parks in the area. Conservation easements and other partners also own and manage a significant amount of land in the surrounding area.

Conservation Corridors

Increasing urbanization and widespread land use changes are greatly affecting natural landscapes and healthy ecological systems by fragmenting and degrading habitats. Traditional approaches to land conservation are often opportunistic, piecemeal, site specific, and narrowly focused. However, increasing attention is being given to collaborative landscape conservation efforts that are proactive, strategic, comprehensive, and integrative. Regional analyses that consider larger geographic extents are helping to focus conservation efforts among a growing consortium of stakeholders and partners. Creating a series of ecological hubs and linkage corridors increases the connectivity, effectiveness, and resiliency of the biological systems that preserve biodiversity and essential ecological services. Efforts are underway in Midwest Region of the U.S. Fish and Wildlife Service to create models that outline a basic conservation network throughout the Midwest. Recent emphasis on Strategic Habitat Conservation and the effects of global climate change have catalyzed these efforts in the Service. Using land cover (Figure 3) and the existing

Figure 4: Other Conservation and Recreation Lands in the Vicinity of Muscatatuck NWR



conservation estate (Figure 4), it is possible to visualize the beginnings of a land conservation network with Muscatatuck NWR, Big Oaks NWR, and other major State and Federal landholdings as major ecological hubs linked through private and public conservation efforts. The Refuge System is positioned well to play an integral role in the design and implementation of a regional conservation network.

Socioeconomic Context

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 (U.S. Census Bureau 2008).

Population and Demographics

The population estimate for the two counties was 70,664 in 2005. The population increased 12.2 percent during the 1990s while the State's population increased 9.7 percent. Jennings County grew more at 16.5 percent, and Jackson County grew 9.6 percent. The two-county population was 98 percent white in 2005; the State population was 88.6 percent white. In Indiana, 6.4 percent of the people 5 years and older speak a language other than English at home; in Jackson County it is 4.3 percent; in Jennings County it is 2.5 percent. The population for Jackson County is projected to be 43,654 in 2025, a 3.4 percent increase from 2005; for Jennings County the projected population is 33,695 for 2025, an 18.5 percent increase from 2005. The largest community in Jackson County is Seymour with a 2005 population of 18,890. The largest community in Jennings County is North Vernon with a 2005 population of 6,433 (STATS Indiana, 2007).

Employment

In 2004 there were a total of 38,327 full- and part-time jobs in the two-county area. 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. Farm jobs made up 5 percent of employment (U.S. Census Bureau 2008).

Income and Education

Average per-capita income in the two counties was \$25,885 in 2004; in Indiana it was \$30,204. The median household income in 2003 for Jackson County was \$41,502; for Jennings County \$39,514; for Indiana and \$43,323. In Jackson County, 11.5 percent of persons over 25 years of age hold a bachelor's degree or higher; in Jennings County 8.4 percent; in Indiana 19.4 percent of persons over 25 years hold a bachelor's degree or higher (U.S. Census Bureau 2008).

Demand and Supply for Wildlife-Dependent Recreation

In order to estimate the potential market for visitors to the Refuge, we looked at 2007 consumer behavior data within approximately 30, 60, and 90-mile drives of the Refuge. The data were organized by zip areas. We used the three driving distances because we thought this was an approximation of reasonable maximum drives to the Refuge for an outing by different groups. From experience we know, for example, that visitors come from the nearby local area to view wildlife in the evening. We also know that people seeking interesting varieties of bird species drive from Cincinnati, Ohio to visit the Refuge. The 30-mile area extended beyond the communities of Bedford, Columbus, Greensburg, Madison, North Vernon, Salem, Scottsburg, and Seymour. The 60-mile area extended from the southern portion of the Indianapolis metropolitan area to the northern portion of the Louisville metropolitan area. The 90-mile area included the Cincinnati metropolitan area.

The consumer behavior data that we used in the analysis is derived from Mediamark Research Inc. data. The company collects and analyzes data on consumer demographics, product and brand usage, and exposure to all forms of advertising media. The consumer behavior data were projected by Tetrad Computer Applications Inc. to new populations using Mosaic data. Mosaic is a methodology that classifies neighborhoods into segments based on their demographic and socioeconomic composition. The basic assumption in the analysis is that people in demographically similar neighborhoods will tend to have similar consumption, ownership, and lifestyle preferences. Because of the assumptions

Table 1: Maximum Adult Audiences Within 30, 60, and 90 Miles of Muscatatuck NWR for Four Activities

Approximate Driving Distance to Refuge	Total Population	Birdwatching	Fishing	Hunting With Shotgun	Contribute to Environmental Organization
30 miles	285,584	15,674	44,988	14,619	3,095
60 miles	1,743,239	82,886	235,698	67,640	15,589
90 miles	5,164,171	235,928	657,836	181,566	41,891

made in the analysis, the data should be considered as relative indicators of potential, not actual participation.

We looked at potential participants in birdwatching, fishing, and hunting with shotgun. In order to estimate the general environmental orientation of the population, we also looked at the number of people who might contribute to an environmental organization.

The consumer behavior data apply to persons greater than 18 years old. Table 1 displays the consumer behavior numbers for each of the three distances to the Refuge. The projections represent the maximum audience that we might expect to make a trip to the Refuge for approximate drives of half-hour, hour, and one and a half hours. Actual visitors will be fewer because the estimate is a maximum, and we expect only a fraction of these people will travel to the Refuge.

We also considered the maximum number of students that might potentially participate in environmental education offered by the Refuge by looking at the school populations in Jackson and Jennings Counties. For Jackson County the school enrollment in preschool through grade 12 was 8,142 according to the 2000 census. For Jennings County the equivalent enrollment was 5,828. The projected school age (5-19) population for the two counties for 2025 is 14,843.

Additional perspective on wildlife-dependent recreation was gained from Indiana's Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2000-2004. In a survey of the population, recreation planners found that in the planning regions that contain the Refuge approximately 58 percent of the respondents participated in fishing regularly in the last year. Fishing was exceeded in participation only by the walking/hiking/jogging category. The approximate percentages of respondents for other activities were: nature observation/photography (36

percent), hunting (33 percent), and trapping (6 percent) (Indiana Department of Natural Resources 2000). Within the nature observation/photography category respondents reported participation in wildlife viewing, gathering (mushroom, berry etc.), viewing fall foliage, nature photography, and bird watching.

The SCORP identified the counties and regions that contain the Refuge as meeting or exceeding the regional recreation land standard of 35 acres per thousand population. The Indiana state trails plan of July 2006 reported 76 miles of trails in Jackson County and 17 miles of trails in Jennings County. The Refuge trails are included in these totals.

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.



Muscatatuck NWR. Photo Credit: U.S. Fish & Wildlife Service

April 20 and October 12 are the frost and freeze dates for 32 degrees Fahrenheit with a 50 percent probability. 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).

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 that 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 Refuge has upland and river valley areas, causing variations in depth of the unconsolidated soil material to bedrock. A well drilled in the northeast part of the Refuge encountered bedrock at a depth of 40 feet. The bedrock depths can vary quite widely depending on the amount of material deposited and subsequently removed by erosion. The glacial material is dominantly stratified sands and clays that have been blanketed with a mantle of wind blown silt (loess).

In the floodplain area, bedrock is typically less than 10 feet below the surface. (Marshall et al. 2007)

Hydric soils (Figure 5) cover 2,962 acres of the Refuge. Non-hydric soils cover the remaining 4,797 acres. Soils on the Refuge are grouped into five soil associations: Dubois-Peoga-Haubstadt, Stendal-Birds-Piopolis, Haymond-Wakeland-Wilbur, Bloomfield-Alvin, and a small amount of Ayrshire-Lyles (Marshall et al. 2007; Nagel et al. 1990; Nickell et al. 1976).

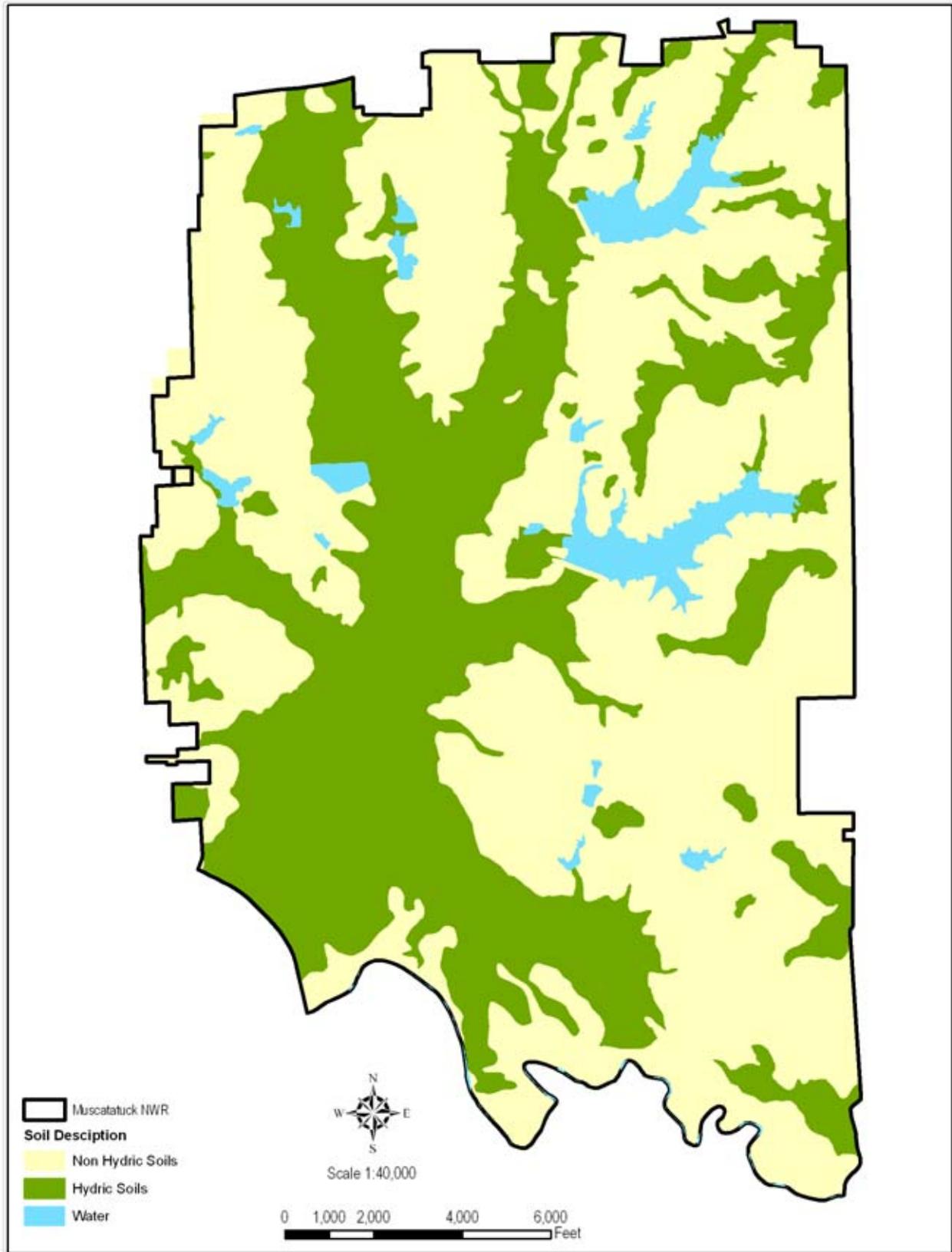
The Dubois-Peoga-Haubstadt association of soils are very deep, nearly level to strongly sloping, moderately well to poorly drained, medium textured soils that have formed in loess and the underlying stratified lacustrine sediments on terraces. The somewhat poorly drained Dubois soils are nearly level to gently sloping on narrow flats and upper side slopes. The moderately well drained Haubstadt

soils are gently to strongly sloping on side slopes. Both Dubois and Haubstadt soils have very slowly permeable fragipans present in the soil profile. Peoga soils are nearly level, poorly drained, and are on broad flats. The moderately well-drained Otwell soils actually have a higher number of acres within the Refuge area, and are often intermixed with the Haubstadt soils. The minor soil in this association is the well-drained Negley soils on steep side slopes. Also included with this association is a small amount of Illinoian till soils in the very eastern boundary of the Refuge. These soils are the somewhat poorly drained Avonburg, moderately well-drained Nabb and Cincinnati, which all have fragipans. The soils of this association comprise approximately 4,172 acres, or about 54 percent of the Refuge area.

The Stendal-Birds-Piopolis association of soils are very deep, nearly level, somewhat poorly to poorly drained, medium and moderately fine textured soils formed in fine-silty acid alluvium on floodplains. Within the Refuge area, Birds soil is the more dominant component of the association, with slightly more than 2,000 acres. Birds soils are poorly drained and are formed in non-acid silty alluvium over alluvium with a higher clay content, in slow backwater areas of floodplains. Stendal soils are somewhat poorly drained, are formed in silty acid alluvium and tend to occur on slightly elevated areas, which are called steps, of the floodplain. Piopolis soils are poorly and very poorly drained and are formed in clay alluvium on floodplains. There is currently no Piopolis mapped within the Refuge area. Minor soils in this association are the poorly drained Bonnie and moderately well-drained Steff soils. Bonnie soils are formed in silty acid alluvium and are found in similar positions as Birds soils. Steff soils are formed in silty acid alluvium and are found in positions similar to Stendal. These soils are found mainly in the watersheds of Mutton Creek Ditch, Storm Creek Ditch, and Sandy Branch. The soils of this association comprise approximately 2,367 acres, or about 30 percent of the Refuge area.

The Haymond-Wakeland-Wilbur association of soils are very deep, well to somewhat poorly drained, nearly level, formed in coarse-silty non-acid alluvium on floodplains. Within the Refuge area, Wakeland soils are the more dominant component of the association, with slightly over 400 acres. Wakeland soils are somewhat poorly drained and are formed in silty non-acid alluvium on floodplains. Haymond soils are well-drained and are formed in silty non-acid alluvium on floodplains. Minor soil in this association is the well-drained,

Figure 5: Hydric Soils, Muscatatuck NWR





Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

coarse loamy Wirt soils on natural levees of the floodplain adjacent to streams. These soils are found mainly in the Vernon Fork of the Muscatatuck River watershed. The soils of this association comprise approximately 600 acres, or about 7 percent of the Refuge area.

The Bloomfield-Alvin association of soils are very deep, nearly level to strongly sloping somewhat excessively to well-drained, coarse textured soils formed in eolian (windblown) sand deposits (dunes) on uplands. Bloomfield soils are nearly level to strongly sloping somewhat excessively drained on ridges and narrow side slopes of dunes. Alvin soils are well-drained and are intermixed with the Bloomfield soils on similar landforms. Minor soils in this association are the Bobtown and Medora soils. Bobtown soils are moderately well-drained and formed in moderately coarse textured eolian (windblown) sand deposits. Medora soils are moderately well-drained and are formed in loess and the underlying sandy outwash material, and have a fragipan. These soils are located mainly in the northwestern corner of the Refuge and comprise approximately 200 acres, or 3 percent of the Refuge area.

The Ayrshire-Lyles association of soils is very deep, nearly level, somewhat poorly and very poorly drained, moderately coarse textured coarse textured soils, formed in eolian (windblown) sand deposits (dunes) on uplands. Ayrshire soils are somewhat poorly drained and are on flats of uplands. Lyles soils are poorly drained, have very dark colored surface layers and are in slight depressions of uplands. These soils comprise about 43 total acres and are located mainly in the northwestern corner of the Refuge area.

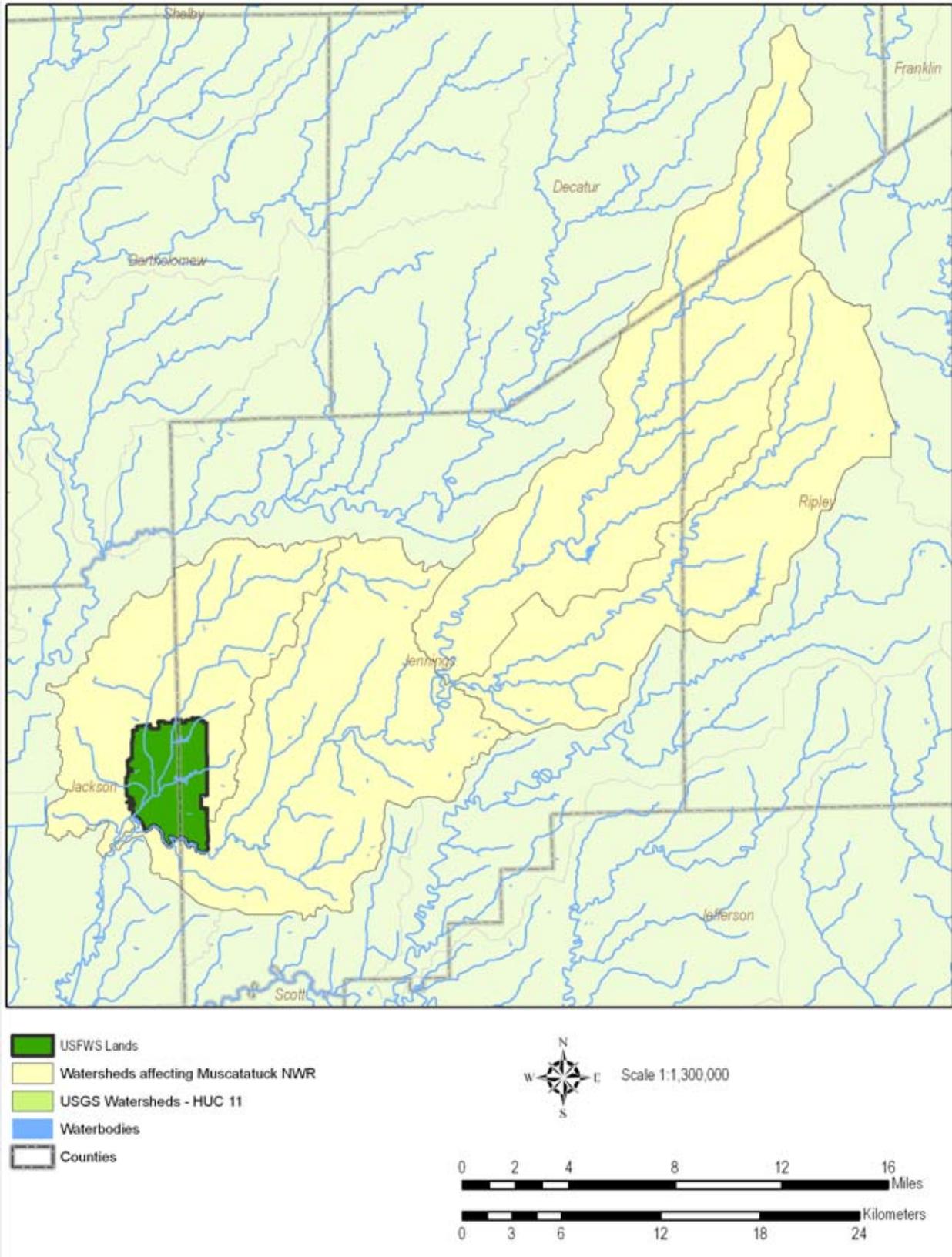
Hydrology and Water Quality

The Refuge lies within a flat, relatively well drained portion of the Wabash River Basin (Figure 6). Water flows away from the Refuge down the Vernon Fork of the Muscatatuck River; into the Muscatatuck River; the White River, and on to the Wabash 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. 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-phosphates, are known to be toxic to fish and wildlife via direct exposure, bioaccumulation, and bio-magnification (Cox 1991).

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 decreases in interception, increased throughfall, and changes in roughness coefficients and slope, all of which contribute to increases in flow rates, erosion, and amount of particles, sediment, and other substances reaching the Refuge (Tang et al. 2005). 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. 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. The Refuge is bordered on two sides by major highways (U.S. 31, U.S. 50 and I-65) and

Figure 6: Muscatatuck NWR and the Wabash River Basin Watershed



by a well-traveled county road (Jennings CR900W) on a third side. Two of the three roads adjacent to the Refuge are hard surface roads. In addition, the CSX Railroad runs approximately three-quarters of a mile north of the Refuge, crossing both Mutton and Storm Creek Ditches. Another railroad, the Madison Railroad, crosses the Vernon Fork upstream in North Vernon.

Refuge Habitats and Wildlife

Wetlands

Wetlands cover 69 percent of the Refuge and much of this land floods annually. (See Figure 7 for current Refuge land cover.)

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), that were built 1979-1982 with Bicentennial Land Heritage Program (BHLP) funds. 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 of which is the Muscatatuck Seep Springs Research Natural Area. This wetland type is an acid seep spring that has only been documented in seven other locations in Indiana, one of which was destroyed, making it extremely rare in the state. Examples of wildlife that use these wetlands include Wood Ducks and Hooded Mergansers, which nest in the bottomland



Mini Marsh, Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

hardwoods, American Bald Eagle, copperbelly watersnake, river otter and many other species from all faunal assemblages.

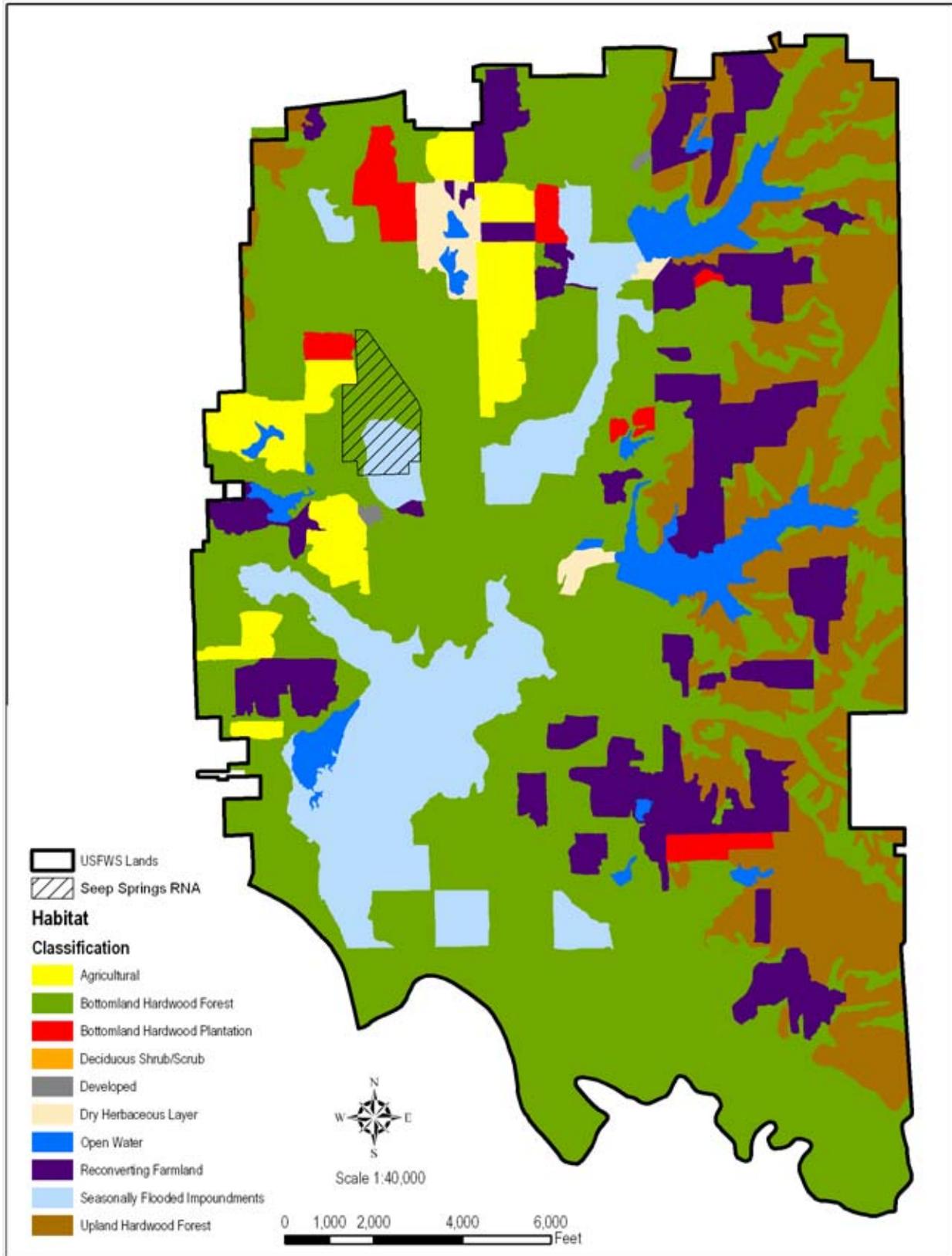
Forests

Approximately 66 percent (5,302 acres) of the Refuge is covered by forests. Of this, about half of the Refuge, or approximately 77 percent of the forested area (4,076 acres), are classified as one of several types of bottomland hardwood forest. Bottomland hardwood forests are a type of cold-deciduous forest that are temporarily or seasonally flooded and occur on wet soils and in floodplains. American beech and a variety of maple and oak species dominate bottomland forests and ash, sweetgum, river birch and sycamore are also present. The remaining 22 percent of the forested area (1,226 acres) of the Refuge is classified as upland hardwood forest. Upland hardwood forest is also classified as 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).

Examples of 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, and American beech. Examples of wildlife that use the forests include white-tailed deer, eastern gray squirrel, eastern fox squirrel, southern flying squirrel, woodchuck, Indiana bat and forest birds such as:

- 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

Figure 7: Current Land Cover, Muscatatuck NWR



- Kentucky Warbler
- Rusty Blackbird
- Yellow-billed Cuckoo
- Wood Thrush

Grasslands

Some areas of grasslands, such as road edges, dam spillways and dikes, are mowed for maintenance purposes and, secondarily, for wildlife viewing along the auto tour route. The majority of these fields contain non-indigenous species such as fescue, timothy and orchard grass, and clover and 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.

A wide variety of wildlife utilize the grasslands including an abundance of small mammals, especially various mice and vole species, eastern cottontail rabbit, and larger mammals such as white-tailed deer and coyote, several snake species including black king snake, black rat snake, eastern garter snake, many raptor species including Red-tailed Hawk, and Northern Harrier, and a plethora of grassland birds such as:

- Sedge Wren
- Grasshopper Sparrow
- Henslow's Sparrow
- Song Sparrow
- Indigo Bunting
- Dickcissel
- Red-winged Blackbird
- Eastern Meadowlark
- Bobolink

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 are 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 hundred of thousands. A



Yellow Warbler, Muscatatuck NWR. Photo credit: Mark Trabue

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) ultra light led Whooping Cranes annually in the fall between 2001 and 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.

Mammals

Thirty-seven species of mammals are known to occur on the Refuge. The mammals include the federally listed endangered Indiana bat and 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). Another notable mammal is the river otter, once extirpated from the State of Indiana. Reintroduction efforts for the state of Indiana were begun in January 1995 with 25 otters released at Muscatatuck NWR. This has resulted in numerous

otters using the Refuge. Three confirmed otter litters were produced in 1996, and Refuge staff believe that they have produced litters annually ever since 1996. The reintroduction in Indiana has been successful and river otters are no longer considered endangered in the state (Johnson et al. 2007). A complete list of mammal species that occur on the Refuge can be found in Appendix C.

Amphibians and Reptiles

The wide diversity of habitats found on the Refuge makes it suitable for a broad range of amphibians and reptiles; 43 species of herpetofauna are known on the Refuge. They include the state-listed endangered four-toed salamander, copperbelly watersnake, and 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, scientific investigation began to better understand the life history patterns of the copperbelly watersnake. The Refuge has been a stronghold for the species, allowing for intimate study (Kingsbury 1997). While many in the scientific community have commented on the ecology of the species, few have detailed aspects of its life history (Conant et al. 1991). 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 this species' dependence on both the palustrine emergent habitat, as well as the floodplain forest habitat provided by the Refuge. Indiana University Professor Dr. Meretsky discovered the state-listed endangered four-toed salamander during her work with the seep spring study. The salamander is associated with mature forests with wetlands with mossy edges and the young spend several months in the water before they come out on land. Records from central and southern Indiana appear to be based upon very small isolated colonies, some of which may no longer exist, making the Refuge population a significant find. A complete list of the amphibians and reptiles that occur on the Refuge is provided in Appendix C.

Fish

Fifty-nine species of fish were collected during a 2007 survey of waterbodies within the Refuge including tributary streams outside the Refuge. A total of 54 species were collected from the Refuge

and are included in a table in Appendix C. The most diverse families represented were the minnow and darter families, which each included 11 species on the Refuge. 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.

In addition to the sites surveyed on the Refuge, 50 more sites were surveyed in the area surrounding the Refuge. New records for the Refuge included the finding of the eastern sand and harlequin darters in the Vernon Fork Muscatatuck River. In addition, the flier was collected from Moss Lake and Mutton Creek, while the redspotted sunfish was collected from Mutton Creek. These records probably represent the northern and eastern records for these species.

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 2008).

Thirty five dragonfly species have been recorded on the Refuge including the beaverpond baskettail, eastern pondhawk, and shadow darter. The Refuge is known as a good location to observe dragonflies in the area (Curry 2001). With accompanying photographs taken at Muscatatuck NWR, many of these dragonfly species are highlighted in the book



Red-eared Sliders. Photo credit: U.S. Fish & Wildlife Service

Dragonflies of Indiana (Curry 2001). The beaverpond baskettail dragonfly occurs on the Refuge and 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 as occurring on the Refuge (Harmon 1996, Fisher 2007). A follow-up investigation of several of the mussel survey sites used by Harmon (1996) was conducted in 2007 (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 that had never been documented on the Refuge, including elephantear, flutedshell, and deerto. The little spectaclecase was found in both the 1996 and the 2007 surveys; however, only fresh dead specimens were encountered (Fisher 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.



Blue gill. Photo credit: U.S. Fish & Wildlife Service

Threatened and Endangered Species

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. Examples of these species include:

- Indiana bat
- evening bat
- southern tubercled orchid
- climbing milkweed
- copperbelly water snake
- four-toed salamander
- Kirtland's snake

- Kirtland's Warbler
- Interior Least Tern
- Peregrine Falcon
- Bald Eagle
- Bewick's Wren
- Yellow-crowned Night-Heron
- Black-crowned Night-Heron
- Virginia Rail
- Common Moorhen
- King Rail
- Least Bittern
- Loggerhead Shrike
- Osprey
- Short-eared Owl
- Trumpeter Swan
- Northern Harrier
- American Bittern
- Upland Sandpiper
- Least Tern
- Black Tern
- Barn Owl
- Short-eared Owl
- Sedge Wren

- Golden-winged Warbler
- Marsh Wren
- Henslow's Sparrow
- Cerulean Warbler
- Black-and-white Warbler

State species of special concern on the Refuge are:

- least weasel
- little spectaclecase mussel
- Sharp-shinned Hawk
- Red-shouldered Hawk
- Great Egret
- Greater Yellowlegs
- Solitary Sandpiper
- Ruddy Turnstone
- Short-billed Dowitcher
- Wilson's Palarope
- Chuck-will's-widow
- Whip-poor-will
- Sandhill Crane
- Broad-winged Hawk
- Worm-eating Warbler
- Hooded Warbler
- rough green snake

Several other plant species are included on a state watch list. Those species are: American ginseng, bog bluegrass, Walter's St. John's-wort, smooth white violet, club spur orchid (also called small green woodland orchid), Loesel's twayblade and American lotus.

State-listed species and their status are noted in Appendix C.

Threatened/Endangered/Candidate Species (Fed 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

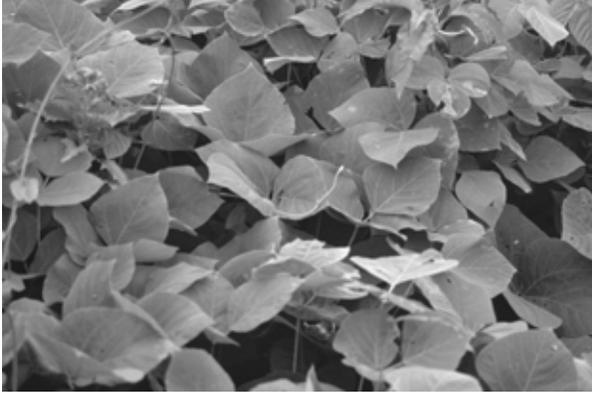
trip down to Florida. Free ranging/ direct release cranes are routinely seen within 20 miles of the Refuge and one was spotted on the Refuge in 2008.

There is substantial documentation of the copperbelly watersnake's use of the Refuge.

The copperbelly watersnake primarily inhabits shallow wetland systems consisting of sloughs, oxbows, river floodplains and buttonbush swamps, much of which have been lost or heavily fragmented (Pruitt and Szymanski 1997). In addition, the copperbelly watersnake is known to rely extensively on terrestrial habitat to traverse between spatially and temporally unpredictable wetland resources (Roe et al. 2003), offering an ideal system to investigate the role of terrestrial habitat on wetland connectivity. Presently, the copperbelly watersnake exists mainly as isolated, often small, populations separated by as much as 300 kilometers. Moreover, northern populations were listed as threatened by the United States Fish and Wildlife Service (USFWS), and endangered by the states of Indiana, Michigan, and Ohio (Pruitt and Szymanski 1997). Genetic testing was done on the Muscatatuck NWR population in 2005 as part of a study that represented seven sampling sites located in Ohio/Michigan, Indiana, and Kentucky. The Indiana regional sampling site was conducted in a disjunct population along the Muscatatuck River, in the Muscatatuck NWR in Jackson County, Indiana, and at a wetland 29 river kilometers south of MNWR in Washington, County, outside of Austin, Indiana (Austin). The two Indiana sites are as different from each other as they are from any of the other sampling sites, despite their geographic proximity. (Marshall et al. In Press)

The federally-listed endangered Indiana bat was confirmed on the Refuge in 1995 and reaffirmed in 2007 by telemetry studies that found that the Indiana bat is a summer breeding resident on the Refuge, (Whittaker 1995; Carter 2007). 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).

Several species that were previously considered candidate species occur at times on the Refuge. These include the Loggerhead Shrike and Cerulean Warbler; bog bluegrass, American ginseng, and the southern tubercled orchid.



Kudzu. Photo credit: U.S. Fish & Wildlife Service

Threats to Resources

Invasive Species

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 passing through 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, tree-of-heaven, autumn olive and kudzu threaten the diversity and health of the bottomland and upland hardwoods while other species, such as reed canary grass, attempt to out-compete native vegetation along riparian corridors, in moist soil units and in other wetland types. Many of the invasive species encountered have the capability over time of producing solid monocultures that shade out native vegetation and reduce overall plant diversity and, consequently, overall animal diversity (Pimentel 2005).

Examples of invasives found on the Refuge include:

- 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 Cowbird
- House Sparrow
- mosquito fish
- gypsy moth

There has only been one account of a gypsy moth (1995) and subsequent traps have not revealed any moths. It is not considered a major problem.

Contaminants

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

- atmospheric deposition
- crop and livestock runoff in Mutton and Storm Creeks
- Sandy Branch Creek
- septic system failures
- surface runoff from the City of Seymour and adjacent highways and roads
- NPDES discharge
- underground storage tanks
- rapid urban development
- accidental spills
- power substations and 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 organochlorines and organo-phosphates, are known to be toxic to fish and wildlife via direct exposure, bioaccumulation, and bio-magnification (Cox 1991).

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 that could result in nutrient and bacterial problems within the watershed. There is also potential for accidental spills to occur. The Refuge is bordered on two sides by major highways (U.S. 31, U.S. 50 and I-65) and by a well-traveled county road (Jennings CR900W) on a third side. Two of the three roads encompassing the Refuge are hard surface roads. In addition, the CSX Railroad runs approximately three-quarters of a mile north of the Refuge, crossing both Mutton and Storm Creek Ditches. Another railroad, the Madison Railroad, crosses the VFMR upstream in North Vernon. In 1980, a derailed train spilled between 8,000 and 10,000 gallons of chlorobenzene directly into Storm Creek Ditch (McWilliams-Munson 1996).

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 in the fish in Indiana (Indiana Department of Natural Resources 2008). The problems associated with heavy metal contamination may be compounded at Muscatatuck NWR 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.



Muscatatuck NWR Visitor Center. Photo credit: U.S. Fish & Wildlife Service

Ozone exposures in Indiana are the highest in the nation's north central region and are relatively high when compared with many states nationwide. The portion of Indiana that contains the Refuge, in particular, exhibits elevated ozone levels. The ozone exposure adversely affects trees and other plants. Ozone stress is expected to be less severe on oaks and maples because they are relatively tolerant of ozone. Nevertheless, given the current ozone exposures and evidence of foliar injury, the potential exists for reduced tree growth and reduced forest health on the Refuge. (Woodall et al. 2005)

Administrative Facilities

The original portion of the Visitor Center (with restrooms) was constructed in the mid-1970s and featured a small office, lobby exhibit area, storage area, projection room, and auditorium/AV room separated by a breezeway from public restrooms. In 1989 the office was converted to a bookstore. Approximately 10 feet was added to the back of the original building in the early 1990s to create a bird viewing room, expanded bookstore, and additional storage areas. In 2003 a new wing, the Conservation Learning Center, was constructed using private funding obtained by one of the Refuge's Refuge Friend's groups, the Muscatatuck Wildlife Society Foundation. The new Conservation Learning center featured a large auditorium, exhibit area, and storage room. Numerous exhibits are located in the new wing. The two wings are connected by a breezeway with large glass windows. The Refuge office is situated in a remodeled ranch-style house

across from the Visitor Center. Workshops, garages, storage buildings, and additional offices are located in the west-central area off of County Road 400 North.

The Muscatatuck Wildlife Society, our primary Friend's Group, operates a bookstore in our Visitor Center that is staffed by volunteers every afternoon and many mornings, and the building is closed when not staffed. Volunteers greet visitors, answer questions, and provide literature and information on Refuge hunting, fishing, and wildlife viewing opportunities. The Visitor Center has a paved, 16-car parking lot in front of the building, and a paved 33-car lot located across from the building off the loop road. A gravel overflow parking lot that can accommodate approximately 50 vehicles is located south of the Office and east of County Line Road, about 100 yards from the building.

Cultural Resources and Historic Preservation

The earliest generally accepted human culture in Indiana is known as the PaleoIndian, a small population of nomadic peoples who moved into the state about 14,000 years ago upon the retreat of the glaciers. Sites are rare, usually disturbed, and important. A PaleoIndian point has been found in Jackson County but none have been found on the Refuge.

The FWS has conducted several archeological investigations on the Refuge, which have identified numerous Archaic culture sites in the period 10,500 to 3,000 years ago. During this period the people engaged in extensive trade of far distant exotic materials. They also adapted to major temperature and resulting environmental changes as the Pleistocene ended and the associated megafauna became extinct following the retreat of the glaciers. This was followed by the hot and dry altithermal, which ended during a climatic period much like the 20th century. The primary subsistence pattern of the Archaic period was hunting and gathering of a large range of animal and plant resources: "The ecotone between the swamp and the adjacent uplands [in the Refuge area] would have provided a unique blend of ecological resources for exploitation." (Myers 1979:11). Two cemeteries, the Berlemen and Myers cemeteries, are located on the Refuge.

Pottery, gardening, mounds (usually burial), and later the bow and arrow are indicative of the Woodland culture commencing about 3,000 years ago. Sites from this culture have been located on the Refuge. The Woodland culture was partially but not entirely displaced by the final prehistoric culture, the Mississippian, in the period 1,100 to 400 years ago. But by the time Western culture (Euro-American) arrived the area had been de-populated.

In the Refuge area neither the archeological nor the early documentary record provides any connection between prehistoric cultures and historic Indian tribes. The earliest written records indicate the Miami, Illinois, and Shawnee lived in the area, but the Iroquois from New York drove out those tribes in the early 1600s. Nevertheless, the Miami and Shawnee along with the Delaware were in Jackson and Jennings Counties until being displaced entirely by 1818.

Between the 1830s and the 1870s farmers settled on what is now the Refuge. Originally subsistence-based hog and corn farmers, the early settlers relied heavily on the abundant wildlife and plant resources. Later a network of rural graveled roads led to the introduction of manufactured goods, which improved rural life during the early 20th century. But concurrently, erosion caused by extensive deforestation from expanding farms stripped away the topsoil and some farmers abandoned the land. To create additional fertile farmland, Mutton and Storm Creeks were ditched for drainage between 1880 and 1900. "By 1870 most of the present refuge area was utilized for farming



Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

and this pattern of small farms continued essentially uninterrupted in the area until the creation of the Refuge in 1966.” (Myers 1979:23)

Cultural resources are all an important part of the Nation’s heritage. The Service is committed to protecting valuable evidence of human interactions with each other and the landscape. Protection is accomplished in conjunction with the Service’s mandate to protect fish, wildlife, and plant resources.

As of March 1, 2008, the National Register of Historic Places listed 11 historic properties in Jackson County and five in Jennings County. This small number is surely not representative of the number of potential historic properties in the counties. Two of the National Register properties are archaeological sites that are located on the Refuge, the listings resulting from Service-funded research: sites 12-J-62 and 12-J-87. Also as of March 1, the Refuge inventory of identified known and potential cultural resources based on Service-sponsored archeological investigations and maps resulted in a list of 140 sites of which 94 are on the National Register; have been determined eligible, or are considered eligible until determined otherwise. Archeological surveys have covered just 1,920 acres of the Refuge so many more sites are likely to occur on the Refuge. Of special note of the known sites is the Carl Myers farm (including log cabin, log barn, and persimmon orchard remnant) which should be nominated to the National Register.

The Refuge has a small number of Native American artifacts on exhibit in the Visitors Center. These artifacts were found on the Refuge and are on loan from the Glenn Black Museum of Indiana University in Bloomington. The display has several artifacts including lithic points, tools, and a pot. The Refuge is included in the Region-wide scope of collections statement dated October 31, 1994.

Visitation

Muscatatuck NWR is open from sunrise to sunset 365 days a year. There are two entrances to the Refuge and both have automatic gates that open at sunrise and close an hour after sunset. Special extended hours are set during hunting seasons. The Conservation Learning Center is also regularly used for meetings and presentations by groups that



Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

have a wildlife conservation or management purpose or program, including during evening hours by prior arrangement.

The Refuge annual visitation was estimated at approximately 174,000 in 2006. The number of visitors per year is obtained through estimates derived in large part from traffic counters at both entrances. Undetected malfunctions in the counters are believed to have led to reports of lower numbers of visitors in some recent years.

The Visitor Center is located on a loop off County Line Road (across from the Office) and is usually by-passed by repeat visitors. A counter at the main point of entry indicated approximately 13,000 visitors to the Visitor Center during the last year.

We do not have an accurate breakdown of visitor numbers per activity but we believe the largest segment of our visitors come for wildlife observation including bird watching, followed by fishing, interpretation/education, and hunting.

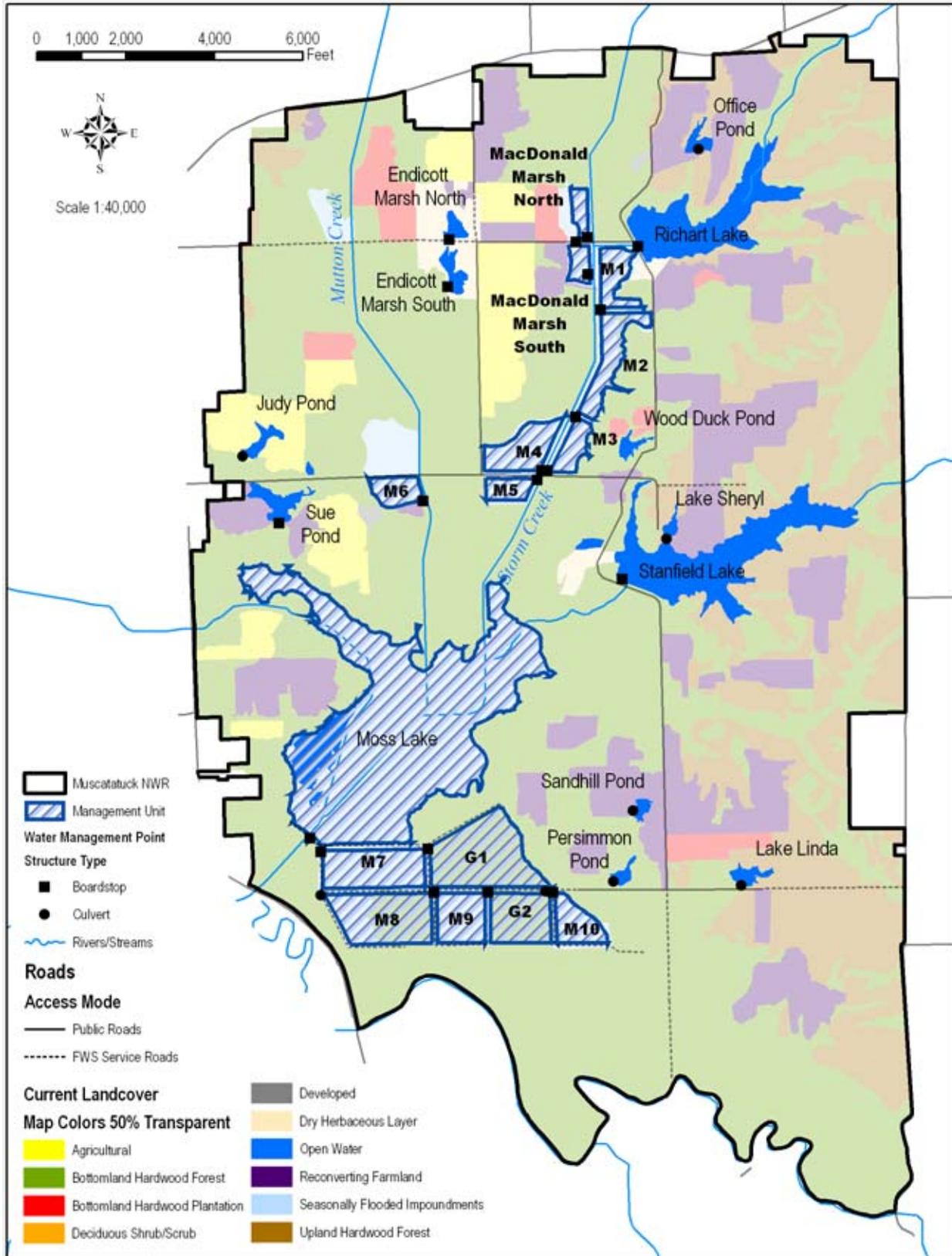
Current Management

Habitat Management

Wetland Management

Nineteen pools of water totaling 1,292 acres have water control structures (Figure 8). Annual water management plans have been followed since 1984 and these plans give management strategies for each unit that include specific water levels needed to create and maintain various habitat or to make food

Figure 8: Water Management Infrastructure, Muscatatuck NWR



available and attractive to wildlife, particularly for Wood Duck production. Water management techniques include removing water to expose mudflats for shorebird use; to allow seed germination of desirable moist soil plants, to allow natural or mechanical rejuvenation of a permanent marsh or moist soil unit; and to discourage use of an area by muskrats, and adding water and maintaining different depths to stimulate invertebrate production and to create and maintain brood habitat and waterfowl migratory feeding areas (Smith and Kadlec 1983). The primary goals of water management are to provide optimum conditions for food and cover for migrating birds, especially waterfowl, nesting and brood habitat for Wood Ducks and Hooded Mergansers, and habitat for other species that use wetland areas.

Moist Soil Units

Muscatatuck NWR actively manages 296 acres of moist soil units through water and vegetation manipulation. Moist soil management on Muscatatuck NWR has been focused primarily on producing dense stands of perennial emergent vegetation on eight units to provide foraging and resting habitat for spring migrating waterfowl. Another objective on these eight units has been to provide brood habitat for resident Wood Ducks, Hooded Mergansers and Canada Geese. These objectives were achieved through water level manipulations timed to coincide with providing optimum habitat conditions for germinating smartweed while also maintaining pool levels throughout the summer months for the broods. Seasonal flooding of these units has generally been planned to occur from September through April. However, proper hydrological manipulation in these units has proven difficult to achieve due to excessive flooding and/or beaver activity combined with a lack of personnel. The remaining two units have been managed to provide sparse perennial emergent vegetation combined with drawdowns timed to coincide with southward migrating shorebird arrival to provide optimum mudflat habitat, a critical need for this avifaunal group (Smith and Kadlec 1983). Water manipulations are generally conducted so that flooding occurs between September and March, although these units have been subjected to the same limitations outlined above.

Regular maintenance of moist soil units is a necessary phase in any management scheme due to the eventual invasion of these areas by more persistent or woody vegetation, i.e. buttonbush,

willows, and Eastern cottonwood. The preferred means of maintaining a particular unit generally involves methods of mechanical disturbance, mowing or disking, to set back succession (Gray et al. 1999). Most units are scheduled to undergo treatment approximately once every 3 to 5 years. However, due to a shortage of staff and impediments to drawdown such as beaver activity and inclement weather, the achievement of many desired management activities as scheduled are often not realized. In a normal year, plans call for the maintenance of one to three of the moist soil units. During this process, drawdown may begin earlier than “normal” to facilitate entry into the units with the necessary equipment. Following vegetation manipulation the units are reflooded and enter back into the “normal” cycle of drawdown and floodup until another maintenance cycle is necessary.

Grasslands

Currently, grassland management is extremely limited. Active management of grasslands in the past entailed mowing, burning, and haying; however, these activities have been abandoned largely due to lack of staff and funds, increasing costs of active management, and changes in objectives. The current objective for many grassland areas is to allow them to revert to hardwood forested areas to reduce forest fragmentation. Once that process begins, those areas are considered in the context of forest management.

Control of invasive species is at the forefront of management goals at the Refuge, and exotic species found in grassland areas are addressed on a case-by-case basis. It is currently considered desirable to control invasives throughout all habitat types because of their threat to the biological integrity and diversity of every habitat as native species are out-competed for space and resources. Often these shifts in the floral community structure and composition are followed by shifts in the faunal community, which in some instances could be detrimental to rare or endangered species and greatly reduces overall diversity.

Forests

Forest restoration is primarily accomplished through natural succession. Most fields are small and are surrounded by excellent seed sources for deciduous trees, although some tree planting of oaks (mast producing trees) has occurred and will



Muscatatuck NWR. Photo credit: Jon Kauffeld

continue to occur and increase as funding permits. The U.S. Forest Service has seven permanent inventory points located on Muscatatuck NWR as part of its national Forest Inventory and Analysis (FIA) Program. The FIA is a national program of the USDA Forest Service that conducts and maintains comprehensive inventories of the forest resources in the United States (Forest Service 2007). This provides forest/landscape level assessments.

Tree planting has occurred sporadically since the Refuge was established. From establishment in 1966 to 2000, approximately 82 acres were planted in selected fields that had been retired from farming (Sieracki et al. 2002). The fields selected were chosen because of their location near existing forested tracts and to help repair forest fragmentation. Since 2000, an additional 30 acres were planted in 2004, 15 acres in 2007, and 19 acres in 2008. The Refuge plans to plant 28 acres in 2009. The Refuge requests planting plans from the local area IDNR Forester prior to undertaking any new planting projects. The plans include native species of a diversity of tree species (mostly oaks) at a rate of 500 trees per acre. Planting has been done by a consulting forester. The Refuge Friends Group, the Muscatatuck Wildlife Society, and the National Wild Turkey Federation have helped fund projects.

Cropland

Food crops of corn and soybeans with wheat as a cover are planted annually on 267 acres of cropland under a cooperative farm agreement with a local farmer. The Refuge share of the crops is left in the field for wildlife. This maintains open habitat and adds diversity to a mostly forested Refuge (Donalty et al. 2003). Canada Geese, waterfowl, Sandhill

Cranes, and resident species forage on the Refuge share of the crop. Wintering raptors prey upon small mammals feeding in these fields. It also creates good wildlife viewing along Refuge roads and the auto tour route.

Monitoring

A number of surveys, censuses, studies, and investigations are conducted on the Refuge that help to monitor the status of its wildlife and plant populations (see Table 2). Birds, mammals, herptofauna, and habitat are monitored on regular schedules. The surveys are conducted by Refuge staff, volunteers and in partnership with IDNR. Weekly waterfowl surveys, mid-winter waterfowl and Bald Eagle counts, and a few other surveys are often requested by the state on an annual basis and the survey data upon completion is sent to IDNR, which in turn summarizes and analyzes the information and provides the Refuge copies of such analyses. The purpose of monitoring is, in general, to determine the presence or absence and estimate the numbers of fish and wildlife present and to aid in making management decisions, and to respond to information requests from state agencies, the public and other partners.

Public Use

The Refuge Improvement Act of 1997 established six priority uses of the Refuge System. These priority uses all depend on the presence of wildlife or expectation of the presence of wildlife, and are thus called wildlife-dependent uses. These uses are:

- hunting
- fishing
- wildlife observation
- photography
- environmental education
- environmental interpretation

Muscatatuck NWR provides opportunities in all of the six priority uses of the Refuge System.

Hunting

Hunting is permitted for white-tailed deer, rabbit, squirrel, turkey, and quail in certain locations on the Refuge during most of the established State seasons. Hunting leaflets are updated annually and hunters are required to sign

Table 2: Monitoring History, Muscatatuck NWR

Study/Survey	Priority (10 high, 1 low)	Scales	FWS R3 RCP	No. Runs	No. Routes
Water Level Monitoring, MSO Hydrology	10	Refuge		26+	1
Invasive Species Mapping and Monitoring	10	Refuge, State, National		N/A	N/A
MSU Vegetation Cover Survey	9	Refuge		1	N/A
Water Quality Monitoring	8	Refuge, State		4	5
Waterfowl Brood Survey	8	Refuge	✓	10	1
Species Lists	7	Refuge	✓	N/A	N/A
Tuberclad Orchid Survey	7	Refuge, State		1	2
Migratory Waterfowl Surveys	6	Refuge, State, National	✓	52	1
Fish Survey	6	Refuge, State	✓	N/A	N/A
FWS Eastern Greater Sandhill Crane Survey	5	Refuge, Region	✓	1	1
Audubon Christmas Bird Count	4	Refuge, State, National	✓	1	?
Audubon Mayday Count	4	Refuge, State, National	✓	1	?
Bald Eagle Count	3	Refuge, State		1	1
NoAm Amphibian Monitoring Program	3	Refuge, State, National		3	1
Great Blue Heron Rookery Count	3	Refuge, State		1	1
Aquatic Invertebrate Survey	3	Refuge, State	✓	N/A	N/A
Abnormal Amphibian Monitoring	3	Refuge, Region, National		N/A	N/A
Butterfly Abundance and Diversity	2	Refuge		1	?

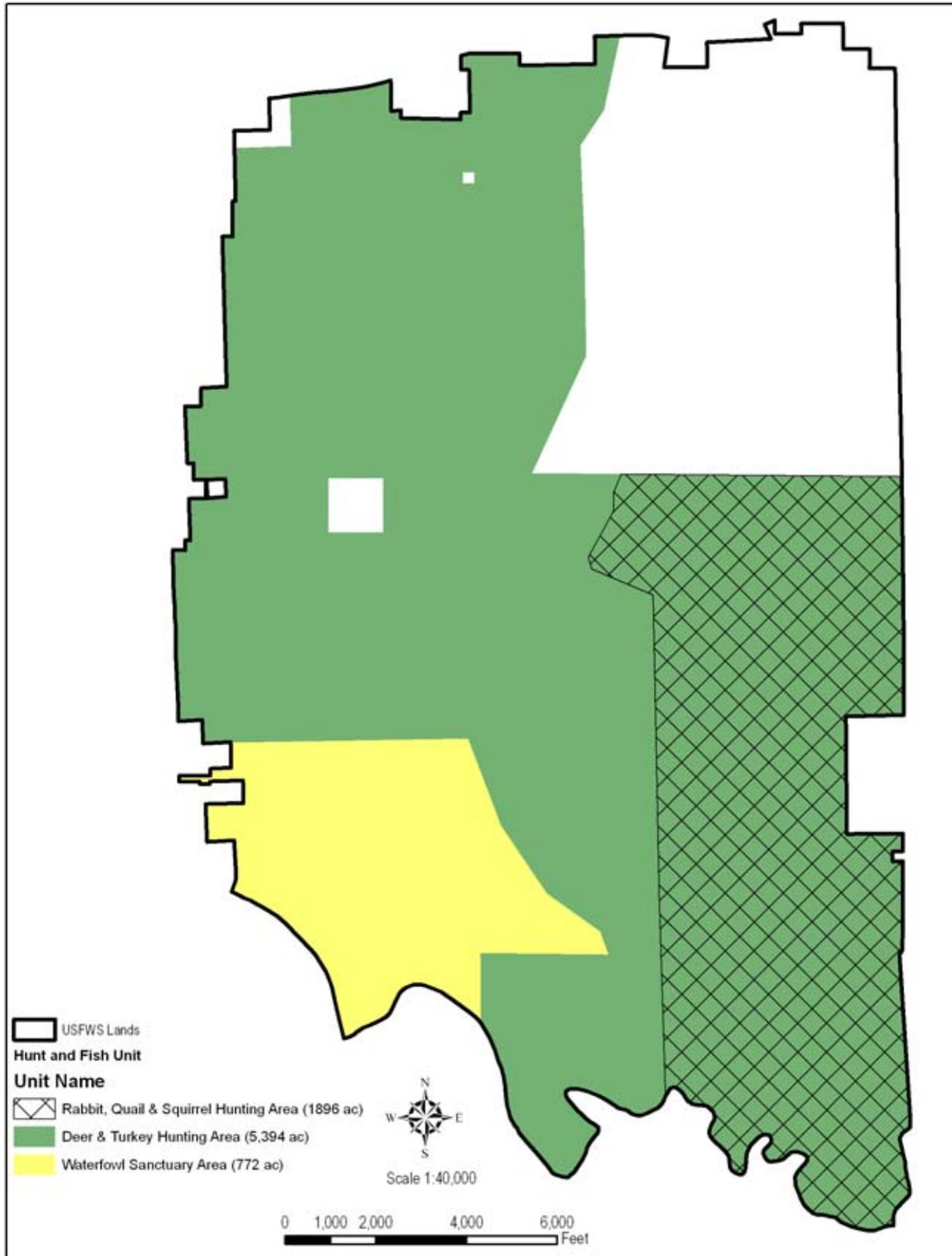
the front of the leaflet and carry it with them while hunting. The Refuge also keeps the State of Indiana Hunting and Trapping Guide with all state rules and regulations in stock as a service to hunters. Deer and turkey hunting are allowed on a large portion of the Refuge during their respective seasons, while squirrel, rabbit, and quail hunting are only allowed in a small portion of the deer and turkey hunting area. No hunting is allowed in the Refuge closed area, in a large section in the northeast corner of the Refuge where the Visitor Center and most of the hiking trails are located, or within 100 yards of any building (Figure 9).

Special deer hunts are held for archery and muzzleloading gun hunters during certain periods and approximately 3,000 hunters participate annually. The deer hunt drawings are done by the

State. Bowhunters hunt in a different time period from the muzzleloading hunters. A late “open” archery season, open to all hunters with a valid state hunting license and available tag, is held on the Refuge after the muzzleloader season is over. Only handicapped hunters are permitted to use crossbows during Refuge deer hunts. The deer hunting area is the same as the turkey area – approximately three-quarters of the land area of the Refuge.

The turkey hunt requires a special permit during the spring season and involves 10-15 hunters/day over approximately three-fourths of the land area of the Refuge. Special permit drawings are done by the State. Rabbit hunting is open to members of the public with a valid state hunting license and involves a small percentage of Refuge visitors. Rabbit and

Figure 9: Public Use, Hunting, at Muscatatuck NWR



quail hunting are the only hunting and activities on the Refuge where dogs may be used and be off-leash. Squirrel hunting is a new, small, but growing activity. The rabbit, quail, and squirrel hunting area covers the southeast quarter of the Refuge and is the area east of County Line Road and south of Barn Road. Very few visitors hunt quail here as the quail population is marginal and most of the hunting area is reverting to brush.

The Refuge remains open to non-hunting activities throughout the hunting season. Refuge visitors and hunters scouting for a future hunt day may enter hunting areas for any otherwise allowed purpose. All Refuge public use roads also remain open during all hunts as do all public fishing sites.

Hunters park on the Refuge only in designated hunting areas to access all parts of the Refuge that are open to hunting. Additionally, many hunters park on adjacent public roads, including CR 900 W., Hwy. 31, and CR 500 N., outside the Refuge and walk in to their hunting areas, but most park along the Refuge roads. Refuge staff have little contact with hunters aside from answering questions prior



Turkey hunting on Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

to and during the hunt. Self-service deer registration boxes are located at each entrance gate where hunters are required to register their kill before taking it to a state authorized check station. Turkey hunters are asked to report the location of their takes, and successful deer hunters are asked to fill out a harvest card.

Fishing

Fishing is provided year-round at two large lakes, Stanfield and Richart, two small lakes, Linda and Sheryl, and at Display, Mallard, Sand Hill, and Persimmon Ponds. A fishing leaflet is available and is updated annually as needed. The Refuge also keeps the State of Indiana Fishing Guide with all state rules and regulations in stock as a service to anglers. Fishing structures and paved paths provide accessibility to handicapped anglers at three sites – Stanfield Lake and Lake Linda, which have accessible floating ramps and platforms, and Sand Hill Pond, which has a paved walkway. Stanfield Lake has a concrete boat ramp and non-motorized boats may be launched and used on this lake. Parking lots and single-panel kiosks with regulations and leaflets are located at each fishing area except for Richart Lake, Display Pond, Mallard Pond, and Lake Sheryl. Concrete outhouse facilities are located at the Stanfield Lake and Persimmon Pond parking lots for the convenience of all visitors. Regular bathroom facilities with running water are located at the Visitors Center. A map of all Refuge fishing areas is provided in the fishing leaflet.

Fishing in the creeks and the seasonal drainages that enter and cross the Refuge is not allowed in an effort to provide relatively undisturbed habitat to Wood Ducks and their broods, which make extensive use of these habitats. Fishing is also not allowed in any of the Refuge's constructed moist soil units or marshes. Fishing is permitted from the banks of the Muscatatuck River except from the shoreline in the waterfowl sanctuary closed area.

Refuge fishing areas are generally shallow. Aquatic weed growth makes bank fishing difficult in the warm months and some Refuge visitors use "float tubes" or "belly-boats" – inner-tube type aides for wading (or floating) across the water. Fishing is permitted by hook and line only, and generally state regulations apply. Sought-after fish species include largemouth bass, bluegill, crappie, and channel catfish.



Visitors at Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

Interpretation, Observation, and Photography

Nine miles of roads are open for wildlife observation from autos, buses, motorcycles, or bicycles, plus an approximately 4-mile auto tour route with numbered posts and an interpretive leaflet. There are two observation structures, the Hackman Overlook on Richart Lake and the Endicott Observation Deck on the Auto Tour Route. The Hackman Overlook is located approximately one-half mile from the Richart Trail parking lot and overlooks Richart Lake. Recently, this structure has attracted vandals who have been marking it with graffiti and carvings, and the structure has been identified by staff as a maintenance problem. The Endicott Viewing Platform is an accessible raised wooden structure that overlooks both the North and South Endicott Marshes, has two fixed public use spotting scopes, and provides good opportunities to view marsh, wading, and waterbirds. (Figure 10)

There are seven hiking trails of various lengths on the Refuge including the .4-mile (paved) Chestnut Ridge Interpretive Trail near the Visitor Center that features numbered posts with a leaflet. Most hiking trails are about a mile long except for the East and West River trails, in the floodplain of

the Muscatatuck River, which between them provide a 7-mile route for wildlife observation and hunter access along the river.

A self-service audiovisual program that presents an overview of the Refuge is available at the Conservation Learning Center. There are interpretive exhibits in both wings of the building and the Indiana Junior Duck Stamp Contest entries are on display in the CLC auditorium. New exhibits were recently built and installed in the old wing of the Visitor Center by a contractor and were opened to the public in the summer of 2008. A two-panel kiosk is located in the Visitor Center parking lot.

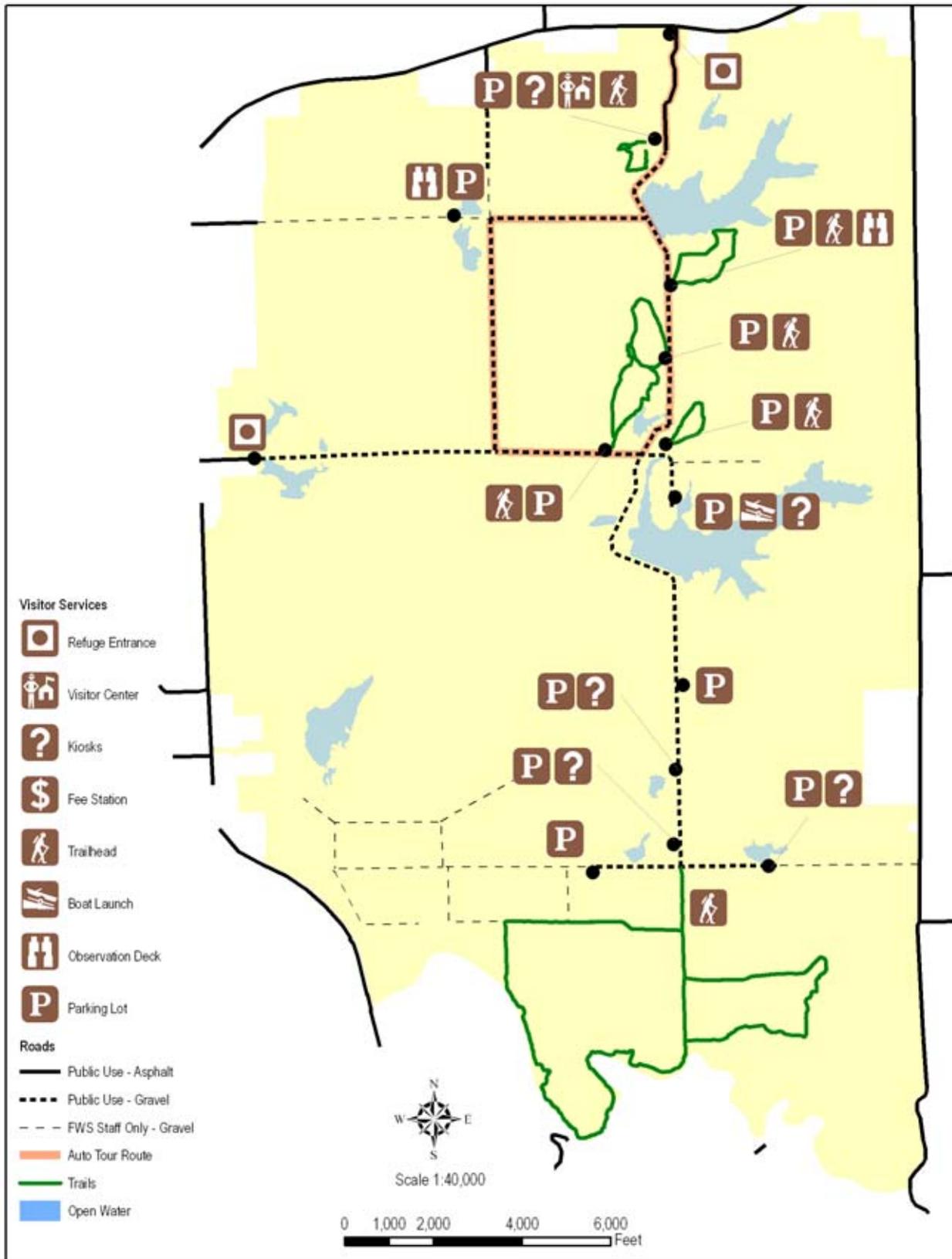
Large Refuge special events include a migratory bird festival in May, kids fishing event in June, and a friends' group Refuge Week "Log Cabin Day" festival in October. The "Wings Over Muscatatuck" bird festival held on International Migratory Bird Day is the Refuge's major annual event and attracts a growing audience of approximately 1,000 visitors when the weather is good. The Jackson County Visitor Bureau and the Muscatatuck Wildlife Society are major sponsors of this event, which features day-long guided birding tours of the Refuge, bird walks, bird banding demonstrations, bird and wildlife interpretive programs, live birds of prey/Bald Eagle programs, exhibits by conservation groups, vendors, and kids' birding activities.

The "Take a Kid Fishing" event at Muscatatuck NWR has been funded by the Muscatatuck Wildlife Society for many years. The 1-day event features special fishing for "kids and friends" in a pond normally closed to fishing, fishing and casting contests, fish art contests, loaner fishing poles, free bait, fishing lessons on request, and lots of door prizes. Trophys are awarded to event winners. Attendance varies between 400-600 people.

With the help of the Service's National Conservation Training Center, Muscatatuck NWR staff operate two booths at the National FFA Convention in Indianapolis for 3 days each October. The focus of the outreach effort is on providing career and background information on the Fish and Wildlife Service and wildlife conservation issues. Between 40,000-50,000 young people and several thousand teachers attend the convention annually, and this event is considered the largest gathering of students anywhere in the United States.

The "Log Cabin Day" festival in October celebrates the end of National Wildlife Refuge Week and is a project of the Muscatatuck Wildlife Society.

Figure 10: Visitor Services Facilities, Muscatatuck NWR



The friends group provides a free ham and bean lunch at Myers Cabin during the event and there are old-time crafts, music, blacksmiths, a storyteller, horse-drawn wagon rides into the adjacent closed area (which is open that week), wildlife exhibits and information, and a volunteer set-up with a spotting scope on the Refuge Bald Eagle nest. “Wetland Day” programs have been held in mid-March for several years and feature guided waterfowl tours.

Wildlife photographers visit the Refuge on a regular basis but exact numbers are unknown. Annual wildlife photography contests are held in conjunction with bird festival and Refuge Week events and the Refuge hosts the monthly meetings of the Muscatatuck Photography Club.

Environmental Education

Many school groups visit the Refuge during the spring and fall, and primarily use the Refuge on their own. Unfortunately, with transportation funding cuts to public schools, numbers have been decreasing over the last few years. Refuge staff assist teachers prior to their visits whenever possible but do not usually work with students directly. Staff does work with Girl Scouts on badge-work and “linking girls to the land” activities.

Four “Conservation Field Day” programs are held for third-graders from Jackson and Jennings Counties in May and October with about 300 youngsters involved each day, and as such provides Refuge contact with most of the third-graders in each of these counties each year. The interagency effort features programs on wildlife, forestry, soils, wetlands, and recycling. Instructors usually include educators from the Indiana Department of Natural Resources, Soil and Water Conservation Districts, Purdue Extension, Indiana Department of Environmental Management, Solid Waste Management Districts and the Refuge. The programs feature hands-on activities for the youngsters and are well received by area teachers.

Muscatatuck NWR manages the Indiana Junior Duck Stamp art contest with over 450 entries each year. Refuge volunteers do much of the work in administering the program and the Muscatatuck Wildlife Society provides a substantial amount of the award funding. Other partners in the program include the Indiana Department of Natural Resources, Ducks Unlimited, and Bass Pro Shops. An awards ceremony is held at the Refuge during the May migratory bird festival. The original art of

the Junior Duck Stamp Contest winners is kept on display in the Visitor Center Auditorium for one year before being returned to the students.

A “Junior Birder” kids program is given during the summer months and is being expanded with volunteers. An “Invasive Species” patch program is available and has been used by scouts and other youth groups. Master Naturalist classes and teacher workshops are held on the Refuge periodically. Songbird, Prairie, and Wetland Trunks are available on loan from the Refuge as are other educational materials. Kids’ activities are an important part of the migratory bird festival held annually in May, and “skins and bones” are featured at the Refuge Week festival.

The “Refuge Rangers,” an elementary school group of about 30 students from Hayden School, has spent considerable time learning about the Refuge and helping with projects under the leadership of their teacher, a Refuge volunteer. This group has recently published a field guide to Muscatatuck NWR written by and for children, and with the assistance of the National Fish and Wildlife Foundation and the Muscatatuck Wildlife Society, this guide is being made available to all students who visit the Refuge as part of a school-based field trip.

Non-wildlife Dependent Recreation

Collecting mushrooms, nuts, and berries is permitted along with collecting shed deer antlers. Large numbers of people collect mushroom species at the Refuge in the spring.

Some jogging and bicycling occurs on the Refuge. Jennings County High School regularly brings their physical education and cross-country teams out for practice runs on Refuge trails.

Predator, Pest, and Invasive Species Management

Animal Species

Currently two mammalian aquatic nuisance species exist at the Refuge, the North American beaver and muskrat. Beaver create serious problems on the Refuge by constructing dams that impede water flow and cause flooding, which has proven to be detrimental to bottomland hardwood stands and has resulted in less than desirable conditions in moist soil units and green tree units. This also creates an enormous workload for Refuge

staff who spend countless hours removing mud and debris from water control structures and tearing out dams from waterways. These animals also damage stands of timber by girdling trees causing either mortality or stunting growth due to the loss of cambium tissue.

Beaver and muskrat will both burrow into dike banks, reducing overall structural integrity. These burrows reduce functionality of the dikes in two ways, both of which are costly to repair. First, over time these burrows cave in, causing surface damage that may encumber travel of vehicles or equipment, thus slowing down or preventing maintenance efforts. Second, these burrows can either directly cause seepage or leaks in dikes or do so indirectly by creating open sites that erode, leading to leaks and seepage. Refuge staff have begun to address these issues by removing problematic animals.

Three other species are targeted for control on the Refuge: feral dogs, feral cats, and Mute Swans. Feral dogs and cats are hand trapped or live trapped when evidence of their presence is detected. These animals are then turned over to a county animal control officer. Mute Swans are an invasive species targeted for control because their aggressive territorial behavior discourages use of wetlands by other waterfowl.

Plant Species

Invasive plant species management requires a multi-faceted approach that involves inventory, control, and monitoring. Preliminary mapping surveys of invasive plant species began in 2003 and is an ongoing project. Japanese stiltgrass, kudzu, garlic mustard, Japanese knotweed, oriental bittersweet, tree-of-heaven, and purple loosestrife have all been mapped, at least partially, with only kudzu and the loosestrife believed to have been fully mapped. A final report from a Challenge Cost Share research grant was submitted in November of 2007 and included information on many of these species and their distributions.

Invasive plant control is a species-specific and site-specific endeavor, and a list of all control methods for every species occurring on the Refuge is beyond the scope of this plan. However, most of the control efforts at Muscatatuck NWR involve chemical application, usually a glyphosate based product, although this is not always the case. Chemical applications may be foliar, basal bark, or cut stump treatments and may be used in combination with mechanical treatments.

Mechanical means are employed when such methods are feasible and judicious. These methods may include hand-pulling, cutting (with weedeaters, brush cutters, or mowers), and disking (Blossey 2004). Fire, although not currently used on the Refuge, is also a viable option for the control of many species and may be considered for use in the future. Currently no biological control methods are in use at the Refuge, however, they could be used if the right opportunity presented itself. Recently, the Refuge has focused on attacking stiltgrass, loosestrife, knotweed, kudzu, garlic mustard, and tree-of-heaven as part of an early detection rapid response philosophy. Work has begun to create “weed free” areas starting with an area surrounding the Visitor Center. Creating an Integrated Pest Management Plan (IPM) is a high priority for the Refuge and will be essential in establishing long-term objectives, strategies, and priorities for invasive plant management.

Treatments are often conducted by volunteers and interns or through partnerships with local groups and organizations. With a limited staff, these associations help the Refuge to accomplish an otherwise impossible task. Partnering and sharing resources is an integral part of the management of invasives at Muscatatuck NWR and will continue to be into the future. Currently, a multi-agency/partner project is under way to establish a Southern Indiana Cooperative Weed Management Area (CWMA). The Refuge has taken a role in the project and expects to work closely with partners as establishment progresses.

Archaeological and Cultural Resources

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 remains close to the cabin. The cabin was continuously occupied by the Myers family and the barn was in use until it was 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 headstones. 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 archaeological 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. Over 73 archaeological sites have been documented on the Refuge by professional archaeologists. Recovered artifacts indicate 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



Myers Cabin, Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

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 at the University of Indiana in Bloomington, Indiana.

Law Enforcement

Until 2003, the Muscatatuck NWR law enforcement staff consisted of one or more collateral duty officers assisted by State Conservation Officers and State Police when needed and as available. From 2003 to 2006 no station staff did law enforcement work and collateral duty officers from Big Oaks NWR worked our deer hunts on a limited basis. In 2006, a full-time Refuge Officer assigned to Big Oaks NWR was responsible for all of the law enforcement work at both Big Oaks NWR and Muscatatuck NWR. That individual left his position in 2007. The full-time law enforcement position at Big Oaks NWR was moved to Muscatatuck NWR in late 2007 and the Refuge has filled the position. This position will be a shared position between both refuges, and provide limited assistance to Patoka River NWR in southwestern Indiana. Law enforcement support is also provided by our Zone Officer, State Conservation Officers, and the State Police.

Historically, the Refuge had a reputation as a “trophy” deer hunting area and was known to local Conservation Officers as an active deer poaching area. In the past, while operating on a part-time basis as a collateral duty, Refuge officers focused on resource oriented violations: fishing in areas closed to fishing, deer poaching, marijuana growing, and ginseng collecting. More recent efforts undertaken by full-time officers have expanded to include a larger number of violations associated with public use including: after-hours trespass, illegal vehicle operation, no driver’s license, and illegal substance possession offenses, in addition to wildlife resource based violations.

The Refuge receives excellent but limited support from State Conservation Officers from two counties. The Seymour State Police Post is within 4 miles of Muscatatuck NWR and responds when called for serious problems. County Sheriff deputies are sometimes seen on the Refuge, and have been helpful, but we are at the edge of both counties. The State Police frequently have been called to let locked-in visitors out of the Refuge at night, and this is becoming a burden for the post and an issue that

requires attention. Law Enforcement personnel from Crab Orchard NWR and Cypress Creek NWR provide assistance by working on larger operations.

Existing Partnerships

The Refuge has partnerships with local, state, and national organizations. These partnerships benefit the Refuge in many ways, including fostering good community relations and enhancing habitats and wildlife populations. Examples of partnerships include the following:

- The Refuge is a host agency for Experience Works (formerly Green Thumb) a senior work training program that supplies enrollees that work on the Refuge an average of 20 hours per week.
- A curatorial cooperative agreement between the Service and the Glenn A. Black Laboratory of Archaeology, University of Indiana, provides for the curation and storage of the 10 Refuge archeological collections containing a total of 23,635 artifacts. Artifacts are owned by the Federal Government and can be recalled by the Regional Historic Preservation Officer for exhibits and other Refuge and Service purposes.
- Muscatatuck NWR has been fortunate to have many partners in the local area, including:
 - Muscatatuck Wildlife Society
 - local Soil and Water Conservation Districts
 - NRCS
 - Purdue Extension
 - local Ducks Unlimited Chapters
 - local Wild Turkey Federation
 - Indiana Department of Natural Resources
 - local Resource Conservation and Development Councils
 - area conservation and birding clubs
 - sporting good stores
 - scouting and civic groups
 - local Visitor Bureaus
 - U.S. Forest Service
 - Hayden School Refuge Rangers
 - local universities

Other Management Areas

Research Natural Area

The Muscatatuck Seep Springs Research Natural Area (MSS-RNA) occupies a 97-acre portion of the Refuge (Figure 12 on page 46). 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 tuberled orchid, bog bluegrass, Walter's St. Johnswort, and smooth white violet. Also found here are the state-listed endangered four-toed salamander and the state-listed endangered copperbelly watersnake.

Restle Unit

The Restle Unit of Muscatatuck NWR is a 78-acre parcel in Monroe County, northwest of Bloomington, Indiana, that was 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, 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 that is frequently flooded, and Burnside silt loam, which is occasionally flooded (Thomas 1981).

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 Heron. Beaver, muskrats, white-tailed deer, eastern fox squirrel, raccoon, red fox, opossum, and eastern mole are mammals that have been seen. Some of the 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 it is suspected to be present because the habitat provided matches its requirements. No studies have been conducted 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).

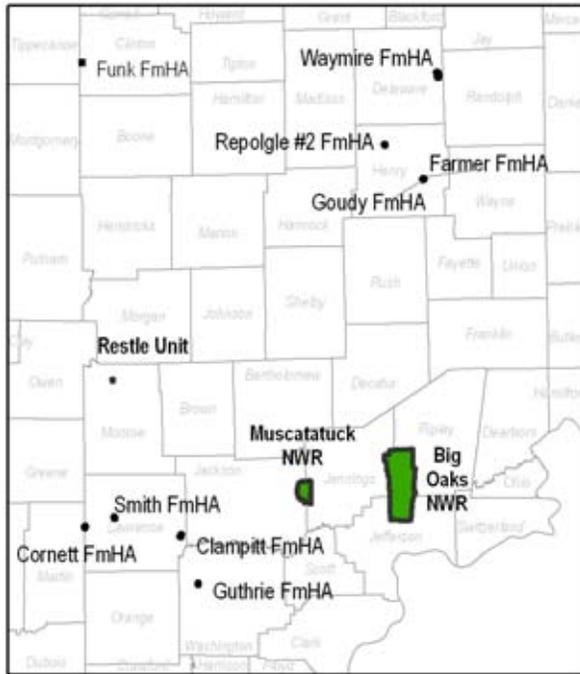


Great Blue Heron. Photo credit: Mark Trabue

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.” Deed restrictions to the management of the property include the prohibition of timbering, burning, hunting, trapping, fishing, use of herbicides or insecticides, construction of buildings, general public access, and commercial sale of any resources. The restrictions have exceptions for the protection of wetlands, protection of native plant and animal habitat, and construction of observation blinds.

Figure 11: FSA Easements Administrated by Muscatatuck NWR



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.

Farm Service Agency Conservation Easements

The Refuge manages nine conservation easement areas totaling 130.5 acres located within the Wildlife Management District, a 30-county area in Indiana (Figure 11). On these FSA easements, the FWS is authorized to protect and manage important natural resource interests including wetlands, floodplains, riparian corridors, and endangered species habitat. Ownership of the easement land is retained by private individuals, but with restrictions related to conservation management. Service employees are responsible for habitat management and are granted access for maintenance, monitoring, enforcement, and other management activities.

Most Farm Service Agency (FSA) conservation easements are visually checked for boundary signs, trespass, and various other infractions every 2 years.

Current Staff and Budget

Staff

The Refuge’s staffing, as of September 2007, includes eight full-time equivalent positions:

- Refuge Manager
- Wildlife Refuge Specialist
- Wildlife Biologist
- Maintenance Mechanic
- Tractor Operator (vacant)
- Park Ranger (law enforcement)
- Outdoor Recreation Planner
- Administrative Technician

Budget

A 6-year history of the operating and maintenance budget for the Refuge is shown in Table 3.

Table 3: Five-year Operating and Maintenance Budget

FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007
\$1,339,425	\$805,000	\$570,343	\$682,920	\$662,410	\$546,139

Chapter 4: Management Direction

Goals and Objectives

This chapter presents the goals, objectives and strategies that will guide management and administration of the Refuge over the next 15 years. This management direction represents the plan for the Refuge and mirrors Alternative C in the Environmental Assessment that was prepared as part of the planning process (Appendix A).

The Refuge has three goals:

- *Goal 1: 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.
- *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.
- *Goal 3: People* – Visitors understand and appreciate the natural environment and its processes through participation in high-quality, wildlife-dependent recreation and educational opportunities.

The goals are general statements of future desired conditions on the Refuge. The objectives under each goal are specific statements of what will be accomplished to help achieve the goal. Strategies listed under each objective specify the activities that will be pursued to realize an objective. The strategies may be refined or amended as specific tasks are completed or new research and information come to light. Some strategies are linked to the duties of an employee position, which indicates that the strategy will be accomplished with the help of a new staff position. When a time in number of years is noted in an objective or strategy, it refers to the number of years from approval of



Wood Duck drake. Photo credit: Mark Trabue

this CCP. If no time is given, the objective is to be accomplished within the 15 years of the life of the plan.

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.

Objective 1.1: Upland Hardwood Forest

Over the long-term (100-200 years), on areas dominated by upland flats and moist slopes, achieve a 1,522-acre mosaic of upland hardwood stands of different age and structural classes dominated by poplar, oak, hickory, white ash, black cherry, maple, and beech. Within 15 years convert 310 acres of farmland to restored upland hardwood and maintain the existing 1,212 acres of upland forest. Also within 15 years enhance 150 acres of upland forest by removing invasive species and employing various improvement techniques to ensure proper understory development, regeneration, and age class and species compositions.

Rationale: Land use practices, invasive plant introduction, and modifications to the hydrology of the landscape over the past century have drastically altered the vegetative communities on the Refuge

and led to increased fragmentation of the habitat. Studies have shown that forest fragmentation reduces nesting success of migratory birds because of increased nest predation and parasitism. Area-sensitive forest bird species generally require large, contiguous blocks of forested habitat and are also negatively impacted when fragmentation results in smaller contiguous acreages (Robinson et al. 1995).

Historically, the Refuge was a part of the expansive, contiguous hardwood forest that covered most of the central and southern part of Indiana (Jackson 1997). Of the identified upland soils within the Refuge boundary, 1,212 acres are currently in upland forest. An additional 310 acres of potential upland forest have been identified that are currently in various cover types considered reconvertible farmland. This acreage will be both allowed to naturally convert to upland hardwoods and planted to trees of species that were historically present. This will help reduce forest fragmentation and provide habitat for migratory birds, Wood Ducks and the Indiana bat.

The Refuge has carried out reforestation activities in recent years to reduce fragmentation of forested habitats and retire former agricultural fields and pastures. The intent is to manage native forest land for structural and plant species diversity and ensure healthy soil and water resources. Closed canopy forests often result in poor regeneration of shade intolerant species, especially oak species, and often result in poor understory development. However, natural openings caused by death or wind throw of one or more trees, create open habitats that are quickly colonized by herbaceous plants, shrubs, and tree seedlings and these temporary openings are desirable because they provide diversity within the otherwise forested matrix, and are important habitat for wildlife (Collins and Battaglia 2002). To replicate these natural openings, openings 1 acre or less in size will be artificially created as part of forest management.

Invasive species such as autumn olive, Japanese honeysuckle, bush honeysuckle, multiflora rose, Japanese stiltgrass, and garlic mustard have invaded a large percentage of the Refuge's forested habitats. These species outcompete and shade out native vegetation resulting in the development of monotypic stands of non-native vegetation, thus reducing vegetative diversity, inhibiting regeneration, and they also threaten rare and endangered plant populations (Pimentel et al. 2005). This objective represents the Refuge's intent to



Muscatatuck NWR. Photo credit: Jon Kauffeld

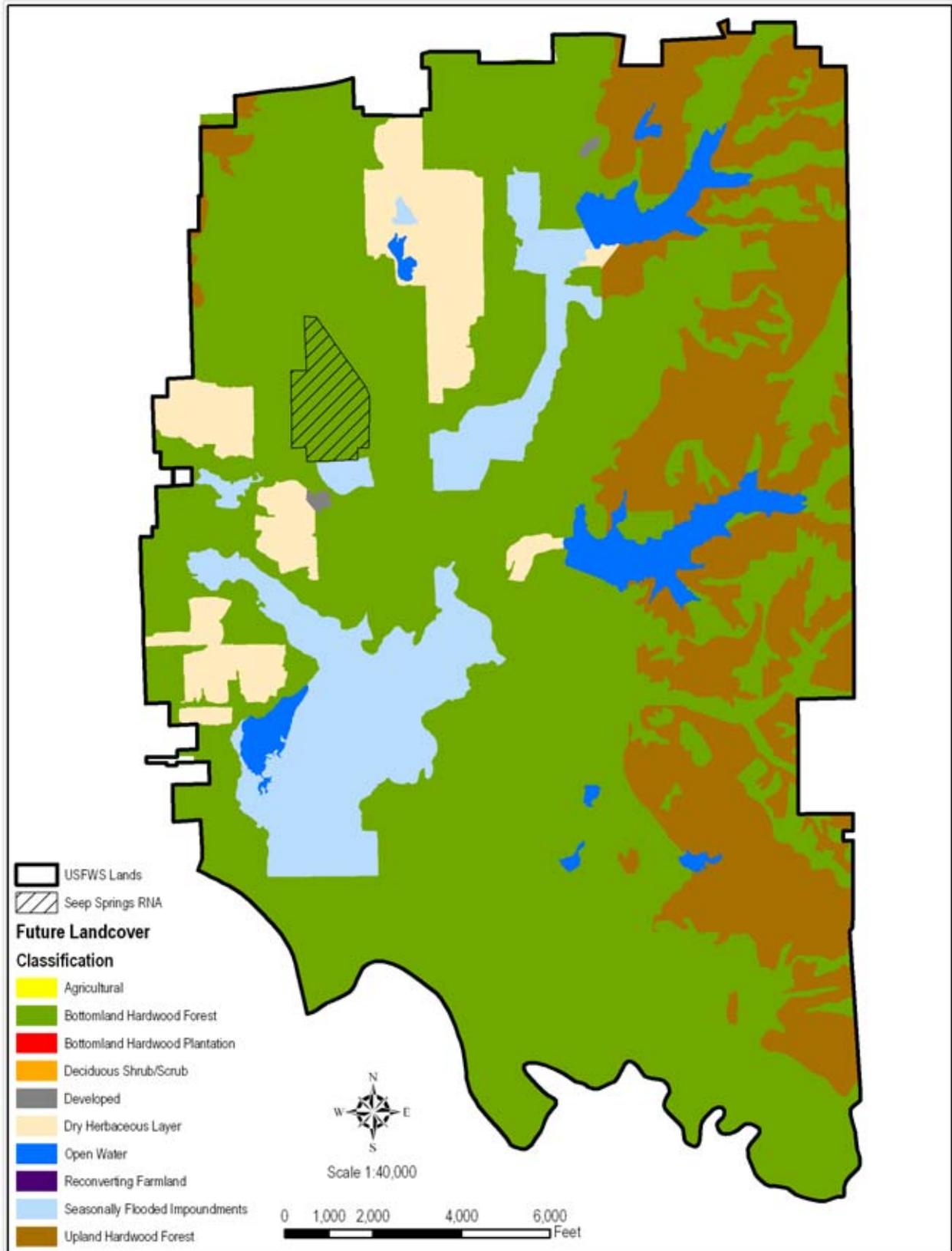
more actively manage and restore upland forest habitat to benefit forest-dependent wildlife, especially certain species of migratory waterfowl, neotropical migratory birds, and mammals (e.g. Indiana bat, southern flying squirrel).

Large contiguous blocks of native upland forests are expected to provide breeding and nesting habitat for the Wood Thrush, Chestnut-sided Warbler, Yellow-billed Cuckoo, Pileated Woodpecker, and Cerulean Warbler, as well as habitat for the Indiana bat, waterfowl and other migratory birds, and upland game species.

Strategies:

1. Conversion of 310 acres of former and current cropland to upland hardwood forest (Figure 12). This may include site preparation, planting a cover crop, planting tree seedlings, and weed control treatments. Some areas may be allowed to naturally revert to forested habitat through natural succession.
2. Tree planting of white and red oaks, black cherry, persimmon, and black walnut taking soil types and native trees into consideration will occur on 160 acres. It is believed that hickory, beech, and maple trees will be restored through natural regeneration. Planting plans will be written in cooperation with the IDNR District Forester.
3. Complete a forest management (habitat management) step-down plan in 5 years.
4. Removal of invasive plant species within upland forested habitats through integrated pest management (IPM) strategies outlined in an approved IPM plan.

Figure 12: Future Land Cover, Muscatatuck NWR



5. Decrease undesirable tree basal area through selective cutting to promote establishment and growth of more desirable native hardwoods. Silvicultural treatments may be conducted under contract by commercial timber harvesting firms.
6. Timber stand improvement to include thinning dense stands, and deadening cull trees that are competing with more valuable wildlife trees, and selective harvest on a small scale to allow for habitat diversity and opening of canopy to stimulate plant growth, regeneration and recruitment on forest floor. Apply appropriate silvicultural treatments to manage forest health, species composition, and age structure. Treatments may include non-commercial forest stand improvement treatments (girdling, cutting, and/or applying herbicide to individual stems), and commercial timber cutting (thinning, improvement cuttings, and regeneration cuttings). Thin young stands of trees (pre-commercial) using appropriate methods to reduce competition for resources and allow residual trees to develop into healthy advanced stands.
7. Artificially replicate the small openings in the forest (1 acre or less) that would have occurred naturally to provide the natural diversity of habitat that should be present within the forest matrix.
8. Fill the existing (vacant) tractor operator position and add a biological science technician to assist with reforestation efforts, eradication of non-native tree species, and timber stand improvement efforts.

Objective 1.2: Bottomland Hardwood Forest

Over the long-term (100-200 years) achieve approximately 4,788 acres in large blocks (greater than 500 acres) of mature bottomland forest (average dbh equals 12-30 inches) with a canopy cover of 60-80 percent consisting of mixed sycamore, oak, beech, green ash, sweetgum and maple.

Within 15 years, restore hydrology in the area of the current greentree reservoirs, moist soil units 8, 9, 10, and Moss Lake greentree area to allow flooding and ebbing with the natural changes in the river. Vary water levels in the shallow northeastern portion of Richart Lake, closely monitoring effects and habitat changes. The area

of the current lower moist soil units, with the exception of M7, will have started reverting back to bottomland hardwood forests with an oak component. Sheet flow through these areas will be restored to allow more natural movement of runoff, dead timber areas within greentree reservoirs will be restored through the natural regeneration of oaks, if possible, and through seeding or planting, if necessary.

Rationale: Historically the Refuge was a part of the expansive, contiguous hardwood forest that covered most of the central and southern part of Indiana (Jackson 1997). The Muscatatuck Flats and lowlands area is in the Bluegrass Natural Region of southeast Indiana. The bottomland is characterized by relatively level plain poorly drained flats. The Muscatatuck River floodplain is one of the most extensive areas of bottomland hardwood forest remaining in the Midwest. The floodplain forest along the Muscatatuck River is characterized by sweetgum, swamp white oak, and shellbark hickory (Sieracki et al. 2002).

Increasing, the bottomland hardwood areas at Muscatatuck NWR along the Muscatatuck River and smaller streams will provide important breeding habitat for Wood Duck, Acadian Flycatcher, and Cerulean Warbler as well as summer habitat for the federally-listed endangered Indiana Bat and habitat for the state-listed endangered Copperbelly watersnake (Sallabanks et al. 2000; Kingsbury 1997).

Land use practices, development of roads, beaver dams, and modifications to the hydrology of the Refuge have impeded drainage, causing seasonal flooding to persist for longer than had occurred historically. The prolonged flooding helped shift composition of bottomland hardwood forests towards tree species with greater water tolerances, and largely eliminated regeneration resulting in single-aged mature stands. In some areas semi-permanent flooding resulted in complete tree mortality and shifts in habitat type from forested wetland to open water or marsh (Kozlowski 2002).

Planned modifications to the drainage system will allow for water management that more closely resembles historical conditions and the restoration of species associated with those conditions. This objective represents the Refuge's intent to more actively manage bottomland forest habitat to benefit forest-dependent wildlife, especially certain species of migratory waterfowl, neotropical migratory

birds, resident cavity nesting species, and mammals (e.g. Indiana bat, southern flying squirrel). The Refuge's intent is to actively manage the return of the forested landscape to conditions that allow passive hydrological management that resembles the historic hydrological regime to benefit and protect the wide array of plant and animal species that flourish in such environments.

One measure of the biological integrity of bottomland hardwood forests is whether the timing and frequency of events such as flooding correspond to historical conditions. The 4,788-acre objective represents an increase of 782 acres over existing acreage; the additional amount comes from conversion of moist soil units and former agriculture and pasture lands (Figure 12 on page 46).

Strategies for Green Tree Reservoirs (G1, G2, and Moss Lake acres):

1. Discontinue prescription flooding of the Green Tree Reservoirs (GTR) and allow them to fluctuate naturally from the creeks and river influences and from precipitation and resulting runoff. The units will no longer be purposely flooded via management intervention.
2. Actively pursue draining excess water prior to the growing season to encourage regeneration and avoid killing trees. The stoplogs within the structure at Moss Lake will not be set higher than 540.0 at any time to protect the forested systems that are struggling to survive along the borders of the unit; it may be determined from bathymetry/forestry investigations that the maximum elevation for stoplogs should be 539.5 or 539.0, and thus the maximum elevation may be further reduced.
3. A bathymetric investigation of Moss Lake will be completed by 2012 to determine the maximum stoplog elevation for the Moss Lake water control structure to prevent impounding water in the forested areas of Moss Lake.
4. Water control structure modifications will be made on the Moss Lake Water control structure by 2013 to increase the discharge capabilities of the structure. Screw gates or other comparable designs will be installed in several if not all of the six bays within the structure to increase discharge and reduce the buildup of sediment within the impoundment. Moss Lake GTR areas will no longer serve as a greentree

reservoir but will function as a floodplain forest whose hydrology will attempt to mimic the natural influence of the Muscatatuck River as if there were no dikes and structures.

5. Acquire the machinery necessary (i.e. small amphibious backhoe) to access and remove the beaver dams and other impediments to water flows on the creeks, at the various water control structures, and other areas where drainage is impeded.

Strategies for Bottomland Hardwoods (includes Green Tree Reservoirs):

1. Allow natural regeneration of trees to occur when possible and augment natural processes with planting seeds or seedlings when necessary. Manage timber to promote regeneration of most producing tree species.
2. Conduct forest surveys or inventories every 5 years to monitor changes in health, composition, and structure of bottomland forests
3. Develop and implement short- and long-term forest management plans.
4. Conduct forest management activities such as thinning dense stands or midstory and selective harvest on a small scale to allow for habitat diversity and opening of canopy to stimulate plant growth, regeneration and recruitment on forest floor.
5. Provide vernal pools where feasible.
6. Conduct a study to learn more about the hydrology and geomorphology of the Refuge.
7. Remove portions of the dikes forming the greentree reservoirs and moist soil units 8, 9, and 10 after completing a hydrological study unless contradicted by the study.
8. Timber stand improvement to include thinning dense stands, selective harvest on a small scale and deadening cull trees that are competing with more valuable wildlife trees to allow for habitat diversity and opening of canopy to stimulate plant growth, regeneration and recruitment on forest floor. Apply appropriate silvicultural treatments to manage forest health, species composition, and age structure. Treatments may include non-commercial forest stand improvement treatments (girdling, cutting, and/or applying herbicide to individual stems), and commercial timber cut-

ting (thinning, improvement cuttings, and regeneration cuttings). Thin young stands of trees (pre-commercial) using appropriate methods to reduce competition for resources and allow residual trees to develop into healthy advanced stands.

9. Restore hydrology and micro/macrotopography based on current knowledge and future recommendations from hydrogeomorphological investigations. Attempt to replicate historic conditions that included hydrologic features such as depressions, oxbows, and swale topography. Also, to replicate permanent, semi permanent and seasonally flooded wetlands that were historically present in the Muscatatuck River Basin.

Objective 1.3: Grassland

Maintain 471 acres of open grassland to benefit wildlife viewing and to provide high-quality nesting and forage habitat for grassland bird species. These areas should be capable of providing high-quality breeding habitat for listed species (e.g., Henslow's Sparrow), waterbirds (e.g. Great Blue Heron) and other migratory birds (e.g. , Bobolink, Dickcissel, Loggerhead Shrike, Grasshopper Sparrow and Sandhill Crane), and contributing to the native biological diversity of the Refuge.

Rationale: Pre-European settlement vegetation within the current boundaries of the Refuge was dominated by deciduous forest with little to no open



Eastern Bluebird. Photo credit: Mark Trabue

grasslands occurring except small openings where natural events (i.e. wind throws, tornadoes, or beaver) created gaps in the forest (Jackson 1997). Small temporary and permanent forest openings are part of the historic vegetative condition of the Refuge. Furthermore, the diversity of birds present at the Refuge can be attributed to the diverse habitat types and many wildlife enthusiasts, observers, and bird watchers are drawn to the Refuge because of the diversity of species and habitats. The diversity provides Refuge visitors with quality wildlife-dependent recreation opportunities. Even though historically larger grasslands were not prominent on the Refuge, benefits to grassland bird species may still be derived from the retention and/or expansion of grassland habitat in strategic locations. Populations of many grassland bird species are declining, in part because of loss of habitat (Herkert 1994). These grasslands can serve as habitat for Grasshopper Sparrow, Henslow's Sparrow, Eastern Meadowlark and Sandhill Crane. They will also provide habitat for Kirtland's snake (Conant and Collins 1991).

Strategies:

1. Protect, restore, or enhance the blocks of grassland habitat and ensure they are comprised of short, medium, and tall height-density patches containing diverse structure (e.g., bare soil, stiff-stemmed forbs, and sparse woody vegetation) with a 75 percent grass and 25 percent forbs mix with a minimum of six grass species and a minimum of 30 herb species. The Refuge will focus on creating blocks of grassland habitat that are structurally open and free of major linear woody edges. In most cases, woody cover will represent less than 5 percent of the grasslands habitat. Maintain Refuge grasslands through periodic burning and/or mowing with some grasslands (25-50 percent of the total grassland landscape) remaining free from burning or mowing, between 3 and 6 years to provide habitat for Henslow's Sparrow, Northern Bobwhite Quail, Field Sparrow, and other species that prefer a well-developed duff layer and the presence of some shrubs. Some thicket areas and isolated trees will be allowed to persist to provide breeding habitat for Loggerhead Shrike, Bell's Vireo, Yellow-breasted Chat, and other species in some of the grassland areas.

2. Place grassland openings along the perimeter of the Refuge and along the wildlife auto tour route to minimize fragmentation, promote habitat diversity, and promote wildlife observation.
3. Periodically inventory grasslands to determine species composition and stem density and to detect invasive species.
4. Under the guidance of an integrated pest management plan, work toward removing and preventing the establishment of non-native invasive species within Refuge grasslands with special emphasis placed on autumn olive, multiflora rose, Johnson grass, and non-native thistles.

Objective 1.4: Moist Soil Units

Maintain 175 acres of Units 1-7 under moist soil management to provide annual food crops and resting habitat for migratory waterbirds, Wood Duck habitat and mudflats for shorebirds. Also, maintain 233 acres including the McDonald and Endicott marshes, Moss Lake, and Sue Pond as emergent marsh to provide, feeding, resting, and nesting habitat for all waterbirds including secretive marsh birds, waterfowl, wading birds, and shorebirds.

Rationale: Moist soil management is a widespread practice for producing a diverse mixture of native herbaceous plant foods and invertebrates. It partially mimics seasonal flooding that has long occurred in the Muscatatuck NWR lowlands, but moist soil units – areas impounded by dikes, and structures that permit precise control of water levels – allow managers to produce conditions favorable to growth of native plants such as millets and sedges (Haukos and Smith 1993). Seeds produced by these plants provide balanced nutrition for migrating waterfowl, and also provide food and habitat for other migratory birds and wildlife. The diverse mixture of native plants also creates conditions that produce abundant invertebrates, a high protein wildlife food source.

Emergent marshes are some of the most productive natural systems in the world (Waide et al. 1999). The productivity, however, is derived from the dynamic nature of hydrological events and the resulting vegetative responses (Haukos and Smith 1993). Cyclical management of marsh units, including periodic full and partial drawdowns need to be incorporated into the water management



Osprey. Photo credit Dan Kaiser

regime. Changes in these systems could drastically increase use of the units and the Refuge by waterbirds, increase amphibian and macroinvertebrate production, and increase the overall plant diversity of the marshes and the Refuge.

Strategies for Moist Soil Units:

1. Disturb (through mowing, disking, fire, etc...) an average of one-third of moist soil unit acreage annually to set back succession.
2. Moist soil units will be maintained in early successional native plant communities for the production of annual seed crops.
3. Limit public access to moist soil units during peak duck use periods by closing the levees to hiking, bird watching, etc.
4. Maintain most moist soil units dry throughout much of the growing season (April through September) to produce food for migratory birds except where shallow irrigation will aid in beneficial moist soil plant production, or when managing a unit for a late summer/fall drawdown to benefit fall migrant shorebirds.
5. Maintain dikes and water control structures in good working order controlling muskrats and beaver to prevent excessive damage (i.e. honeycombing) and disruption of water management capability.
6. Provide additional fall-flooded, shallow-water habitat for shorebirds when feasible.

7. Begin draining some moist soil units in March when feasible to expose mudflats by April to benefit migrating shorebirds that can feed on invertebrates.
 8. Manage water levels within moist soil units to provide optimum depths for dabbling ducks, shorebirds, and wading birds.
 9. Ensure that water management regimes between and within years incorporates variation in depth, duration, and in the timing of drawdown and reflooding. The seasonal and annual shifts in hydrologic condition set the stage for vegetation development within the various impoundments.
 10. Remove trees, stumps, fallen logs, and other woody debris from Units M1-M6 via bulldozer or whatever means necessary, yet ensure that significant amounts of topsoil are not removed. This will facilitate proper management of these units especially during maintenance/disturbance operations and will help to prevent the establishment of willows and other undesirable woody vegetation within the units.
 11. Remove debris piles from previous rehabilitation work to allow disturbance throughout the units via disking or mowing and to prevent establishment and continued issues with the proliferation of willows within the units.
 12. Control exotic and invasive plant and animal species.
 13. Conduct annual vegetation monitoring to gather data necessary to make management decisions and to evaluate and document management actions and corresponding responses.
- annual shifts in hydrologic condition set the stage for vegetation development within the various impoundments.
4. Conduct periodic drawdowns to consolidate sediment, increase plant germination, and reduce fish populations.
 5. Control exotic and invasive plant and animal species.
 6. Within 2 years of CCP approval, identify and adopt marsh management strategies conducive to meeting emergent marsh objectives.
 7. Conduct periodic marsh monitoring using established rapid assessment protocols for wetlands including vegetative, amphibian, and macroinvertebrate indices of biotic integrity and secretive marsh bird surveys.

Objective 1.5: Invasive Plant Species

Inventory all Refuge lands for invasive plant species within 5 years of plan approval. Identify, monitor, control, and eliminate exotic and invasive species found on the Refuge and rapidly respond to new invasive species.

Rationale: Invasive species are detrimental to native plant and animal populations. Invasive species are considered to be one of the greatest threats to the National Wildlife Refuge System.

Autumn olive, garlic mustard, reed canary grass, Canada thistle, crown vetch and many other species dominate certain portions of the Refuge landscape. Japanese stiltgrass, multiflora rose, Japanese honeysuckle, tree-of-heaven, and kudzu threaten the diversity and health of the bottomland and upland hardwoods while other species, such as reed canary grass and purple loosestrife, compete with native vegetation along riparian corridors, in moist soil units, and in other wetland types.

Many of the invasive species encountered have the capability over time of producing solid monocultures, shading out native vegetation and reducing overall plant diversity and consequently overall animal diversity (Blossey 2004). Many of the same natural disturbances, such as drought, flood and wildfire, that maintain productivity of natural systems also provide opportunities for invasive species to multiply and spread.

Human activities and disturbances on the landscape also create conditions conducive to the spread of invasive species. It is very important that

Strategies for Emergent Marsh Units:

1. Ensure proper water levels to promote the development of diverse complex vegetative structure within the units and to provide water depths suitable for waterbird use.
2. Increase the distribution and interspersions of cattail and other emergent vegetation.
3. Ensure that water management regimes between and within years incorporates variation in depth, duration, and in the timing of drawdown and reflooding. The seasonal and

the Refuge staff is able to inventory and monitor the spread of invasive species and take actions to minimize the distribution of a species or control its abundance on the landscape.

We will probably never be able to eliminate these species from the landscape, but targeted chemical, mechanical, manual, and biological control or prescribed fire are methods that can reduce their impact on native species. Success will be based on factors that include reduction in the spread and shrinkage of infestations, complete eradication, or stabilization of infestations. The Refuge will employ a strategy of early detection, rapid assessment, and rapid response (ED/RA/RR). ED/RA/RR amplifies the probability that invasions will be managed effectively while populations are confined to a small area and eradication is feasible. Populations, once well established, are rarely completely eradicated; mitigation of their negative impacts is about all that is realistic (Blossey 2004). Furthermore, overall costs of ED/RA/RR are inevitably much lower than costs associated with long-term reduction and control of well established populations.

Strategies:

1. Develop an integrated pest management plan (IPM).
2. Inventory and map distribution of invasive species. (Biological technician)
3. Identify treatment protocols for all known invasive plants inhabiting the Refuge and for the plants most likely to invade in the near future using IPM strategies.
4. Prioritize species and locations for treatment. Use a diverse array of control tools and techniques individually or in combination, including but not limited to mowing, biological controls, herbicides, prescribed fire, and revegetation.
5. Evaluate all ground-disturbing management actions for their potential to facilitate the spread of invasive plants. Establish and implement a survey design that monitors invasive species and allows comparison of different management regimes.
6. Develop an annual monitoring and mapping strategy for invasive species.

7. Implement early detection, rapid assessment, and rapid response strategies for ‘new’ invaders.
8. Increase training for staff members on invasive species identification.
9. Increase public awareness of the invasive species issues facing the Refuge and encourage public involvement through workshops, presentations, work days, special events, and other stewardship opportunities.
10. Cooperate with state and federal agencies, non-government organizations, and neighboring landowners to strategize, inventory, monitor, and treat invasive species on a larger landscape level scale.
11. Fill the existing (vacant) full-time tractor operator position to assist with invasive species eradication. Also add one wildlife biologist to oversee and manage field efforts and two full-time biological science technicians to help with controlling invasives, forestry, and grassland management.
12. Develop and enhance relationships with universities, colleges, schools, and other organizations such as the Boy Scouts, Girl Scouts, Wildlife Society, Audubon Society etc. and encourage participation in the fight against invasive species on the Refuge.

Objective 1.6: Seep Springs Research Natural Area

Restore the hydrology for the Seep Springs Research Natural Area to a condition that approximates an undisturbed site.

Rationale: The Research Natural Area is one of only seven acid seep springs documented in Indiana. The cold, acidic groundwater yields a unique assemblage of plant species, and 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 as Globally Rare in the Natural Heritage system, a ranking system developed by The Nature Conservancy.

State-listed plant species found here are: American ginseng, club spur orchid, southern tubercled orchid, bog bluegrass, Walter’s St. Johns wort, and smooth white violet. The state-listed

endangered four-toed salamander and the state-listed endangered copperbelly watersnake are found in the Area, also.

A Refuge road to the south of the Area and beaver activity have raised the water level and altered the water flow within the Area. The changed conditions in the Area have caused an observable change in the vegetation with severe tree mortality and a shift in habitat type from a seasonally flooded forested wetland to more of a permanently flooded marsh.

In order to preserve the special characteristics of the Area, it is necessary to better understand the current and historical conditions at the site and then formulate possible approaches to returning the site to a less disturbed condition. The key piece for understanding what is happening at the site is to understand how water flows into and out of the site and what historical hydrologic regime existed that allowed the development of the seep. Therefore, the first step in restoring and maintaining the Research Natural Area is conducting a hydrogeomorphological investigation. The site is also threatened by a number of invasive species including garlic mustard,



Red fox. Photo credit: U.S. Fish & Wildlife Service

moneywort, reed canary grass, and Japanese stilt-grass. Control of these invasive species will need to be addressed.

Strategies:

1. Conduct a hydrogeomorphological investigation to determine historic water regimes and to determine realistic recommendations for restoring the hydrology.
2. Determine best management practices for restoring the forested habitat that has been degraded, ensuring proper species composition and preventing establishment or release of invasive species into the Area.
3. Reduce the influence of Mutton Creek on the Area during the growing season, March-November.
4. Inventory, monitor, map, and control invasive species in and near the Area.
5. Develop a monitoring plan/protocol to monitor the overall health of the Area and to watch for changes in plant communities, sedimentation, and hydrology.
6. Form a working group of qualified professionals and stakeholders to collaboratively assist in the implementation of these strategies.
7. Determine if the Area should be protected from all public entry and if so sign the area and develop and make available informational material to educate the public.

Objective 1.7: Restle Unit

Maintain 48 acres of bottomland forest and manage a 30-acre moist soil unit to support water bird feeding, resting, and breeding.

Rationale: The Refuge must “perpetually manage the real estate as a wetland habitat for native wildlife and plant enhancement and protection.” To best fulfill its commitment, the Refuge will manage the constructed unit on the Restle Unit as a moist soil unit because this follows the establishing direction for the Refuge. The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

The forest will be maintained, but not managed. Exhibit “A” included in the donation document of the Restle Unit states that “No timbering, burning,



Bald Eagles at Muscatatuck NWR. Photo credit: Mark Trabue

hunting, trapping, or fishing shall be permitted, except that plant harvesting or controlled burning for the protection of the wetland or research into the protection of wetlands are permitted.

Wildlife harvesting within the levee constructed by the Fish and Wildlife Service in 1990 is also permitted for the protection of the wetland within the levee. The permitted activities specified in this paragraph are to be conducted only by personnel of the grantee or their designees for that specific purpose.”

Strategies:

1. Develop a water management plan within 2 years of plan approval to guide management of the impoundment.
2. Maintain dike and water control structure in good working order.
3. Use mechanical, chemical and biological controls to check the spread of invasive plant species.
4. Communicate with other state and federal resource agencies, as well as non-governmental organizations, to stay current on emerging threats and effective management and control techniques related to invasive species.

Objective 1.8: Conservation Easements

Meet Service monitoring guidelines for FSA over next 15 years.

Rationale: The Refuge is responsible for managing FSA easements (formerly Farmers Home Administration easements, or FmHA) within a 30-county Wildlife Management District. These easements were placed on the properties when landowners defaulted on their Farmers Home Administration loans. Properties were then resold to the original landowner at a discounted price due to the easement or sold to another individual. FSA easements are an agreement between the FSA and the FWS, authorizing the Service to protect important natural resource interests on easement properties such as wetlands, floodplains, riparian corridors, and endangered species habitat. Ownership of the easement land is retained by private individuals, but with certain restrictions on altering important natural resources on the easement lands. Service employees are granted access for management, maintenance, monitoring, and enforcement purposes. There is no public access to these easement properties unless explicitly stated in the individual easement document.

Strategies:

1. Bi-annually inspect each FSA easement and follow-up with landowner contact.
2. Send letters to new landowners informing them of existing easements on their property, along with the associated regulations
3. Follow protocols within the Service’s easement manual to handle all potential violations

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.

Objective 2.1: Monitoring

Over the long-term, document the effect of reforestation and management on wildlife species diversity and abundance. Surveys will identify the presence/absence of species and abundance of select high priority species as well as surveying

key indicator species to monitor the overall health of the local environment and impacts due to management actions.

Rationale: The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act. Approximately 280 species of birds have been documented as using the Refuge. Most of the birds that use the Refuge are migrants either passing through during spring and fall, or wintering on the Refuge. However, the Refuge also supports an abundance of breeding bird species with 121 species confirmed as breeding at the Refuge. Among these breeding species are Wood Duck, Canada Geese, Least Bittern, and Sora Rail, as well as many passerine species, and a colony of Great Blue Heron. Water and moist soil management efforts focus on providing suitable resting, nesting, and foraging habitat for all waterbirds, and monitoring populations can give indications of whether the Refuge is effective in its management actions.

The Refuge is home to a diversity of reptile and amphibian species attributable to the abundance of wetlands and diversity of habitats. Many of these species are invaluable assets as a food supply to the myriad of species that prey on them. More than 40 species have been documented, including frogs,



Wild Turkey at Muscatatuck NWR. Photo credit: Mark Trabue

toads, salamanders, skinks, turtles, and snakes. Among the snakes are the State-listed endangered Kirtland’s snake and copperbelly watersnake. Several other species of reptiles and amphibians that occur on Muscatatuck NWR are listed as endangered or threatened at the state level, including the four-toed salamander. Amphibians are especially sensitive to changes in their environment and their populations are declining worldwide (Houlahan et al. 2000; Wake 1991; Blaustein et al. 1994). Monitoring the health of reptile and amphibian populations at Muscatatuck NWR may help detect other environmental problems such as contaminants or impacts due to global climate change. Baseline data on reptiles and amphibians that occur at the Refuge are incomplete, outdated, and possibly unreliable.

With ample water year-round and the influence of the Vernon Fork, Storm, Mutton, and Sandy Creeks, a wide variety of fish species flourish at Muscatatuck NWR (Patrick and Palavage 1994). A total of 85 species have been documented on the Refuge. The most diverse are the minnow (22 species) and darter (13 species) families. Anglers fish for largemouth bass, bluegill, redear sunfish, black crappie, and catfish. The eastern sand darter and harlequin darter have been found in the Vernon Fork of the Muscatatuck River at the south end of the Refuge. In addition, a flier was collected from Moss Lake and Mutton Creek in 2007 and a redspotted sunfish was collected from Mutton Creek the same year; these are perhaps the furthest north and eastern records for these species. Monitoring fish assemblages can serve numerous purposes. Several species of fish can be surveyed as indicator species for water quality and environmental health i.e. darter spp (Patrick and Palavage 1994). Fishing pressure, if too great or too little can have serious implications to the health of a fisheries system and therefore periodic evaluation will allow for recommendations necessary for regulation of sport fishing.

The Refuge supports several resident game species that attract visitors for hunting and wildlife observation. White-tailed deer and Wild Turkey are abundant in southern Indiana and on the Refuge. Food and cover are available in plentiful supply. The Northern Bob-white Quail and eastern cottontail rabbit populations are relatively small and will likely diminish with the reduction in Refuge grasslands and fragmentation of the forest (Twedt et al. 2007; Harper 2007). Squirrel populations are healthy and

these species will likely experience a positive effect from reforestation efforts (Fisher and Wilkinson 2005).

Deer monitoring on Muscatatuck NWR is lacking. Spotlight surveys, deer exclosures, and/or indicator plant surveys should be utilized and interpreted to determine population sizes and make management recommendations. Emigration and immigration can greatly alter population size and density and can be extremely variable from year to year. Food availability, mainly mast production, is largely responsible for these variations in deer demographics. Damage to surrounding landowners' property can occur during years of poor mast production. Overpopulation of deer can lead to the damage of seedlings, especially oaks, which can impede regeneration success in the hardwood areas of the Refuge. Overgrazing can lead and contribute to changes in species composition, which in turn can result in negative effects on other plant and animal species (Rooney and Waller 2003). A firm understanding of population size and management decisions based on regular monitoring is necessary to prevent these negative effects, while sustaining a viable population.

Reforestation of the open, fallow, and retired farm fields and other grassy openings may result in significant changes in the faunal assemblages currently present at the Refuge. It is believed that closing in the forests and reducing fragmentation will result in increases to forest interior bird species. However, this will be to the detriment of grassland bird species. It is imperative that Refuge staff be able to monitor the bird response to such large scale changes to verify changes at the Refuge following reforestation.

Strategies:

1. Develop a monitoring plan within 5 years and incorporate when possible the recommendations from the Biological Review and Inventory and Monitoring Review.
2. Conduct weekly waterfowl surveys to monitor use, production, and effectiveness/impacts of management actions; send this data to cooperating state partners.
3. Conduct secretive marsh bird surveys every 5 years using an established protocol to monitor use and response to management actions.

4. Work with partners, the Biological Monitoring Team, and other professionals to develop a method to correlate vegetation surveys, water level monitoring, and waterbird response to enhance existing knowledge and provide data necessary for management.
5. Conduct pre- and post-bird monitoring in conjunction with habitat management efforts including conversions and restoration/regeneration efforts.
6. Conduct heron rookery surveys annually to monitor the health of the colony; send this data to cooperating state partners.
7. Annually monitor Bald Eagle nest production and conduct annual nest searches for this species.
8. Conduct shorebird surveys using the International Shorebird Survey Protocol to track occurrence, relative abundance, and response to management regimes.
9. Conduct thorough baseline inventory of herpetofauna occurring on Refuge.
10. Establish surveying and monitoring for several herptile species as indicators to environmental health, water quality, as well as monitoring impacts of global climate change.
11. Conduct annual frog call surveys in accordance with the North American Amphibian Monitoring Program protocols; send this data to cooperating state partners.
12. Conduct fisheries surveys every 5 years to monitor populations, environmental health, water quality, and to allow for recommendations necessary for regulation of sport fishing.
13. Monitor deer populations to protect regenerating trees, prevent depredation issues on adjacent lands, ensure viable populations, and to generate data necessary for establishing annual hunting regulations.
14. Partner with conservation and private organizations to assist with monitoring inventory and educational efforts.
15. Monitor Region 3 Regional Conservation Priority (RCP) species every 5 years through nationally recognized protocols and link results to regional and national databases.



Refuge sign. Photo credit: U.S. Fish & Wildlife Service

16. Ensuring high-quality scientifically based monitoring will require the addition of one wildlife biologist and two full-time biological science technicians.

Objective 2.2: Federally Listed Threatened and Endangered Species

Protect federally listed species and their habitats.

Rationale: Whooping Cranes, Indiana bats, and Least Terns use the Refuge. Least Terns and Whooping Cranes use the Refuge during migration. Indiana bats are resident species. The Refuge population of copperbelly watersnakes is not included in the federal listing, which addresses populations north of Indianapolis. However, ongoing research indicates that the Muscatatuck NWR population may be important because it is thriving while many populations are declining and may be attributable to various habitat components. A population of bog bluegrass is located in the seep spring area. This plant is apparently flourishing and well in that area.

Strategies:

1. Maintain close coordination with the Ecological Services office on any habitat alteration that may affect Indiana bat habitat.

2. Facilitate continued research and monitoring of Indiana bats on the Refuge.
3. Facilitate continued research and monitoring of copperbelly watersnakes on the Refuge.
4. Facilitate inventory, mapping, monitoring, and research as necessary on federally-listed or candidate species that are found at the Refuge within the life of this plan.
5. Consider federally-listed species when making management decisions and actions.
6. Protect, as necessary, areas and habitats known to benefit or support federally-listed species.

Objective 2.3: State T&E Species and Species of Concern

Consider known populations of state-listed species in management actions.

Rationale: Species on the state endangered list that occur on the Refuge include:

- Indiana bat
- southern rein orchid
- climbing hempvine
- copperbelly water snake
- four-toed salamander
- Kirtland's snake
- eastern mud turtle
- Kirtland's Warbler
- Peregrine Falcon
- Bald Eagle
- Yellow-crowned Night-Heron
- Black-crowned Night-Heron
- Virginia Rail
- Common Moorhen
- King Rail
- Least Bittern
- Loggerhead Shrike
- Osprey
- Trumpeter Swan
- Northern Harrier

- American Bittern
- Upland Sandpiper
- Least Tern
- Black Tern
- Barn Owl
- Short-eared Owl
- Sedge Wren
- Golden-winged Warbler
- Cerulean Warbler
- Marsh Wren
- Henslow's Sparrow

The following state species of special concern occur on the Refuge:

- least weasel
- little spectaclecase mussel
- rough green snake.
- Sharp-shinned Hawk
- Red-shouldered Hawk
- Great Egret
- Sandhill Crane
- Broad-winged Hawk
- Black-and-white Warbler
- Worm-eating Warbler
- Hooded Warbler
- Greater Yellowlegs
- Solitary Sandpiper
- Ruddy Turnstone
- Short-billed Dowitcher
- Wilson's Phalarope
- Chuck-will's-widow
- Whip-poor-will

Several other plant species are included on a state watch list. Those species are: American ginseng, bog bluegrass, Walter's St. John's-wort, smooth white violet, and club spur orchid. The Refuge is within the range of several other state-listed species. Surveys need to be conducted to document the presence of these species on Refuge lands. A monitoring plan will be developed and

surveys will be conducted to confirm species presence. State-listed threatened and endangered species will be considered in management actions on the Refuge.

Strategies:

1. Facilitate inventory, mapping, monitoring, and research as necessary of state-listed or candidate species that are found at the Refuge within the life of this plan.
2. Protect, as necessary, areas and habitats known to benefit or support state-listed species.
3. Consider state-listed species when making management decisions and actions.

Goal 3: People

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

Introduction: "Quality," as used in the following objectives, is defined by the criteria for developing and evaluating wildlife-dependent recreation programs in the Service Manual (605 FW 1). Quality incorporates elements of safety, minimal conflict, accessibility, resource stewardship, understanding, appreciation, and satisfaction. Quality also incorporates the reasonable opportunity to experience wildlife. The Improvement Act of 1997 also directs refuges to promote opportunities for families to experience wildlife-dependent recreation, which will be considered in visitor services planning.

Objective 3.1: Hunting

Refuge hunters will experience quality hunting opportunities for deer, Wild Turkey, squirrel, and rabbit. An opportunity to hunt quail will continue to be provided.

Rationale: As one of the six priority wildlife-dependent recreational uses identified in the National Wildlife Refuge System Improvement Act of 1997, hunting provides a traditional recreational activity on the Refuge with no definable adverse impacts to the biological integrity or habitat sustainability of Refuge resources.

For safety, hunters will need to wear hunter orange on all hunts with the exception of turkey hunts. To minimize conflict with the purposes of the



Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

Refuge there will be no waterfowl hunting and no hunting of any kind in the waterfowl sanctuary and the north east portion of the Refuge that is currently a no hunting area. Interpretive and informational programs delivered through brochures and special events will be developed to promote resource stewardship, understanding, and appreciation among hunters. Hunting times for squirrel, rabbit, and quail will be consistent with the State season. Archery deer hunting will extend, except for a break during the muzzleloader season, from after National Wildlife Refuge Week in October through the end of the State season. A muzzleloader hunt for deer will occur by special permit drawing during the State season. A hunt for turkey will occur by special permit drawing during the state spring season. To expand opportunities for youth and family participation, State youth hunts will be offered with the help of cooperators. Partners will also be solicited to help recruit under-represented populations to participate in the hunting programs. (See Figure 9 on page 34.)

Strategies:

1. Develop a Visitor Services Step-down plan within 2 years.
2. Update Refuge-specific hunting regulations.
3. Recruit cooperators to assist with hunts by youth and under-represented populations.

Objective 3.2: Fishing

Refuge anglers will experience quality boat, shore and float-tube fishing on Stanfield Lake and quality bank, pier, or platform fishing

opportunities on Stanfield and Richart Lakes, Lakes Sheryl and Linda, and Persimmon and the Sand Hill Ponds.

Rationale: As one of the six priority wildlife-dependent recreational uses identified in the National Wildlife Refuge System Improvement Act of 1997, fishing provides a traditional recreational activity on the Refuge with no definable adverse impacts to the biological integrity or habitat sustainability of Refuge resources.

To better fulfill the quality criteria, modifications will be made to the current fishing program. To improve accessibility, electric trolling motors will be allowed on Stanfield Lake following several years of monitoring to develop a baseline understanding of fish populations and additional accessible fishing sites will be developed on Lake Sheryl and Persimmon Pond. Shoreline improvements (deepening) to existing fishing areas will be made in select areas to improve bank fishing. Interpretive and informational programs delivered through brochures, kiosks, and special events will be developed to promote resource stewardship, understanding, and appreciation. To improve the reasonable opportunity to experience wildlife, the take of fish will be more closely monitored and managed through regulation, which will insure sustainable, healthy populations. Spawning and nursery habitat will also be improved when feasible. To promote opportunities for children to fish, a pond will be designated as a “kids only” fishing pond with the possible restriction of catch and release.

To evaluate improvements in the fishing program and summarize progress, the Refuge will use the evaluation standards of RAPP (Refuge Annual Performance Plan). RAPP measures act as a general indicator or how successful management is in satisfying the criteria for quality of recreation use as described in the Service Manual. As the visitor services program of the Refuge matures and more details are specified in a visitor services plan, the Refuge will be able to move to more direct and specific measure of recreation quality. These direct measures will include a survey of visitors.

Strategies:

1. Develop a Visitor Services Step-down plan within 2 years.
2. Develop a fishery management plan in cooperation with the USFWS Cartersville Fisheries Office.

3. Update Refuge-specific regulations to permit electric motors on Stanfield Lake and designate a “kids only” fishing area.
4. Construct additional accessible fishing sites and modify existing sites.
5. Continue annual kids fishing event.
6. Improve banks and shoreline to enhance fishing opportunities in select areas.

Objective 3.3: Wildlife Observation and Photography

Refuge visitors will experience quality wildlife observation and photography opportunities.

Rationale: Wildlife observation and photography are both priority wildlife-dependent recreation activities listed in the National Wildlife Refuge System Improvement Act of 1997. These activities occur, for the most part, along or near Refuge roads and trails (Figure 13). To promote the safety and experience of participants, the west entrance to the Refuge will be closed. Closing the entrance will eliminate the use of Refuge roads as a short-cut for highway traffic and ensure that motorists using Refuge roads are there to visit the Refuge. The reduced traffic flow will contribute to a reduction in the conflicts between commuters and wildlife viewers. Bicycling is permitted on paved or gravel roads and would likely increase with less vehicle traffic and paving of the auto tour route. Trails will remain closed to bicycles to minimize conflict among visitors on narrow trail treads. To minimize maintenance work load and expense the East and West River Trails will not be maintained and allowed to revert back to forest. To improve accessibility and reduce dust, efforts will be made to obtain funding to pave with asphalt the auto tour route and improve the surface of trails. A wildlife observation structure will be built near the Shop area to facilitate viewing of wildlife using the open area. Species that are expected to be seen from the structure include deer, Wild Turkey, Sandhill Cranes occasionally, and Canada Geese. The Hackman Overlook structure will be evaluated in a visitor services step-down plan for potential modification or removal. The observation platform at the Restle Unit will be maintained and interpretation provided. Two annual photo contests and annual migratory bird day activities will be held to promote public understanding and increase appreciation of natural resources and the Refuge’s role in managing and conserving them.

Strategies:

1. Develop a Visitor Services Step-down plan within 2 years.
2. Define and enter construction needs in the appropriate databases.
3. Survey visitors to determine the quality of their Refuge experience within 15 years.
4. Close West Entrance Road.

Objective 3.4: Interpretation and Environmental Education

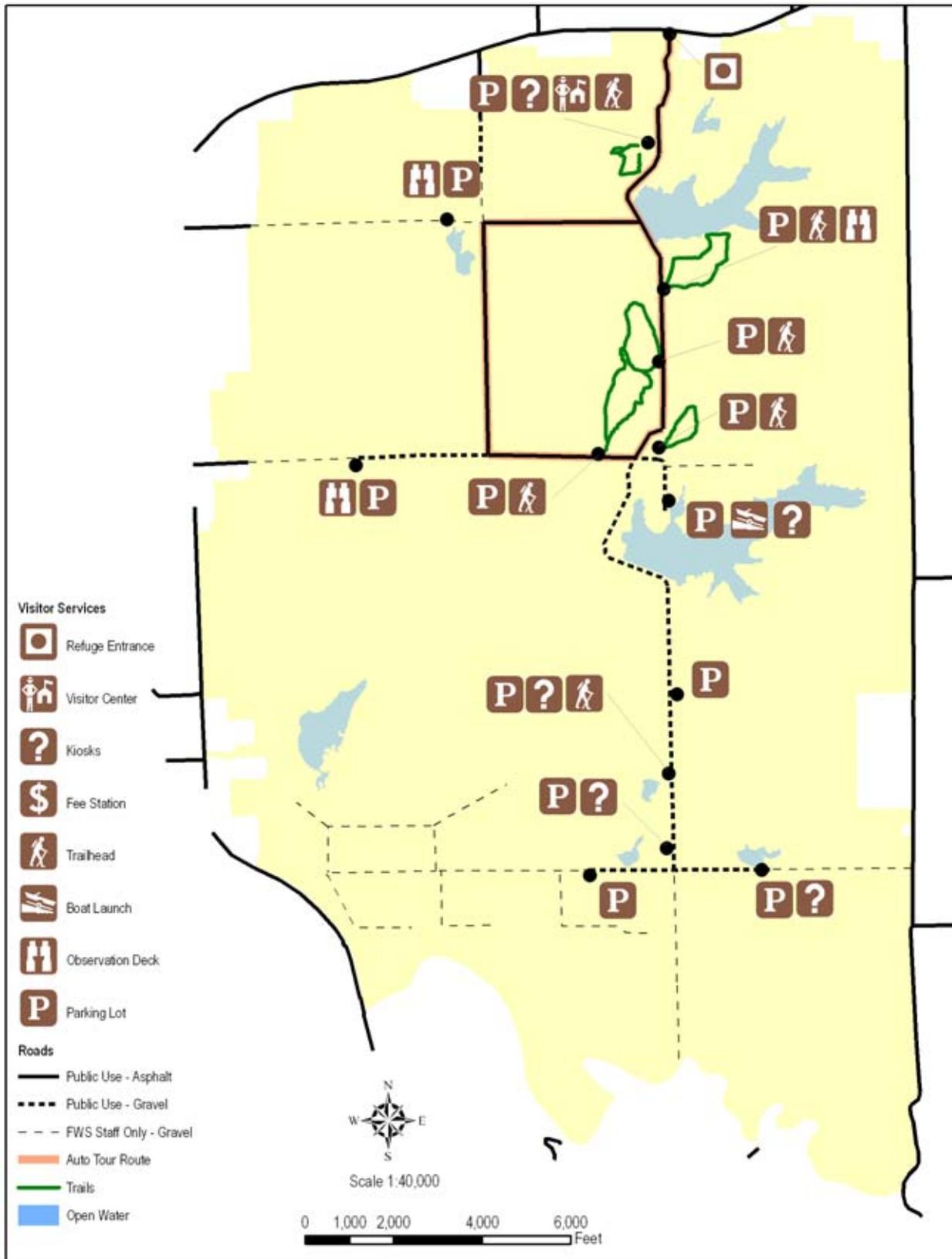
Participants will experience quality interpretive and environmental education opportunities at or above the 2008 level.

Rationale: Interpretation and environmental education are both priority wildlife-dependent recreational uses listed in the National Wildlife Refuge system Improvement Act of 1997. Interpretation will be delivered through visitor center exhibits, programs, brochures, a website, and signs along the auto tour route, Chestnut Ridge Trail, trailhead and fishing area kiosks, and at the Myers Cabin. The Refuge will continue to host the annual Conservation Field Days for Jackson and Jennings County third-graders as part of the interpretive program. The Refuge will also continue to host the annual Indiana Junior Duck Stamp Program and contest. Interpretive activities will continue to be designed to promote resource stewardship, conservation, understanding, and appreciation of America’s natural resources and the Refuge’s role in managing those resources. Environmental education programs will be developed and administered to satisfy the Service’s description of environmental education as specified in current policy. Following the principle of allowing program participants to demonstrate learning through Refuge-specific stewardship tasks and projects that they can carry over into their everyday lives (605 FW 6.4.B), the Refuge will continue to work with Hayden School and others on Refuge activities.

Strategies:

1. Develop a Visitor Services Step-down plan within 2 years.
2. Continue interpretive programs and visitor center exhibits at 2008 level or higher.
3. Improve Refuge brochures and website.

Figure 13: Future Visitor Facilities, Muscatatuck NWR





The Refuge Bookstore, Muscatatuck NWR. Photo credit: U.S. Fish & Wildlife Service

4. Continue activities with the Hayden School group and the Junior Birder program.
5. Continue the Conservation Field Day events.
6. Improve interpretive signs on the Auto Tour Route, Chestnut Ridge Interpretive Trail, trailheads, and fishing sites.
7. Hire one full-time park ranger to organize and augment the interpretation and environmental education program, including oversight of the visitor services step-down plan, increasing Refuge programming, and ongoing coordination with local schools. (Position will also serve to enhance volunteer coordination.)

Objective 3.5: Volunteers

The 3-year moving average of annual hours contributed by volunteers will increase throughout the life of the plan.

Rationale: The Refuge has received strong support from volunteers and interns. Opportunities for enhancing the wildlife and visitor services programs will likely always exceed the Refuge's budget. Therefore, all Refuge activities will continue to benefit from volunteer participation, and certain activities will require volunteer participation to be successful. A coordinated and efficiently run volunteer program will be essential to achieving many Refuge goals. A continuously expanding program is desirable, but unforeseen circumstances may affect the level of participation in a particular year. Therefore, a 3-year moving average will be used to monitor the participation in the volunteer program, which will permit some variation from year to year but document long-term growth.

Strategies:

1. Recruit new volunteers to assist with resource management and visitor services.
2. Recognize and supervise volunteers as adjunct staff.
3. Continue to staff the Visitor Center with volunteers.
4. Add one full-time park ranger with split responsibilities between volunteer coordination, environmental education, and interpretation.

Objective 3.6: Partnerships

Increase and improve partnerships over the level of the 2007 program.

Rationale: Partnerships greatly expand the range of conservation activities. Muscatatuck NWR has been fortunate to have many partners in the local area including the Refuge friends group (the Muscatatuck Wildlife Society), the local Soil and Water Conservation Districts, NRCS, Purdue Extension, local Ducks Unlimited Chapters, the local Wild Turkey Federation, the Indiana Department of Natural Resources, local Resource Conservation and Development Councils, area Conservation and Birding Clubs, sporting good stores, scouting and civic groups, local Visitor Bureaus, the U.S. Forest Service, the Hayden School Refuge Rangers, local universities, and many others.

Strategies:

1. Maintain existing partnerships by committing staff time to work with partners on FWS priority conservation activities.
2. Contact at least one new potential partner each year.

Objective 3.7: Community Outreach

Promote public understanding and appreciation of Muscatatuck National Wildlife Refuge to traditional and under-represented populations through off-site events, programs, newsletters and website at levels at least as great as 2008.

Rationale: The Refuge values its visitors, neighbors, and the local community. The Refuge is an asset to the community and has received strong support in the past. Continued support is essential for the success of the Refuge. It is important that

the Refuge continues efforts to build and maintain open communications with neighbors and the broader community to let them know the successes, challenges, and opportunities in conservation and wildlife-dependent recreation. In an ideal setting, the objective would be to achieve an appreciation of the value and need for fish and wildlife conservation among a larger percentage of the population living around the Refuge. The success in achieving the objective would be determined through a survey of the general population. However, for an objective to be useful it must be measurable in both a conceptual and practical sense. It is not practical to propose that the Refuge will conduct a survey of the general population anytime in the next few years, because the approvals and costs are beyond the likely resources of the Refuge. As an alternative, the objective reflects the assumption that providing neighbors and community members with written and oral information will lead to positive conservation attitudes and action. Public understanding of the purpose of Refuge lands, including appropriate and compatible uses, may lead to a reduction in illegal activities such as dumping, littering, and speeding on Refuge roads.

Strategies:

1. Upgrade the Refuge website with both basic and time-sensitive and newsworthy information about Muscatatuck NWR.
2. Maintain a Refuge mailing list and Refuge newsletter.
3. Review and update the station outreach plan.

Objective 3.8: Law Enforcement

People feel safe on Muscatatuck NWR and the resource is protected.

Rationale: The Refuge is responsible for protecting Refuge resources and providing a safe environment for employees and visitors. The Refuge's law enforcement program is a critical tool in protecting trust resources, habitat, public facilities, employees, and the visiting public. To provide this essential service, the Refuge will share regional resources and cooperate with other law enforcement authorities to meet its responsibilities.

Strategies:

1. Share regional law enforcement resources.

2. Partner with Indiana DNR Conservation Officers and other state and local law enforcement officers.

Objective 3.9: Cultural Resources

Over the life of the plan, avoid and protect against disturbance all known Refuge cultural, historic, or archeological sites.

Rationale: Cultural resources are an important facet of the country's heritage. Muscatatuck NWR, like all national wildlife refuges and wetland management districts, remains committed to preserving archeological and historic sites against degradation, looting, and other adverse impacts. The guiding principle for management derives from the National Historic Preservation Act of 1966 as amended, 16 U.S.C. 470 et seq. and the Archeological Resources Protection Act of 1979 as amended, 16 U.S.C. 47011-mm, which establish legal mandates and protection against identifying sites for the public, etc. The Refuge must ensure archeological and cultural values are described, identified, and taken into consideration prior to implementing projects. It is also essential that new site discoveries are documented. In order to meet these responsibilities, the Refuge intends to maintain an open dialogue with the Regional Historic Preservation Officer (RHPO) and to provide the RHPO with information about new archeological site discoveries. The Refuge will also cooperate with Federal, state, and local agencies, American Indian tribes, the Muscatatuck Wildlife Society, and the public in managing cultural resources on the Refuge.



The Muscatatuck Wildlife Society was instrumental in preserving the Myers Barn. Photo credit: U.S. Fish & Wildlife Service

Strategies:

1. Conduct site-specific surveys prior to ground disturbing projects and protect known archeological, cultural and historic sites.
2. Inform the Regional Historic Preservation Officer early in project planning to ensure compliance with Section 106 of National Historic Preservation Act.
3. In the event of inadvertent discoveries of ancient human remains or artifacts, follow instructions and procedures indicated by the RHPO.
4. Ensure archeological and cultural values are described, identified, and taken into consideration prior to implementing undertakings.
5. Inspect the condition of known cultural resources on the Refuge and report to the RHPO changes in the conditions.
6. Integrate historic preservation with planning and management of other resources and activities.

Chapter 5: Plan Implementation

Introduction

This chapter summarizes the actions, funding, coordination, and monitoring to implement the CCP. As noted in the inside cover of this document, this plan does not constitute a commitment for staffing increases or operational and maintenance increases. These decisions are at the discretion of Congress in overall appropriations, and in budget allocation decisions made at the Washington and Regional levels of the Service.

New and Existing Projects

This CCP outlines an ambitious course of action for the future management of Muscatatuck NWR. It will require considerable staff commitment as well as funding commitment to actively manage the wildlife habitats and add and improve public use facilities. The Refuge will continually need appropriate operational and maintenance funding to implement the objectives in this plan. A full listing of unfunded Refuge projects and operational needs can be found in Appendix G.

Staffing

Implementing the vision set forth in this CCP will require changes in the organizational structure of the Refuge. Existing staff will direct their time and energy in new directions and new staff members will need to be added to assist in these efforts.

In March of 2008 a national team of Refuge System professionals developed a staffing model to estimate the personnel required to effectively operate and manage the existing 589 field stations of the NWRs. Fifteen factors were used in the evaluation, covering the following topics:

- total acres, acres actively managed, and number of easement contracts
- endangered and invasive species populations



Little Blue Heron. Photo credit: Mark Trabue

- biological management and monitoring; threats and conflicts
- wilderness management
- visitor services: visitation, education programs, volunteers, Friends
- maintenance needs and existing assets

The model attempts to project staffing levels in a systematic, qualitative manner. No model is perfect or the final word in estimating staffing needs, but this type of model is useful for supporting personnel actions and fosters consistent staffing decision-making. The 2008 model projected only the total maximum number of full-time equivalent (FTE) positions needed at each station, not the individual disciplines or specialties. Law enforcement positions were not included in the assessment. In order to implement the staffing model, the final report recommended that each Region adjust the final model numbers as necessary and identify the most appropriate position types for each station.

Table 4: Additional Staffing as Indicated by the 2008 Refuge System Staffing Model

PROPOSED NEW POSITIONS	FTE	RANK
Wildlife Biologist (Invasive Species Management)	1	1
Equipment Operator	1	2
Park Ranger (Interpretation/Volunteer Coordination)	1	3
Biological Science Technician (Invasive Species Management)	1	4
Biological Science Technician (Forestry & Invasive Species)	1	5

The 2008 staffing model results for Muscatatuck NWR included a total of 14 FTE positions, with a subsequent adjustment at the regional level to 11. With current staffing of six FTEs, the Refuge was asked to identify five additional positions and rank them from greatest to least priority (see Table 4). The additional personnel would expand and improve the quality of the field program, especially invasive species control, the forestry program, water resource management, and environmental education on the Refuge.

The staffing model illustrates full staffing at Muscatatuck NWR under optimum conditions. Due to the reality of financial constraints and operating budgets within the Service, it may not be possible to reach full staffing levels immediately. However, the amount and quality of management on a refuge heavily depends on the personnel resources available to implement the plan.

Partnership Opportunities

Partnerships are an essential element for the successful accomplishment of goals, objectives, and strategies at Muscatatuck National Wildlife Refuge. The objectives outlined in this CCP need the support and the partnerships of federal, state and local agencies, non-governmental organizations and individual citizens. Refuge staff will continue to seek creative partnership opportunities to achieve the vision of the Refuge.

We expect to continue to work with the following notable partners while developing new partnerships:

- Muscatatuck Wildlife Society
- local Soil and Water Conservation Districts

- NRCS
- Purdue Extension
- local Ducks Unlimited chapters
- National Wild Turkey Federation
- Indiana Department of Natural Resources
- local Resource Conservation and Development Councils
- area conservation and birding clubs
- sporting good stores
- Scouting and civic groups
- local Visitor Bureaus
- U.S. Forest Service
- Hayden School Refuge Rangers
- local universities
- The Nature Conservancy
- Sycamore Land Trust

Step-Down Management Plans

The CCP is a plan that provides general concepts and specific wildlife, habitat, and people related objectives. Step-down management plans provide greater detail to managers and employees who will carry out the strategies described in the CCP. The Refuge staff will revise or develop the following step-down plans:

- Habitat Management Plan, including a forest component (5 years)

- Water Management Plan for Restle Unit (2 years)
- Integrated Pest Management Plan (5 years)
- Visitor Services Plan (2 years)
- Fishery Management Plan (5 years)
- Habitat and Wildlife Monitoring Plans (3 years)

Monitoring and Evaluation

The direction set forth in this CCP and specifically identified strategies and projects will be monitored throughout the life of this plan. On a periodic basis, the Regional Office will assemble a station review team whose purpose will be to visit the Refuge and evaluate current activities in light of this plan. The team will review all aspects of Refuge management, including direction, accomplishments and funding. The goals and objectives presented in this CCP will provide the baseline for evaluation of this field station.

Plan Review and Revision

The CCP is meant to provide guidance to the Refuge manager and staff over the next 15 years. However, the CCP is also a dynamic and flexible document and several of the strategies contained in this plan are subject to uncontrollable events of nature. Likewise, many of the strategies are dependent upon Service funding for staff and projects. Because of all these factors, the recommendations in the CCP will be reviewed periodically and, if necessary, revised to meet new circumstances. If any revisions are major, the review and revision will include the public.

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.

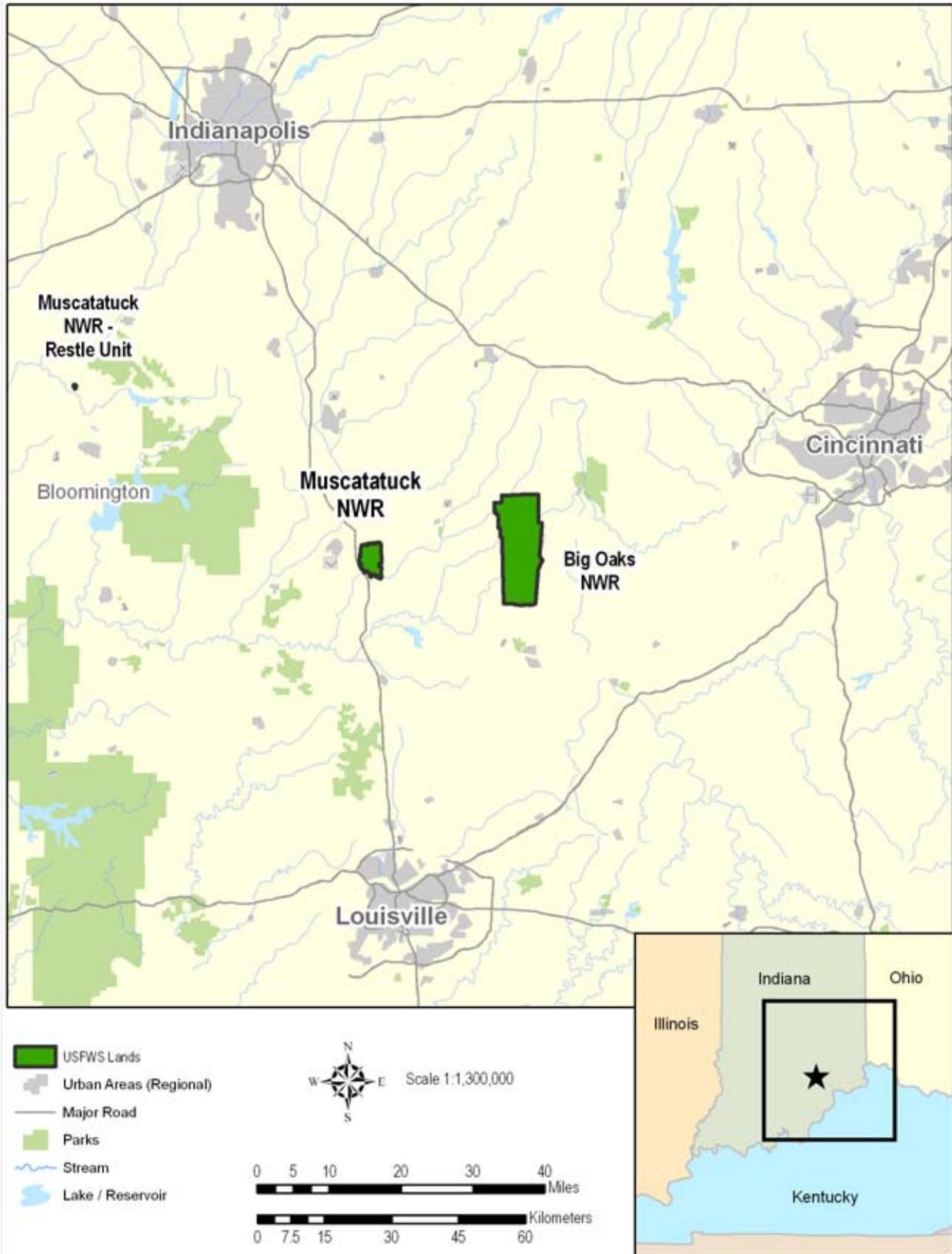
Wildlife: Support the maximum sustainable breeding and post-breeding populations of cavity-nesting waterfowl, neotropical migratory birds, Indiana bats, and a diversity of migratory, rare wetland, and resident species.

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

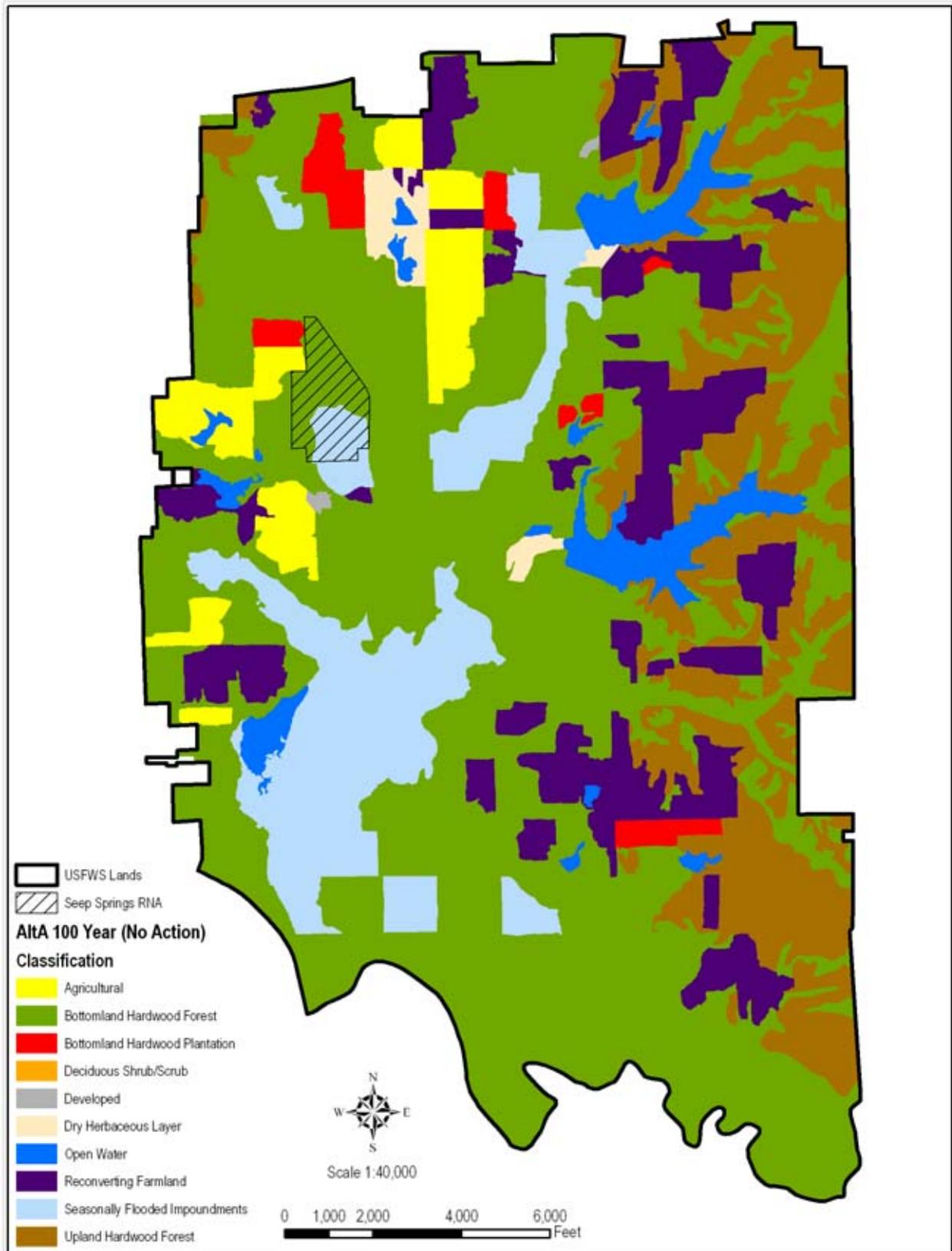
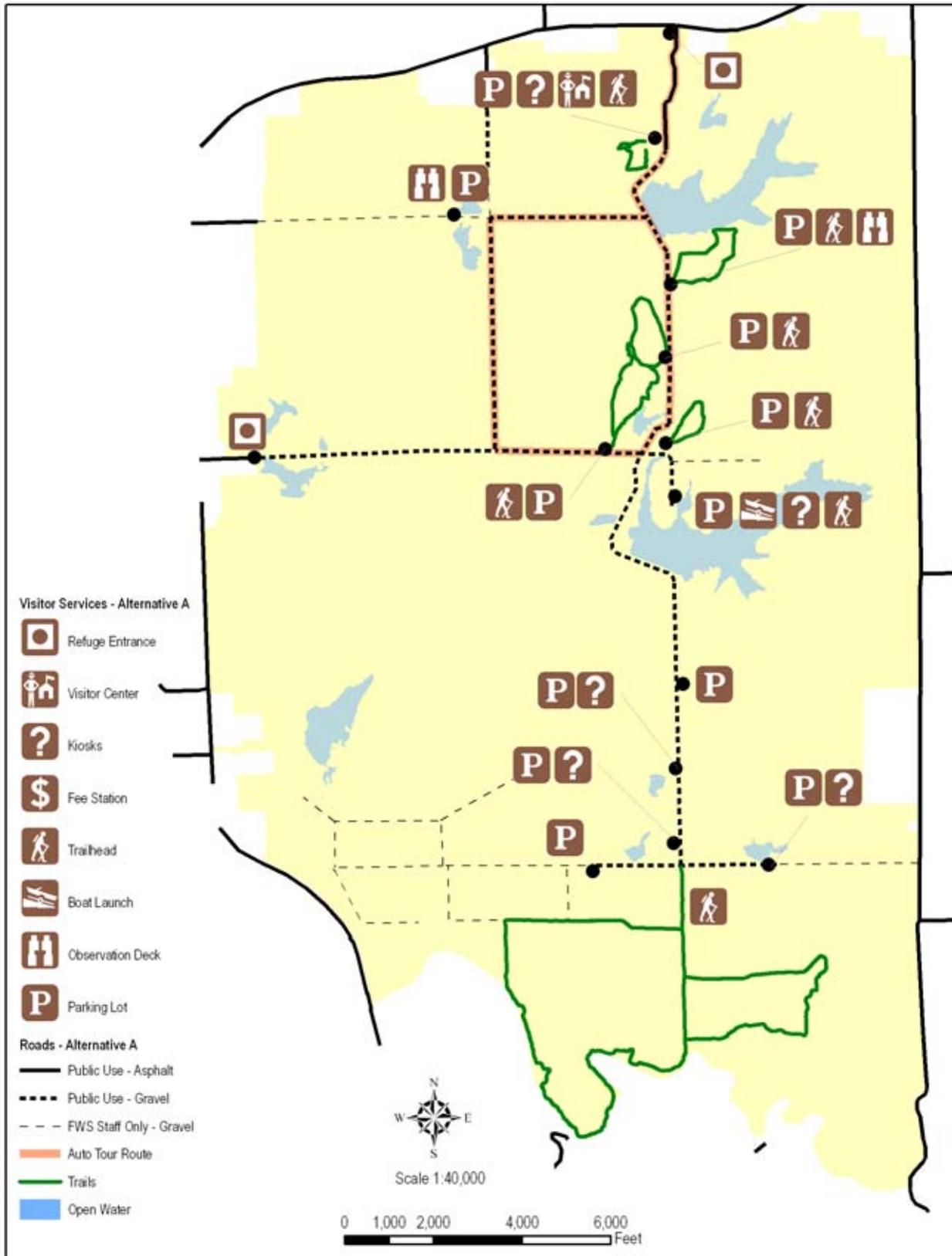


Figure 3: Visitor Services Facilities Under Alternative A, Muscatatuck NWR



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

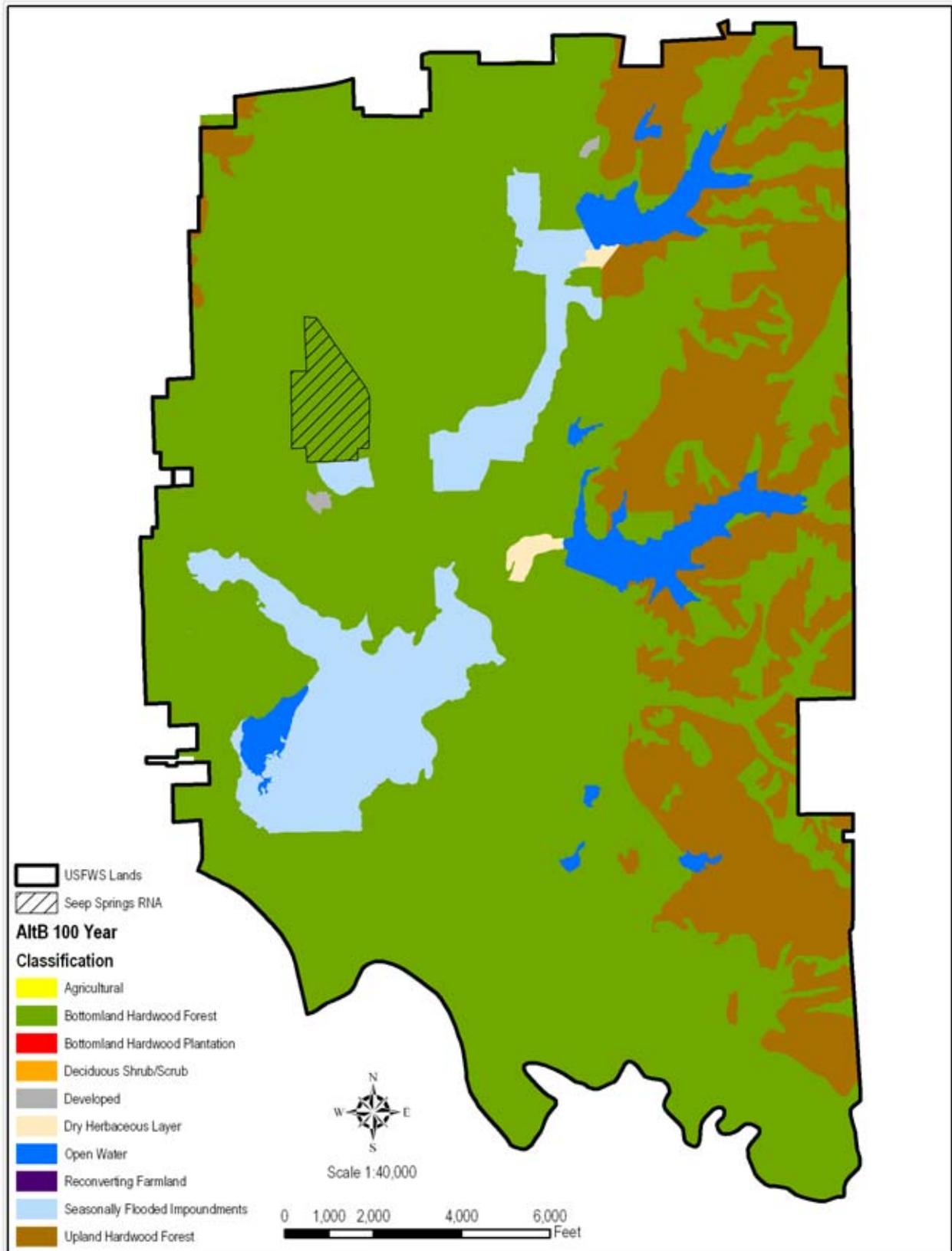
With the goal of providing an expanse of upland and bottomland forest, management of existing forest would consist of restoring forest to more closely resemble historic conditions and to allow succession to occur through natural processes. Active forest management could include timber stand improvement 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 herpetofauna.

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.

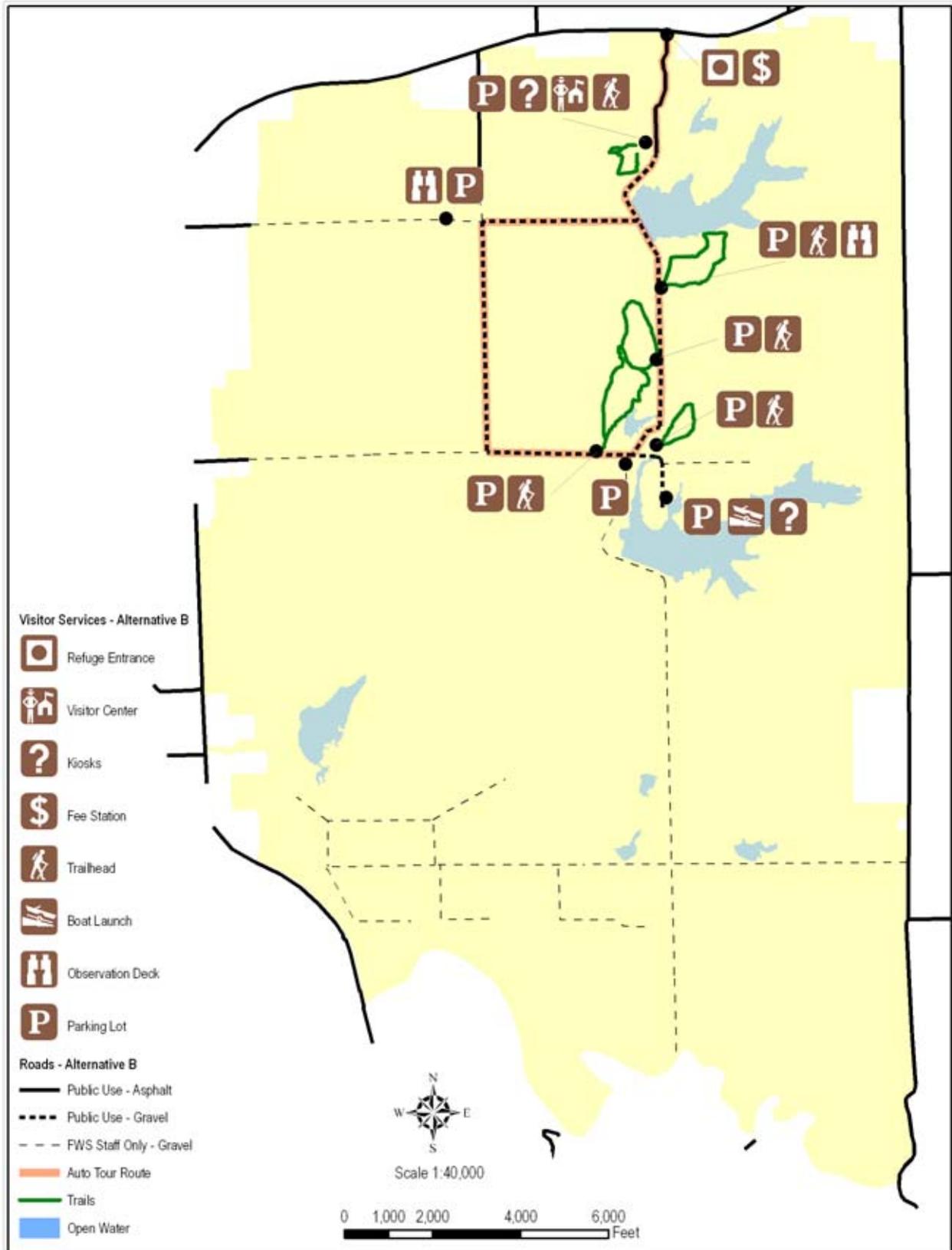
2.3.3 People

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

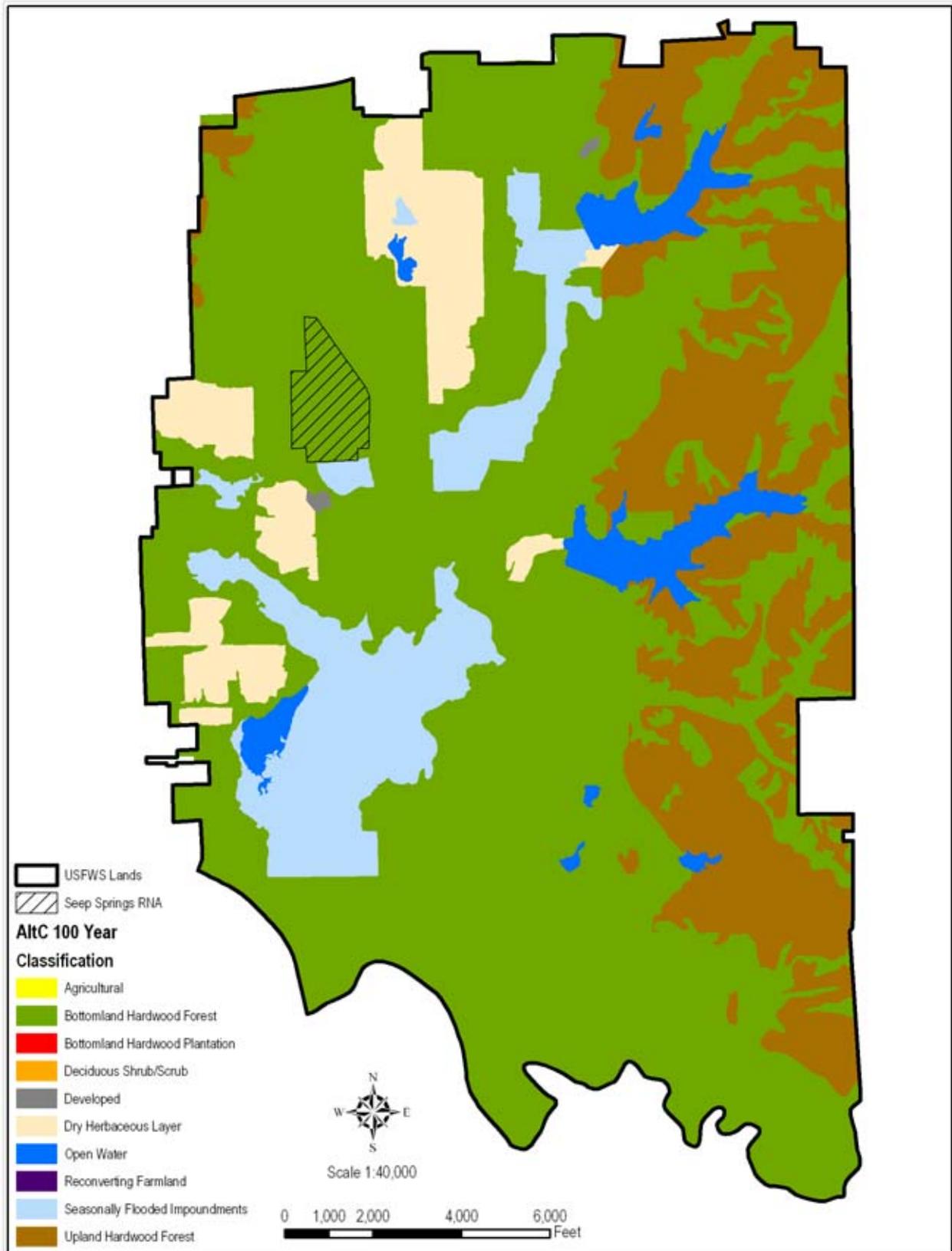
With the goal of providing an expanse of upland and bottomland forest, management of existing forest would consist of restoring forest to more closely resemble historic conditions and to allow succession to occur through natural processes (Figure 6). Active forest management could include timber stand 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.

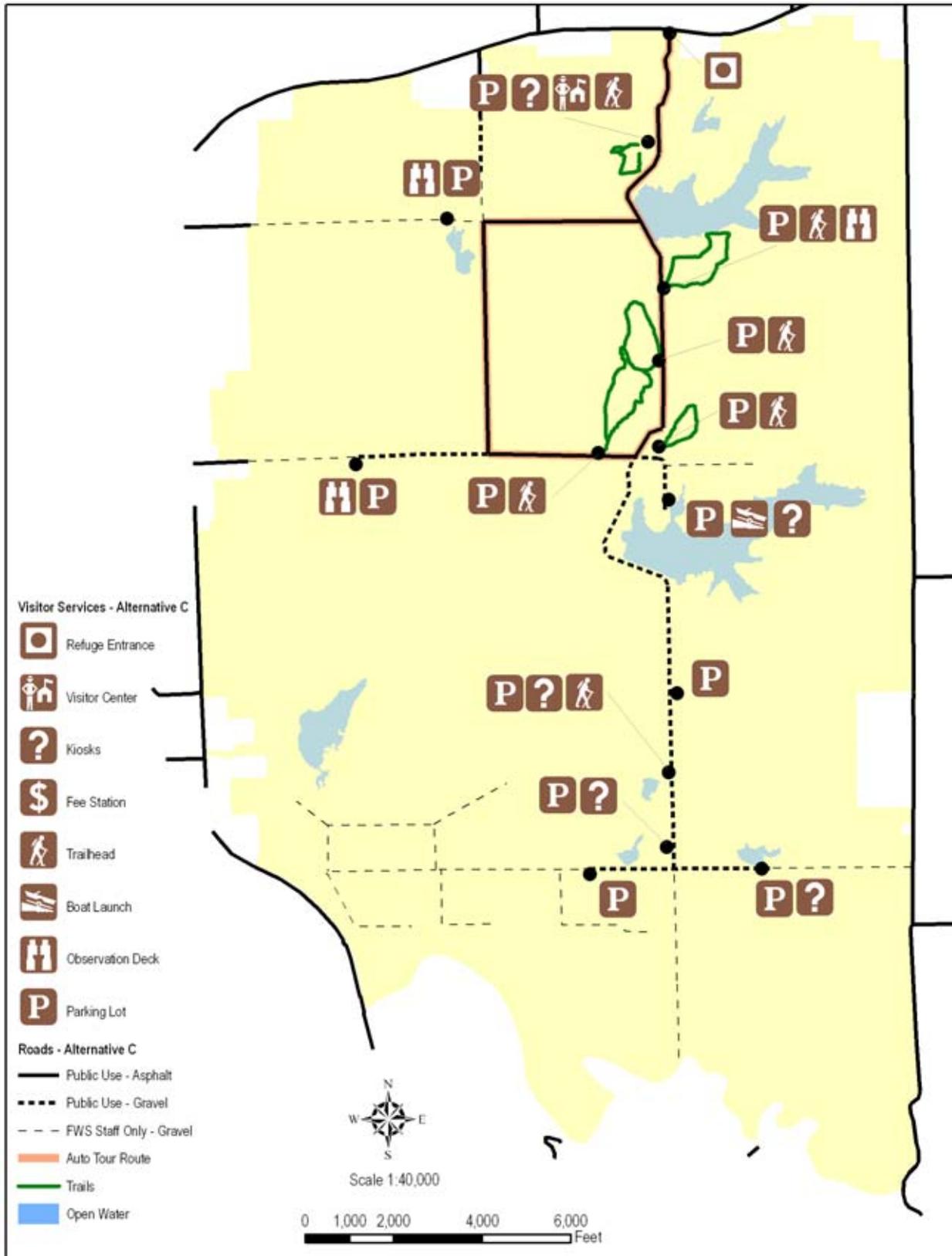
2.4.2 Wildlife

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

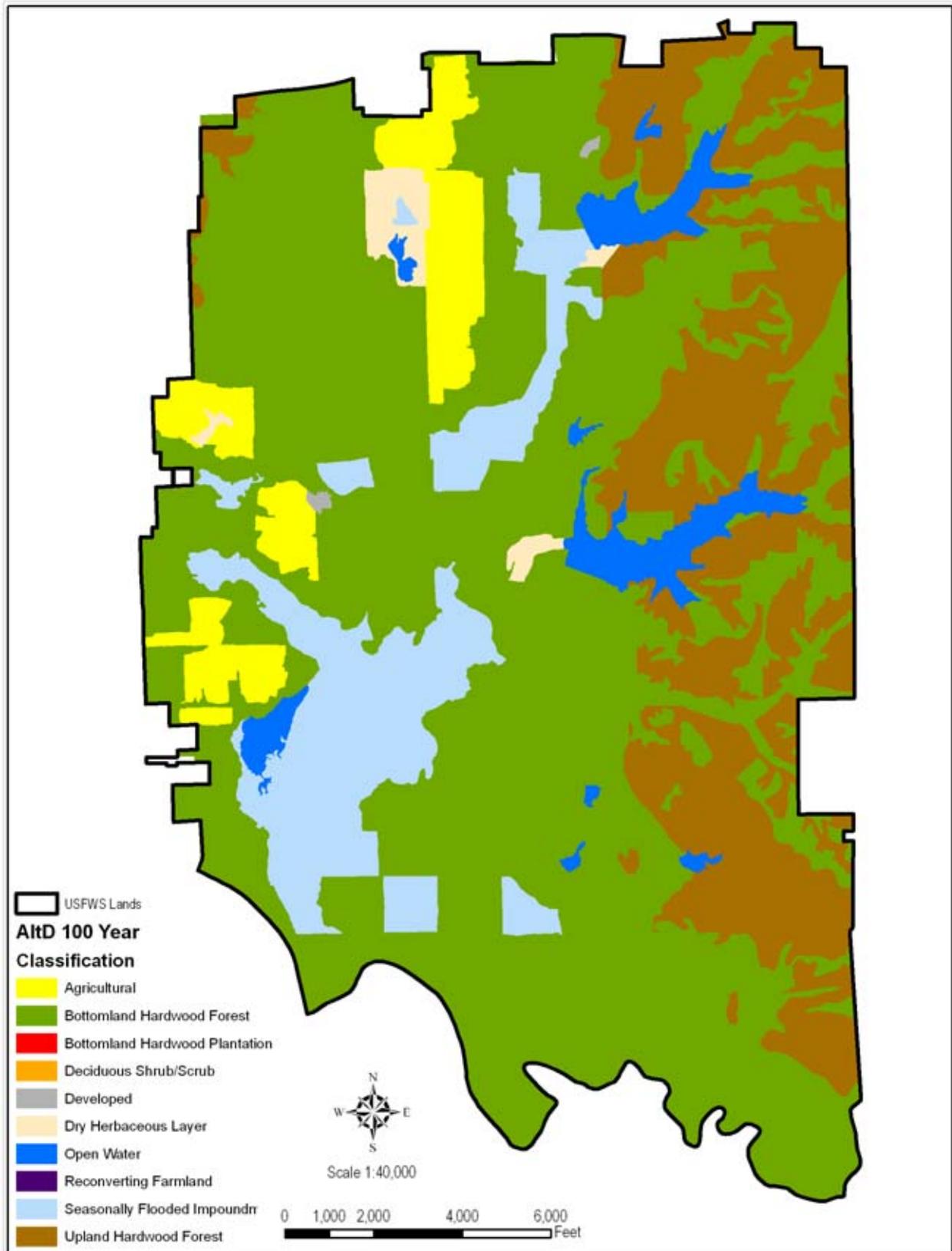
Under this alternative the Refuge would increase the size of its forests and manage its constructed wetlands more intensively. There would be increased attention to surveys and monitoring. A biological technician, an equipment operator, and a park ranger (interpretation) would be added to the staff to 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

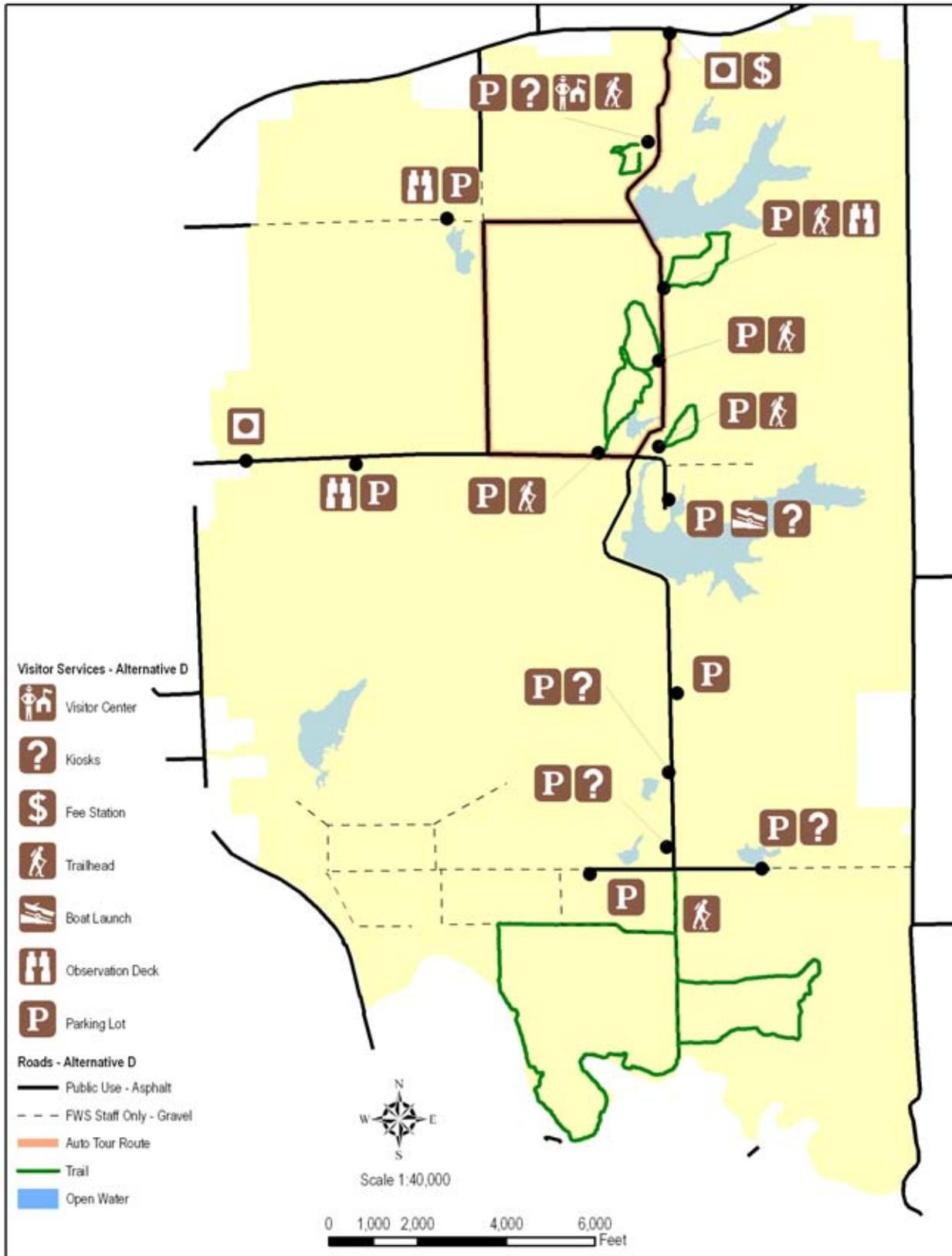
Wildlife surveys on the Refuge would be expanded from current levels under this alternative. More attention would be devoted to Indiana bats, cavity-nesting waterfowl, neo-tropical migratory birds, marsh birds, and shorebirds under this alternative with the intention of documenting the effect of reforestation 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.				
<i>Upland Hardwood Forest</i>	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.
<i>Bottomland Hardwood Forest Natural Constructed</i>	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.
<i>Open Water</i>	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.

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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

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<i>Seep Springs Research Natural Area</i>	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
<i>Restle Unit</i>	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.				
<i>Federally-listed Threatened and Endangered Species</i> <i>Indiana bat</i>	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
<i>Cavity-nesting waterfowl</i>	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
<i>Neotropical migratory birds</i>	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

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<i>Secretive marsh birds and shorebirds</i>	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
<i>Rare wetland species</i>	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
<i>Migratory waterbirds</i>	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
<i>Native resident and other wildlife</i>	Variety of studies being conducted	Same as Alt. A.	Same as Alt. A	Same as Alt. A
<i>Fish and other aquatic species</i>	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

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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.

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Hunting <i>(continued)</i>		<p>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.</p> <p>Muzzleloader by special permit drawing during State Season.</p> <p>Hunter orange required for all hunts except turkey.</p> <p>Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.</p>		
Fishing	<p>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.</p>	<p>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.</p> <p>Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.</p> <p>Improve quality of fishing areas.</p>	<p>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 develop 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.</p>	<p>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.</p> <p>Reduce disturbance to migrants on northern seasonally flooded and managed units through limitation of public access during peak duck use periods.</p>

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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.	<p>Dikes removed from Moist Soil Units 7, 8, 9 and 10.</p> <p>Roads south of Stanfield Lake and east of the auto tour loop would be maintained for Service vehicle access only.</p> <p>The west entrance to the Refuge would be closed.</p> <p>Additional accessible fishing sites would be developed at ponds and lakes with public road access.</p>	<p>Dikes would be removed from Moist Soil Units 8, 9 and 10.</p> <p>The auto tour route would be paved. Existing gravel roads and parking lots would be improved.</p> <p>The west entrance to the Refuge would be closed.</p> <p>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.</p> <p>A wildlife observation structure would be built near the Refuge shop area.</p> <p>The Hackman Overlook structure would be evaluated for modification or removal.</p> <p>Additional accessible fishing sites would be developed at current fishing locations to supplement the existing facilities.</p>	<p>Maintenance of water control structures would increase.</p> <p>All Refuge roads would be paved and parking lots improved.</p> <p>Both Refuge entrances would be maintained.</p> <p>All trails would be maintained and trail surfaces improved.</p> <p>A wildlife observation structure would be built near the shop area.</p> <p>The Hackman Overlook structure would be evaluated for modification or removal.</p> <p>Additional accessible fishing sites would be developed at current fishing locations to supplement the existing facilities.</p>

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 Vicinity of Muscatatuck NWR

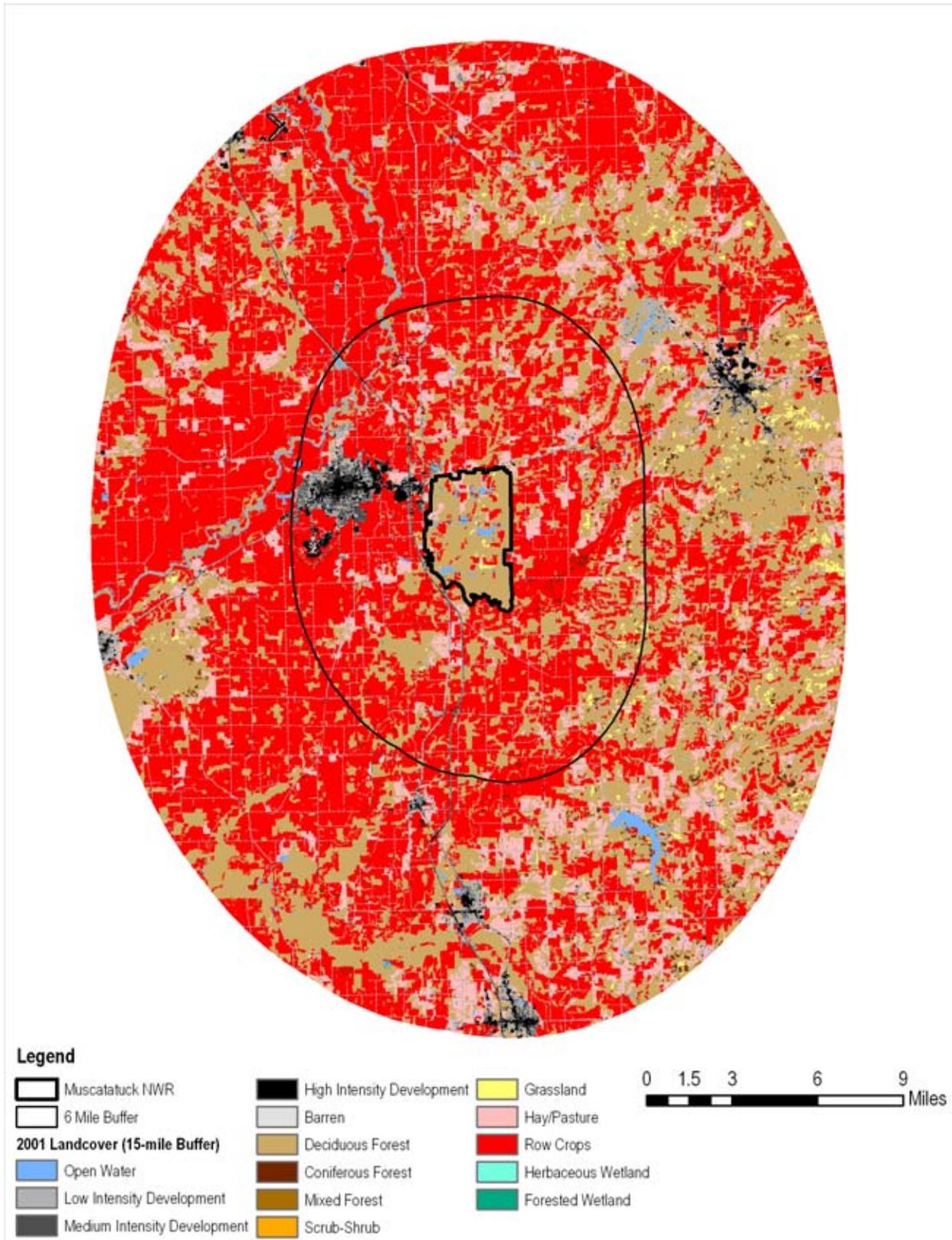
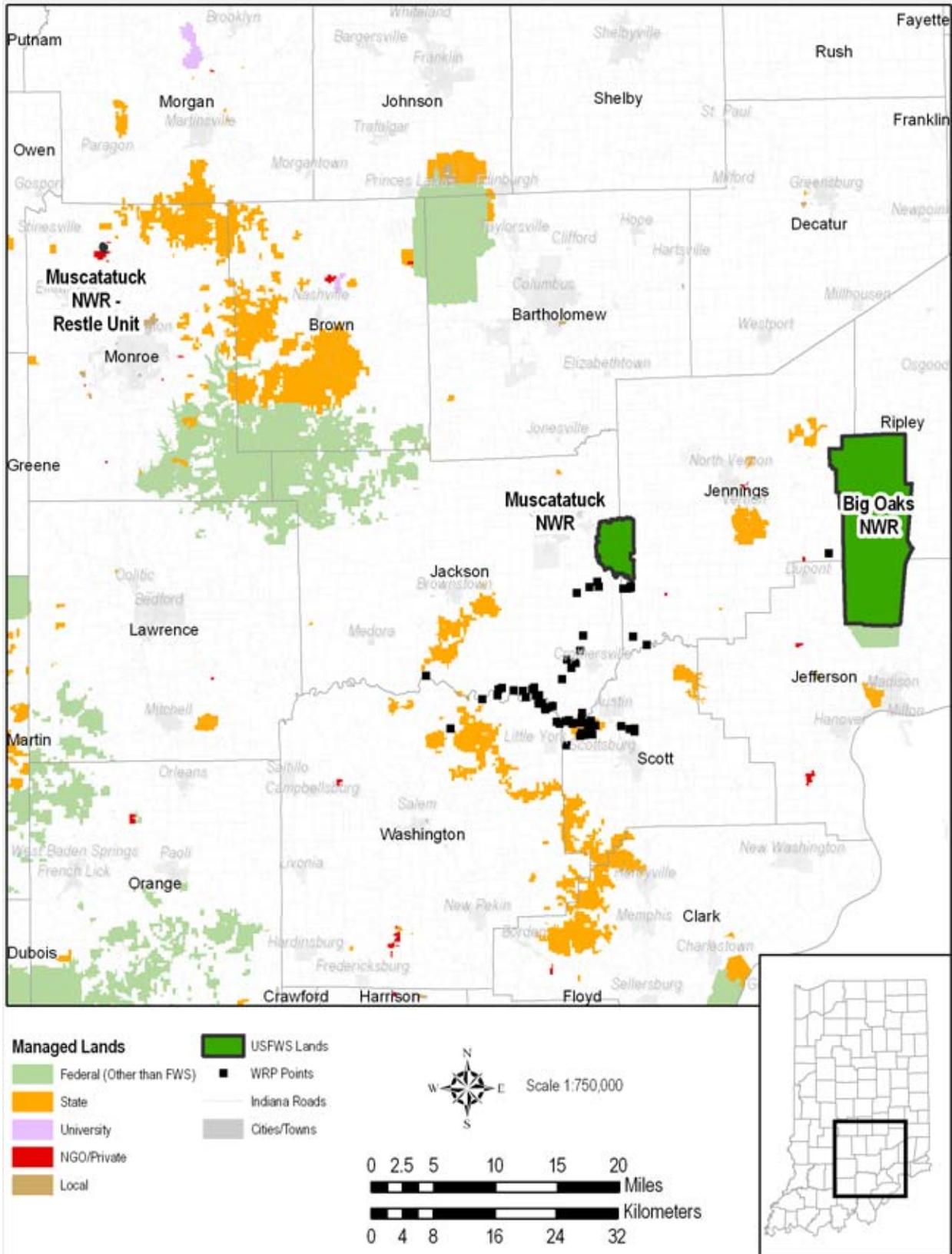


Figure 11: Conservation Lands Surrounding Muscatatuck NWR



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 darter. 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-phosphates, 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 archaeological 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 archaeological 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 positive 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 “Continental 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 inconvenienced 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, neotropical 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 vegetation 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				
<i>Waterfowl Productivity</i>	Continue at present level.	Remain stable	Remain stable	Increase
<i>Grassland-dependent migratory birds</i>	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.
<i>Forest dependent migratory birds</i>	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.
<i>Other Migratory Birds</i>	Continue at present level.	Increase in shorebird use.	Increase in shorebird use. Increase in fall migrant waterfowl use.	Same as Alt. C.
<i>Reptiles and Amphibians</i>	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.
<i>Threatened and Endangered Species</i>	Remain stable	Remain stable	Remain stable	Remain stable
Impacts Associated with Wildlife				
<i>Biological Inventories and Monitoring</i>	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
<i>Resident Wildlife</i>	Continue at present level.	Deer population decrease to a stable lower number.	Same as Alt B	Same as Alt B
<i>Invasive Species</i>	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				
<i>Road Access</i>	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 <i>(Season days based on 2007-2008)</i>	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.

Chapter 5: List of Preparers

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- Susan Knowles, Wildlife Refuge Specialist
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Regional Office Staff

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- John Dobrovolny, Regional Historic Preservation Officer
- Jane Hodgins, Technical Writer/Editor
- John Schomaker, Refuge Planner (retired)

Appendix B: Glossary

Appendix B: Glossary

Aquatic Species

Includes all freshwater, anadromous and estuarine fishes, freshwater mollusks, freshwater crustaceans and freshwater amphibians.

Archaeological and Cultural Values

Any material remains of past human life or activity greater than 100 years old which are of archaeological interest as defined by Section 4(a) of the Archaeological Resources Protection Act and 43 CFR Part 7.3.

Biodiversity

The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.

Candidate Species

Those species for which the Service has on file sufficient information on biological vulnerability and threats to propose them for listing.

Compatible Use

A wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgment of the Director or designee, will not materially interfere with or detract from the fulfillment of the mission of the System or the purposes of the refuge (PL 105-57).

Comprehensive Conservation Plan

Plan: A document, completed with public involvement, that describes the desired future condition and provides long-term (15 year planning horizon) guidance to accomplish the purposes of the Refuge System and the individual refuge units.

Conservation

The management of natural resources to prevent loss or waste. Management actions may include preservation, restoration and enhancement.

Conservation (Species)

The use of all methods and procedures which are necessary to bring any species to the point at which the measures provided are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with

scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation. Conservation is the act of managing a resource to ensure its survival and availability.

Cultural Resources

Cultural Resources: “those parts of the physical environment – natural and built – that have cultural value to some kind of sociocultural group... [and] those non-material human social institutions...” (King, p.9). Cultural resources include historic sites, archeological sites and associated artifacts, sacred sites, traditional cultural properties, cultural items (human remains, funerary objects, sacred objects, and objects of cultural patrimony) (McManamon, Francis P. DCA-NPS; letter 12-23-97 to Walla Walla District, COE), and buildings and structures.

Ecosystem

Dynamic and interrelating complex of plant and animal (including humans) communities and their associated non-living environment.

Ecosystem Approach

1) Protecting or restoring the natural function, structure, and species composition of an ecosystem, recognizing that all components are interrelated. 2) Management of natural resources using system-wide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and that basic ecosystem processes are perpetuated indefinitely (Clark and Zaunbrecher 1987).

Endangered Species

A listed species in danger of extinction throughout all or a significant portion of its range.

Enhance (habitats)

Improves habitat through alteration, treatment, or other land management of existing habitat to increase habitat value for one or more species without bringing the habitat to a fully restored or naturally occurring condition.

Forest Fragmentation

Fragmentation may occur when a forested landscape is subdivided into patches. Fragmentation may also occur when numerous openings for such

things as fields, roads, and powerlines interrupt a continuous forest canopy. The resulting landscape pattern alters habitat connectivity and edge characteristics, influencing a variety of species.

Interjurisdictional Fish

Populations of fish that are managed by two or more states or national or tribal governments because of the scope of their geographic distributions or migrations.

Invasive Species

An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.

Migratory Nongame Birds of Management Concern

Those species of nongame birds that (a) are believed to have undergone significant population declines; (b) have small or restricted populations; or (c) are dependent upon restricted or vulnerable habitats.

Migratory Species

Species that move substantial distances to satisfy one or more biological needs, most often to reproduce or escape intolerable cyclic environmental conditions.

National Wildlife Refuge System

All lands and waters and interests therein administered by the Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas for the protection and conservation of fish and wildlife, including those that are threatened with extinction.

Protect (habitat)

Maintain current quality or prevent degradation to habitat. The act of ensuring that habitat quantity and quality do not change, most often as a result of human activities but sometimes in response to unwelcome natural processes or phenomena.

Recovery Plans (species)

Documents developed by the Service that outline tasks necessary to stabilize and recover listed species. Recovery plans include goals for measuring species progress towards recovery, estimated costs and time frames for the recovery process,

and an identification of public and private partners that can contribute to implementation of the recovery plan.

Restore (habitat)

Returns the quantity and quality of habitat to some previous naturally occurring condition, most often some baseline considered suitable and sufficient to support self-sustaining populations of fish and wildlife.

Riparian Habitats

Those lands adjacent to streams or rivers that form a transition zone between aquatic and upland systems and are typically dominated by woody vegetation that is of a noticeably different growth form than adjacent vegetation. Riparian areas may or may not meet the definition of wetlands used by Cowardin *et al.* (1979).

Rotation

The period during which a single generation is allowed to grow.

Species of Concern

A species not on the federal list of threatened or endangered species, but a species for which the Service or one of its partners has concerns.

Stakeholders

State, tribal, and local government agencies, academic institutions, the scientific community, non-governmental entities including environmental, agricultural, and conservation organizations, trade groups, commercial interests, and private landowners.

Threatened Species

A listed species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Undertaking

A project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; those requiring a Federal permit, license or approval..." (36 CFR 800.16(y); 12-12-2000), i.e., all Federal actions.

Uplands

All lands not meeting the definition of wetlands, deepwater, or riverine.

Watershed

The area drained by a river or stream and its tributaries.

Wetlands

Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin *et al.*, 1979. In layman's terms, this habitat category includes marshes, swamps and bogs.

Wildlife-dependent Recreational Use

A use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation.

Appendix C: Species Lists

Bird Species That Occur on Muscatatuck NWR	147
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Bird Species That Occur on Muscatatuck NWR

Family	Common Name	Scientific Name	Probable Abundance by Season				Status	
			Sp	S	F	W	State	Federal
			A: Abundant, should find on every trip C: Common, should find on 75% of trips U: Uncommon, present but in lesser numbers R: Rare, infrequent or few identifications H: Accidental, not expected at this location O: Occasional				E: Endangered T: Threatened SC: Special Concern	
			Sp	S	F	W	State	Federal
Loons	Common Loon	<i>Gavia immer</i>	o	r	o	o		
Grebes	Pied-billed Grebe	<i>Podilymbus podiceps</i>	c	u	c	o		
Grebes	Horned Grebe	<i>Podiceps auritus</i>	o		o			
Grebes	Red-Necked Grebe	<i>Podiceps grisegena</i>	r					
Cormorants	Double-crested Cormorant	<i>Phalacrocorax auritus</i>	c	o	c	r		
Hérons and Bitterns	American Bittern	<i>Botaurus lentiginosus</i>	o	o			E	
Hérons and Bitterns	Least Bittern	<i>Ixobrychus exilis</i>	o	o	o		E	
Hérons and Bitterns	Cattle Egret	<i>Bubulcus ibis</i>	r		r			
Hérons and Bitterns	Great Egret	<i>Ardea alba</i>	u	u	u		SC	
Hérons and Bitterns	Snowy Egret	<i>Egretta thula</i>	r	r	r			
Hérons and Bitterns	Great Blue Heron	<i>Ardea herodias</i>	c	c	c	u		
Hérons and Bitterns	Little Blue Heron	<i>Egretta caerulea</i>	o	o	o			
Hérons and Bitterns	Tricolored Heron	<i>Egretta tricolor</i>		r	r			
Hérons and Bitterns	Green Heron	<i>Butorides virescens</i>	c	c	u			
Hérons and Bitterns	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	u	u	u		E	
Hérons and Bitterns	Yellow-crowned Night Heron	<i>Nyctanassa violacea</i>	r	r	r		E	
Vultures								

Bird Species That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Probable Abundance by Season				Status	
			Sp	S	F	W	State	Federal
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			Sp	S	F	W	State	Federal
Vultures	Black Vulture	<i>Coragyps atratus</i>	o	o	o	o		
Vultures	Turkey Vulture	<i>Cathartes aura</i>	c	c	c	o		
Swans, Geese and Ducks	Greater White-fronted Goose	<i>Anser albifrons</i>				r		
Swans, Geese and Ducks	Snow Goose	<i>Chen caerulescens</i>				r		
Swans, Geese and Ducks	Canada Goose	<i>Branta canadensis</i>	a	a	a	a		
Swans, Geese and Ducks	Mute Swan	<i>Cygnus olor</i>	o		o	o		
Swans, Geese and Ducks	Tundra Swan	<i>Cygnus columbianus</i>	o		o	o		
Swans, Geese and Ducks	Trumpeter Swan	<i>Cygnus buccinator</i>				r	E	
Swans, Geese and Ducks	Wood Duck	<i>Aix sponsa</i>	a	a	a	c		
Swans, Geese and Ducks	Gadwall	<i>Anas strepera</i>	c	o	c	r		
Swans, Geese and Ducks	American Wigeon	<i>Anas americana</i>	c		c	o		
Swans, Geese and Ducks	American Black Duck	<i>Anas rubripes</i>	c	r	c	u		
Swans, Geese and Ducks	Mallard	<i>Anas platyrhynchos</i>	a	c	a	a		
Swans, Geese and Ducks	Blue-winged Teal	<i>Anas discors</i>	c	u	c	o		
Swans, Geese and Ducks	Northern Shoveler	<i>Anas clypeata</i>	c		c	o		
Swans, Geese and Ducks	Northern Pintail	<i>Anas acuta</i>	u		u	r		
Swans, Geese and Ducks	Green-winged Teal	<i>Anas carolinensis</i>	c		u	r		
Swans, Geese and Ducks	Canvasback	<i>Aythya ferina</i>	o		o	r		
Swans, Geese and Ducks	Redhead	<i>Aythya americana</i>	u		u	o		

Bird Species That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Probable Abundance by Season				Status	
			Sp	S	F	W	State	Federal
			A: Abundant, should find on every trip C: Common, should find on 75% of trips U: Uncommon, present but in lesser numbers R: Rare, infrequent or few identifications H: Accidental, not expected at this location O: Occasional				E: Endangered T: Threatened SC: Special Concern	
			Sp	S	F	W	State	Federal
Swans, Geese and Ducks	Ring-necked Duck	<i>Aythya collaris</i>	a		a	u		
Swans, Geese and Ducks	Greater Scaup	<i>Aythya marila</i>	o		o	r		
Swans, Geese and Ducks	Lesser Scaup	<i>Aythya affinis</i>	c		c	u		
Swans, Geese and Ducks	Oldsquaw	<i>Clangula hyemalis</i>	r			r		
Swans, Geese and Ducks	Bufflehead	<i>Bucephala albeola</i>	u		c	u		
Swans, Geese and Ducks	Common Goldeneye	<i>Bucephala clangula</i>	u		u	o		
Swans, Geese and Ducks	Hooded Merganser	<i>Lophodytes cucullatus</i>	u	o	c	o		
Swans, Geese and Ducks	Common Merganser	<i>Mergus merganser</i>	u		o	u		
Swans, Geese and Ducks	Red-breasted Merganser	<i>Mergus serrator</i>	o		o			
Swans, Geese and Ducks	Ruddy Duck	<i>Ocyura jamaicensis</i>	u		u	o		
Hawks and Eagles	Osprey	<i>Pandion haliaetus</i>	u		u		E	
Hawks and Eagles	Bald Eagle	<i>Haliaeetus leucocephalus</i>	o		o	o	E	
Hawks and Eagles	Northern Harrier	<i>Circus cyaneus</i>	u	r	u	c	E	
Hawks and Eagles	Sharp-shinned Hawk	<i>Accipiter striatus</i>	u	o	u	u	SC	
Hawks and Eagles	Cooper's Hawk	<i>Accipiter cooperii</i>	u	u	u	u		
Hawks and Eagles	Red-shouldered Hawk	<i>Buteo lineatus</i>	c	c	c	c	SC	
Hawks and Eagles	Broad-winged Hawk	<i>Buteo platypterus</i>	o		o		SC	
Hawks and Eagles	Red-tailed Hawk	<i>Buteo jamaicensis</i>	c	c	c	c		
Hawks and Eagles	Rough-legged Hawk	<i>Buteo lagopus</i>	o		o	o		

Bird Species That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Probable Abundance by Season				Status	
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			Sp	S	F	W	State	Federal
Hawks and Eagles	Golden Eagle	<i>Aquila chrysaetos</i>	r		r	r		
Falcons	American Kestrel	<i>Falco sparverius</i>	c	c	c	c		
Falcons	Merlin	<i>Falco columbarius</i>	u		u	r		
Falcons	Peregrine Falcon	<i>Falco peregrinus</i>	u		u		E	
Upland Game Birds	Ring-necked Pheasant	<i>Phasianus colchicus</i>	r	r	r	r		
Upland Game Birds	Ruffed Grouse	<i>Bonasa umbellus</i>	r	r	r	r		
Upland Game Birds	Wild Turkey	<i>Meleagris gallopavo</i>	c	c	c	c		
Upland Game Birds	Northern Bobwhite Quail	<i>Colinus virginianus</i>	c	c	c	c		
Rails and Coots	Yellow Rail	<i>Coturnicops noveboracensis</i>	r		r			
Rails and Coots	King Rail	<i>Rallus elegans</i>	o	r	r		E	
Rails and Coots	Virginia Rail	<i>Rallus limicola</i>	u	o	u		E	
Rails and Coots	Sora	<i>Porzana carolina</i>	u	c	u			
Rails and Coots	Common Moorhen	<i>Gallinula chloropus</i>	o	o	o		E	
Rails and Coots	American Coot	<i>Fulica americana</i>	a	o	a	o		
Cranes	Sandhill Crane	<i>Grus canadensis</i>	u	r	u	u	SC	
Shorebirds	Black-bellied Plover	<i>Pluvialis squatarola</i>	o	o	o			
Shorebirds	Semipalmated Plover	<i>Charadrius semipalmatus</i>	o	o	u			
Shorebirds	Killdeer	<i>Charadrius vociferus</i>	c	c	c	o		
Shorebirds	Greater Yellowlegs	<i>Tringa melanoleuca</i>	c	c	c		SC	

Bird Species That Occur on Muscatatuck NWR (Continued)

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			Sp	S	F	W	State	Federal
Shorebirds	Lesser Yellowlegs	<i>Tringa flavipes</i>	c	c	c			
Shorebirds	Solitary Sandpiper	<i>Tringa solitaria</i>	c	c	c		SC	
Shorebirds	Willit	<i>Catoptrophorus semipalmatus</i>			u			
Shorebirds	Spotted Sandpiper	<i>Actitis macularia</i>	u	o	u			
Shorebirds	Upland Sandpiper	<i>Bartramia longicauda</i>	r	r	r		E	
Shorebirds	Ruddy Turnstone	<i>Arenaria interpres</i>	r	r	r		SC	
Shorebirds	Semipalmated Sandpiper	<i>Calidris pusilla</i>	u	u	u			
Shorebirds	Western Sandpiper	<i>Calidris mauri</i>	o	o	o			
Shorebirds	Least Sandpiper	<i>Calidris minutilla</i>	u	o	c			
Shorebirds	White-rumped Sandpiper	<i>Calidris fuscicollis</i>	o	r	r			
Shorebirds	Baird's Sandpiper	<i>Calidris bairdii</i>	o	r	o			
Shorebirds	Pectoral Sandpiper	<i>Calidris melanotos</i>	c	c	c			
Shorebirds	Dunlin	<i>Calidris alpina</i>	c	c	c			
Shorebirds	Stilt Sandpiper	<i>Calidris himantopus</i>	u	u	u			
Shorebirds	Short-billed Dowitcher	<i>Limnodromus griseus</i>	u	o	o		SC	
Shorebirds	Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	r	r	r			
Shorebirds	Common Snipe	<i>Gallinago stenura</i>	c	c	c	u		
Shorebirds	American Woodcock	<i>Scolopax minor</i>	c	u	u	o		

Bird Species That Occur on Muscatatuck NWR (Continued)

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			Sp	S	F	W	State	Federal
Shorebirds	Wilson's Phalarope	<i>Phalaropus tricolor</i>	u	u	u		SC	
Gulls and Terns	Franklin's Gull	<i>Larus pipixcan</i>			r	r		
Gulls and Terns	Bonaparte's Gull	<i>Larus philadelphia</i>	r		r			
Gulls and Terns	Ring-billed Gull	<i>Larus delawarensis</i>	o	r	o	r		
Gulls and Terns	Herring Gull	<i>Larus argentatus</i>	r		r			
Gulls and Terns	Caspian Tern	<i>Sterna caspia</i>	o		o			
Gulls and Terns	Common Tern	<i>Sterna hirundo</i>	o		o			
Gulls and Terns	Forster's Tern	<i>Sterna forsteri</i>	o		o			
Gulls and Terns	Least Tern	<i>Sterna antillarum</i>	r		r		E	
Gulls and Terns	Black Tern	<i>Chlidonias niger</i>	r		r		E	
Doves	Rock Dove	<i>Columba livia</i>	u	u	u	u		
Doves	Mourning Dove	<i>Zenaida macroura</i>	a	a	a	a		
Cuckoos	Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	o	o	u			
Cuckoos	Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	u	c	c			
Owls	Barn Owl	<i>Tyto alba</i>	r	r	r	r	E	
Owls	Eastern Screech Owl	<i>Otus asio</i>	c	c	c	c		
Owls	Great Horned Owl	<i>Bubo virginianus</i>	c	c	c	c		
Owls	Barred Owl	<i>Strix varia</i>	c	c	c	c		
Owls	Long-eared Owl	<i>Asio otus</i>	r			r		

Bird Species That Occur on Muscatatuck NWR (Continued)

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			Sp	S	F	W	State	Federal
Owls	Short-eared Owl	<i>Asio flammeus</i>	o		o	o	E	
Owls	Northern Saw-whet Owl	<i>Aegolius acadicus</i>	r		r	r		
Nighthawks and Nightjars	Common Nighthawk	<i>Chordeiles minor</i>	u	a	u			
Nighthawks and Nightjars	Chuck-will's-widow	<i>Caprimulgus carolinensis</i>	r	r			SC	
Nighthawks and Nightjars	Whip-poor-will	<i>Caprimulgus vociferus</i>	r	u	r		SC	
Swifts	Chimney Swift	<i>Chaetura pelagica</i>	c	c	c			
Hummingbirds	Ruby-throated Hummingbird	<i>Archilochus colubris</i>	c	c	c			
Kingfishers	Belted Kingfisher	<i>Ceryle alcyon</i>	c	c	c	u		
Woodpeckers	Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	c	c	c	c		
Woodpeckers	Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	c	c	c	c		
Woodpeckers	Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	u		u	u		
Woodpeckers	Downy Woodpecker	<i>Picoides pubescens</i>	c	c	c	c		
Woodpeckers	Hairy Woodpecker	<i>Picoides villosus</i>	c	c	c	c		
Woodpeckers	Northern Flicker	<i>Colaptes auratus</i>	c	c	c	c		
Woodpeckers	Pileated Woodpecker	<i>Dryocopus pileatus</i>	c	c	c	c		
Flycatchers	Olive-sided Flycatcher	<i>Contopus cooperi</i>	o		o			
Flycatchers	Eastern Wood-Pewee	<i>Contopus virens</i>	c	c	c			
Flycatchers	Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	u		u			
Flycatchers	Acadian Flycatcher	<i>Empidonax virescens</i>	c	c	c			

Bird Species That Occur on Muscatatuck NWR (Continued)

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Flycatchers	Willow Flycatcher	<i>Empidonax traillii</i>	c	c	c			
Flycatchers	Least Flycatcher	<i>Empidonax minimus</i>	u	r	u			
Flycatchers	Eastern Phoebe	<i>Sayornis phoebe</i>	c	c	c			
Flycatchers	Great Crested Flycatcher	<i>Myiarchus crinitus</i>	c	c	c			
Flycatchers	Eastern Kingbird	<i>Tyrannus tyrannus</i>	c	c	c			
Shrikes	Loggerhead Shrike	<i>Lanius ludovicianus</i>	r	r	r	r	E	
Shrikes	Northern Shrike	<i>Lanius excubitor</i>				r		
Vireos	White-eyed Vireo	<i>Vireo griseus</i>	c	c	c			
Vireos	Bell's Vireo	<i>Vireo bellii</i>	r	r				
Vireos	Yellow-throated Vireo	<i>Vireo flavifrons</i>	c	c	c			
Vireos	Blue-headed Vireo	<i>Vireo solitarius</i>	u		o			
Vireos	Warbling Vireo	<i>Vireo gilvus</i>	c	c	c			
Vireos	Philadelphia Vireo	<i>Vireo philadelphicus</i>	u		u			
Vireos	Red-eyed Vireo	<i>Vireo olivaceus</i>	c	c	c			
Jays, Magpies and Crows	Blue Jay	<i>Cyanocitta cristata</i>	a	a	a	a		
Jays, Magpies and Crows	American Crow	<i>Corvus caurinus</i>	a	a	a	a		
Larks	Horned Lark	<i>Eremophila alpestris</i>	u	u	u	u		
Swallows	Purple Martin	<i>Progne subis</i>	c	c	c			
Swallows	Tree Swallow	<i>Tachycineta bicolor</i>	a	a	a			

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Swallows	Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	u	u	u			
Swallows	Bank Swallow	<i>Riparia riparia</i>	o	o	o			
Swallows	Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	r	r	r			
Swallows	Barn Swallow	<i>Hirundo rustica</i>	c	c	c			
Chickadees and Titmice	Carolina Chickadee	<i>Poecile carolinensis</i>	a	a	a	a		
Chickadees and Titmice	Tufted Titmouse	<i>Baeolophus bicolor</i>	a	a	a	a		
Nuthatches	Red-breasted Nuthatch	<i>Sitta canadensis</i>	u	u	u	u		
Nuthatches	White-breasted Nuthatch	<i>Sitta carolinensis</i>	c	c	c	c		
Creepers	Brown Creeper	<i>Certhia americana</i>	u		u	u		
Wrens	Carolina Wren	<i>Thryothorus ludovicianus</i>	c	c	c	c		
Wrens	Bewick's Wren	<i>Thryomanes bewickii</i>	r	r	r			
Wrens	House Wren	<i>Troglodytes aedon</i>	c	c	u			
Wrens	Winter Wren	<i>Troglodytes troglodytes</i>	u		u	u		
Wrens	Sedge Wren	<i>Cistothorus platensis</i>	c	c	c		E	
Wrens	Marsh Wren	<i>Cistothorus palustris</i>	u	r	u		E	
Kinglets, Bluebirds, and Thrushes	Golden-crowned Kinglet	<i>Regulus satrapa</i>	c		c	u		
Kinglets, Bluebirds, and Thrushes	Ruby-crowned Kinglet	<i>Regulus calendula</i>	c		c	u		

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			Sp	S	F	W	State	Federal
Kinglets, Bluebirds, and Thrushes	Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	c	c	c			
Kinglets, Bluebirds, and Thrushes	Eastern Bluebird	<i>Sialia sialis</i>	c	c	c	c		
Kinglets, Bluebirds, and Thrushes	Veery	<i>Catharus fuscescens</i>	u		u			
Kinglets, Bluebirds, and Thrushes	Gray-cheeked Thrush	<i>Catharus minimus</i>	u		u			
Kinglets, Bluebirds, and Thrushes	Swainson's Thrush	<i>Catharus ustulatus</i>	c		c			
Kinglets, Bluebirds, and Thrushes	Hermit Thrush	<i>Catharus guttatus</i>	c		c	o		
Kinglets, Bluebirds, and Thrushes	Wood Thrush	<i>Hylocichla mustelina</i>	c	c	c			
Kinglets, Bluebirds, and Thrushes	American Robin	<i>Turdus migratorius</i>	a	a	a	a		
Mimics	Gray Catbird	<i>Dumetella carolinensis</i>	c	c	c			
Mimics	Northern Mockingbird	<i>Mimus polyglottos</i>	c	c	c	u		
Mimics	Brown Thrasher	<i>Toxostoma rufum</i>	c	c	c	r		
Starlings	European Starling	<i>Sturnus vulgaris</i>	a	a	a	a		
Pipits	American Pipit	<i>Anthus rubescens</i>	o		u	o		

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Waxwings	Cedar Waxwing	<i>Bombycilla cedrorum</i>	c	c	c	c		
Warblers	Blue-winged Warbler	<i>Vermivora pinus</i>	c	c	c			
Warblers	Golden-winged Warbler	<i>Vermivora chrysoptera</i>	r		r		E	
Warblers	Tennessee Warbler	<i>Vermivora peregrina</i>	c		c			
Warblers	Orange-crowned Warbler	<i>Vermivora celata</i>	r		r			
Warblers	Nashville Warbler	<i>Vermivora ruficapilla</i>	c		c			
Warblers	Northern Parula	<i>Parula americana</i>	u	u	u			
Warblers	Yellow Warbler	<i>Dendroica petechia</i>	c	c	c			
Warblers	Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>	c		c			
Warblers	Magnolia Warbler	<i>Dendroica magnolia</i>	c		c			
Warblers	Cape May Warbler	<i>Dendroica tigrina</i>	u		u			
Warblers	Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	u		u			
Warblers	Yellow-rumped Warbler	<i>Dendroica coronata</i>	c		c	u		
Warblers	Black-throated Green Warbler	<i>Dendroica virens</i>	c		c			
Warblers	Blackburnian Warbler	<i>Dendroica fusca</i>	u		u			
Warblers	Yellow-throated Warbler	<i>Dendroica dominica</i>	c	c	u			
Warblers	Pine Warbler	<i>Dendroica pinus</i>	u	u	u			
Warblers	Prairie Warbler	<i>Dendroica discolor</i>	c	c	u			
Warblers	Palm Warbler	<i>Dendroica palmarum</i>	c		c			

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Warblers	Bay-breasted Warbler	<i>Dendroica castanea</i>	u		c			
Warblers	Blackpoll Warbler	<i>Dendroica striata</i>	c		c			
Warblers	Cerulean Warbler	<i>Dendroica cerulea</i>	u	u	u		E	
Warblers	Black-and-white Warbler	<i>Mniotilta varia</i>	c		c		E	
Warblers	American Redstart	<i>Setophaga ruticilla</i>	c	c	c			
Warblers	Prothonotary Warbler	<i>Protonotaria citrea</i>	c	c	c			
Warblers	Worm-eating Warbler	<i>Helmitheros vermivorus</i>	o	o	o		SC	
Warblers	Ovenbird	<i>Seiurus aurocapillus</i>	c	c	c			
Warblers	Northern Waterthrush	<i>Seiurus noveboracensis</i>	r		r			
Warblers	Louisiana Waterthrush	<i>Seiurus motacilla</i>	u	u	u			
Warblers	Kentucky Warbler	<i>Oporornis formosus</i>	c	c	c			
Warblers	Connecticut Warbler	<i>Oporornis agilis</i>	o		o			
Warblers	Mourning Warbler	<i>Oporornis philadelphia</i>	o		o			
Warblers	Common Yellowthroat	<i>Geothlypis trichas</i>	c	c	c	r		
Warblers	Hooded Warbler	<i>Wilsonia citrina</i>	o	o	o		SC	
Warblers	Wilson's Warbler	<i>Wilsonia pusilla</i>	o		o			
Warblers	Canada Warbler	<i>Wilsonia canadensis</i>	o		o			
Warblers	Yellow-breasted Chat	<i>Icteria virens</i>	c	c	c			
Tanager	Summer Tanager	<i>Piranga rubra</i>	u	u	u			

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Tanager	Scarlet Tanager	<i>Piranga olivacea</i>	c	c	c			
Sparrows, Buntings, and Grosbeaks	Eastern Towhee	<i>Pipilo erythrophthalmus</i>	c	c	c	c		
Sparrows, Buntings, and Grosbeaks	American Tree Sparrow	<i>Spizella arborea</i>	c		c	c		
Sparrows, Buntings, and Grosbeaks	Chipping Sparrow	<i>Spizella passerina</i>	c	c	c			
Sparrows, Buntings, and Grosbeaks	Field Sparrow	<i>Spizella pusilla</i>	c	c	c	u		
Sparrows, Buntings, and Grosbeaks	Vesper Sparrow	<i>Pooecetes gramineus</i>	u	o	u	o		
Sparrows, Buntings, and Grosbeaks	Savannah Sparrow	<i>Passerculus sandwichensis</i>	c	o	c	r		
Sparrows, Buntings, and Grosbeaks	Grasshopper Sparrow	<i>Ammodramus savannarum</i>	o	o	o			
Sparrows, Buntings, and Grosbeaks	Henslow's Sparrow	<i>Ammodramus henslowii</i>	o	o	r		E	
Sparrows, Buntings, and Grosbeaks	Le Conte's Sparrow	<i>Ammodramus leconteii</i>	r		r			
Sparrows, Buntings, and Grosbeaks	Nelson's Sharp-tailed Sparrow	<i>Ammodramus nelsoni</i>	r	r	r			

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Sparrows, Buntings, and Grosbeaks	Fox Sparrow	<i>Passerella iliaca</i>	c		c	c		
Sparrows, Buntings, and Grosbeaks	Song Sparrow	<i>Melospiza melodia</i>	c	c	c	c		
Sparrows, Buntings, and Grosbeaks	Lincoln's Sparrow	<i>Melospiza lincolni</i>	c		c	r		
Sparrows, Buntings, and Grosbeaks	Swamp Sparrow	<i>Melospiza georgiana</i>	c		c	c		
Sparrows, Buntings, and Grosbeaks	White-throated Sparrow	<i>Zonotrichia albicollis</i>	c		c	c		
Sparrows, Buntings, and Grosbeaks	White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	c		c	c		
Sparrows, Buntings, and Grosbeaks	Dark-eyed Junco	<i>Junco hyemalis</i>	c		c	c		
Sparrows, Buntings, and Grosbeaks	Lapland Longspur	<i>Calcarius lapponicus</i>				r		
Sparrows, Buntings, and Grosbeaks	Snow Bunting	<i>Plectrophenax nivalis</i>				r		
Sparrows, Buntings, and Grosbeaks	Northern Cardinal	<i>Cardinalis cardinalis</i>	a	a	a	a		
Sparrows, Buntings, and Grosbeaks	Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	c	o	c			

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Sparrows, Buntings, and Grosbeaks	Blue Grosbeak	<i>Guiraca caerulea</i>	u	u	u			
Sparrows, Buntings, and Grosbeaks	Indigo Bunting	<i>Passerina cyanea</i>	a	a	a			
Sparrows, Buntings, and Grosbeaks	Dickcissel	<i>Spiza americana</i>	r	r	r			
Blackbirds and Orioles	Bobolink	<i>Dolichonyx oryzivorus</i>	o		r			
Blackbirds and Orioles	Red-winged Blackbird	<i>Agelaius phoeniceus</i>	a	a	a	u		
Blackbirds and Orioles	Eastern Meadowlark	<i>Sturnella magna</i>	a	a	a	u		
Blackbirds and Orioles	Rusty Blackbird	<i>Euphagus carolinus</i>	u		u	u		
Blackbirds and Orioles	Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	r		r			
Blackbirds and Orioles	Common Grackle	<i>Quiscalus quiscula</i>	a	a	a	u		
Blackbirds and Orioles	Brown-headed Cowbird	<i>Molothrus ater</i>	a	a	c	u		
Blackbirds and Orioles	Orchard Oriole	<i>Icterus spurius</i>	c	c	c			
Blackbirds and Orioles	Baltimore Oriole	<i>Icterus galbula</i>	c	c	c			
Finches	Purple Finch	<i>Carpodacus purpureus</i>	c		c	c		
Finches	House Finch	<i>Carpodacus mexicanus</i>	c	c	c	c		
Finches	Red Crossbill	<i>Loxia curvirostra</i>				r		
Finches	White-winged Crossbill	<i>Loxia leucoptera</i>				r		
Finches	Common Redpoll	<i>Carduelis flammea</i>				r		

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Finches	Pine Siskin	<i>Carduelis pinus</i>	u		u	u		
Finches	American Goldfinch	<i>Carduelis tristis</i>	c	c	c	c		
Finches	Evening Grosbeak	<i>Coccothraustes vespertinus</i>	r			r		
Old World Sparrows	House Sparrow	<i>Passer domesticus</i>	c	c	c	c		
Extremely Rare or Accidental	Whooping Crane							
Extremely Rare or Accidental	Eared Grebe	<i>Podiceps nigricollis</i>						
Extremely Rare or Accidental	Western Grebe	<i>Aechmophorus occidentalis</i>						
Extremely Rare or Accidental	Glossy Ibis	<i>Plegadis falcinellus</i>						
Extremely Rare or Accidental	Cinnamon Teal	<i>Anas cyanoptera</i>						
Extremely Rare or Accidental	Ruddy Shelduck	<i>Tadorna ferruginea</i>						
Extremely Rare or Accidental	Fulvous Whistling Duck	<i>Dendrocygna bicolor</i>						
Extremely Rare or Accidental	White-winged Scoter	<i>Melanitta fusca</i>						
Extremely Rare or Accidental	Black Scoter	<i>Melanitta nigra</i>						

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Extremely Rare or Accidental	Surf Scoter	<i>Melanitta perspicillata</i>						
Extremely Rare or Accidental	American Swallow-tailed Kite	<i>Elanoides forficatus</i>						
Extremely Rare or Accidental	Mississippi Kite	<i>Ictinia mississippiensis</i>						
Extremely Rare or Accidental	White Pelican	<i>Pelecanus occidentalis</i>						
Extremely Rare or Accidental	Ruff	<i>Philomachus pugnax</i>						
Extremely Rare or Accidental	Brambling	<i>Fringilla montifringilla</i>						
Extremely Rare or Accidental	Fish Crow	<i>Corvus ossifragus</i>						
Extremely Rare or Accidental	Varied Thrush	<i>Ixoreus naevius</i>						
Extremely Rare or Accidental	Black-capped Chickadee	<i>Poecile atricapillus</i>						
Extremely Rare or Accidental	Harris Sparrow	<i>Zonotrichia querula</i>						

Butterflies That Occur on Muscatatuck NWR

Family	Common Name	Scientific Name	Status	
			State	Federal
Papilionidae	Spicebush Swallowtail	<i>Papilio troilus</i>	Secure	Secure
Papilionidae	Pipevine Swallowtail	<i>Battus philenor</i>	Secure	Secure
Papilionidae	Zebra Swallowtail	<i>Eurytides marcellus</i>	Secure	Secure
Papilionidae	Black Swallowtail	<i>Papilio polyxenes asterius</i>	Secure	Secure
Papilionidae	Eastern Tiger Swallowtail	<i>Papilio glaucus</i>	Secure	Secure
Pieridae	Cabbage White	<i>Pieris protodice</i>	exotic	NNA
Pieridae	Checkered White	<i>Pieris rapae</i>	Apparently Secure	Apparently Secure
Pieridae	Falcate Orange Tip	<i>Anthocharis midea</i>	Apparently Secure?	Apparently Secure/Secure
Pieridae	Alfalfa	<i>Colias eurytheme</i>	Secure	Secure
Pieridae	Clouded Sulphur	<i>Colias philodice</i>	Secure	Secure
Pieridae	Cloudless Sulphur	<i>Phoebis sennae</i>	Secure	Secure
Pieridae	Orange Sulphur	<i>Colias eurytheme</i>	Secure	Secure
Lycaenidae	Spring Azure	<i>Celastrina ladon</i>	Secure	Secure
Lycaenidae	Eastern Tailed Blue	<i>Everes comyntas</i>	Secure	Secure
Lycaenidae	Bronze Copper	<i>Lycaena hyllus</i>	Apparently Secure	Secure
Lycaenidae	Little Copper	<i>Lycaena phlaeas</i>	Not Ranked	Secure
Lycaenidae	Gray Hairstreak	<i>Strymon melinus</i>	Secure	Vulnerable
Lycaenidae	Banded Hairstreak	<i>Strymon falacer</i>	Not Ranked	Secure
Lycaenidae	Striped Hairstreak	<i>Strymon liparops</i>	Not Ranked	Apparently Secure
Libytheidae	American Snout	<i>Libytheana bachmannii</i>	Not Ranked	Secure
Nymphalidae	Great Spangled Fritillary	<i>Speyeria cybele</i>	Secure	Secure
Nymphalidae	Meadow Fritillary	<i>Boloria toddi ammiralis</i>	Secure	Secure
Nymphalidae	Variiegated Fritillary	<i>Euptoieta claudia</i>	Apparently Secure	Apparently Secure
Nymphalidae	Pearl Crescent	<i>Phyciodes tharos</i>	Secure	Secure
Nymphalidae	Silvery Checkerspot	<i>Chlosyne nycteis</i>	Apparently Secure	Apparently Secure
Nymphalidae	Question Mark	<i>Polygonia progne</i>	Secure	Secure
Nymphalidae	Hop Merchant (Comma)	<i>Polygonia interrogationis</i>	Secure	Secure
Nymphalidae	Eastern Comma	<i>Polygonia comma</i>	Secure	Secure
Nymphalidae	Mourning Cloak	<i>Nymphalis antiopa</i>	Secure	Secure

Butterflies That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Status	
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Nymphalidae	Red Admiral	<i>Vanessa atalanta</i>	Secure	Secure
Nymphalidae	American Painted Lady	<i>Vanessa virginiensis</i>	Secure	Secure
Nymphalidae	Painted Lady	<i>Vanessa cardui</i>	Secure	Secure
Nymphalidae	Common Buckeye	<i>Junonia coenia</i>	Secure	Secure
Nymphalidae	Red-Spotted Purple	<i>Basilarchia arthemis astanax</i>	Not Ranked	Secure
Nymphalidae	Viceroy	<i>Limenitis archippus</i>	Secure	Secure
Nymphalidae	Hackberry Emperor	<i>Asterocampa celtis</i>	Secure	Secure
Nymphalidae	Tawny Emperor	<i>Asterocampa clyton</i>	Secure	Secure
Nymphalidae	Monarch	<i>Danaus plexippus</i>	Secure	Secure
Nymphalidae	Common Wood Nymph	<i>Cercyonis pegala</i>	Secure	Secure
Nymphalidae	Little Wood Satyr	<i>Megisto cymela</i>	Secure	Secure
Hesperiidae	Silver-Spotted Skipper	<i>Epargyreus clarus</i>	Secure	Secure
Hesperiidae	Hobomok Skipper	<i>Poanes hobomok</i>	Secure	Secure
Hesperiidae	Ocola Skipper	<i>Panoquina ocola</i>	Not Ranked	Secure
Hesperiidae	Checkered Skipper	<i>Pyrgus communis</i>	Not Ranked	Secure
Hesperiidae	Least Skipper	<i>Ancyloxypha numitor</i>	Secure	Secure
Hesperiidae	Tawny-edged Skipper	<i>Polites themistocles</i>	Secure	Secure
Hesperiidae	Delaware Skipper	<i>Anatrytone logan</i>	Secure	Secure
Hesperiidae	Crossline Skipper	<i>Polites origenes</i>	Secure	Secure
Hesperiidae	Zabulon Skipper	<i>Poanes zabulon</i>	Secure	Secure
Hesperiidae	Fiery Skipper	<i>Hylephila phyleus</i>	Not Ranked	Secure
Hesperiidae	Peck's Skipper	<i>Polites peckius</i>	Secure	Secure
Hesperiidae	Dun Skipper	<i>Euphyes vestris</i>	Not Ranked	Secure
Nymphalidae	Northern Pealy Eye	<i>Enodia anthedon</i>	Imperiled	Secure
Hesperiidae	Dreamy Dusky Wing	<i>Erynnius icelus</i>	Secure	Secure
Hesperiidae	Sleepy Dusky Wing	<i>Erynnius brizo</i>	Apparently Secure	Secure
Hesperiidae	Horace's Dusky Wing	<i>Erynnius horatius</i>	Secure	Secure
Hesperiidae	Wild Indigo Dusky Wing	<i>Erynnius baptisiae</i>	Apparently Secure	Secure
Hesperiidae	Northern Broken-dash	<i>Wallengrenia egeremet</i>	Secure	Secure
Hesperiidae	Little Glassy Wing	<i>Pompeius verna</i>	Secure	Secure
Hesperiidae	Sachem	<i>Atalopedes campestris</i>	Not Ranked	Secure

Dragonflies That Occur on Muscatatuck NWR

Common Name	Scientific Name	Status	
		State	Federal
Shadow Darner	<i>Aeshna umbrosa</i>	Apparently Secure	Secure
Common Green Darner	<i>Anax junius</i>	Secure	Secure
Springtime Darner	<i>Basiaeschna janata</i>	Vulnerable	Secure
Fawn Darner	<i>Boyeria vinosa</i>	Secure	Secure
Cyrano Darner	<i>Nasiaeschna pentacantha</i>	Vulnerable	Secure
Unicorn Clubtail	<i>Arigomphus villosipes</i>	Vulnerable	Secure
	<i>Gomphus lividus</i>		
Lancet Clubtail	<i>Gomphus exilis</i>	Apparently Secure	Secure
Common Sanddragon	<i>Progomphus obscurus</i>	Vulnerable	Secure
Stream Cruiser	<i>Didymops transversa</i>	Vulnerable	Secure
Swift River Cruiser	<i>Macromia illinoiensis</i>	Apparently Secure	Secure
Royal River Cruiser	<i>Macromia taeniolata</i>	Apparently Secure	Secure
	<i>Epitheca canis</i>		
Beaverpond Baskettail	<i>Epitheca cynosura</i>	Apparently Secure	Secure
Prince Baskettail	<i>Epitheca princeps</i>	Apparently Secure	Secure
Mocha Emerald	<i>Somatochlora linearis</i>	Imperiled	Secure
Calico Pennant	<i>Celithemis elisa</i>	Apparently Secure	Secure
Halloween Pennant	<i>Celithemis eponina</i>	Apparently Secure	Secure
	<i>Celithemis verna</i>		
Banded Pennant	<i>Celithemis fasciata</i>	Apparently Secure	Secure
Eastern Pondhawk	<i>Erythemis simplicicollis</i>	Secure	Secure
Spangled Skimmer	<i>Libellula cyanea</i>	Apparently Secure	Secure
Blue Corporal	<i>Libellula deplanata</i>	Vulnerable	Secure
Slaty Skimmer	<i>Libellula incesta</i>	Apparently Secure	Secure
Widow Skimmer	<i>Libellula luctuosa</i>	Secure	Secure
Common Whitetail	<i>Plathemis lydia</i>	Secure	Secure
Twelve-spotted Skimmer	<i>Libellula pulchella</i>	Apparently Secure	Secure
Great Blue Skimmer	<i>Libellula vibrans</i>	Vulnerable	Secure
Blue Dasher	<i>Pachydiplax longipennis</i>	Secure	Secure

Dragonflies That Occur on Muscatatuck NWR

Common Name	Scientific Name	Status	
		State	Federal
Eastern Amberwing	<i>Perithemis tenera</i>	Secure	Secure
Autumn Meadowhawk	<i>Sympetrum vicinum</i>	Apparently Secure	Secure
Carolina Saddlebags	<i>Tramea carolina</i>	Vulnerable	Secure
Black Saddlebags	<i>Tramea lacerata</i>	Secure	Secure

Herpetofauna Species That Occur on Muscatatuck NWR

Family	Common Name	Scientific Name	Status			Habitat in Muscatatuck NWR
			State	Federal	Local	
Salamander	Spotted Salamander	<i>Ambystoma maculatum</i>	Apparently Secure	Secure	Rare	Hardwood Uplands
Salamander	Marbled Salamander	<i>Ambystoma opacum</i>	Apparently Secure	Secure	Rare	Hardwood Uplands
Salamander	Jefferson Salamander	<i>Ambystoma jeffersonianum</i>	Apparently Secure	Apparently Secure	Abundant	Hardwood Uplands
Salamander	Smallmouth Salamander	<i>Ambystoma texanum</i>	Apparently Secure	Secure	Common	Wet Lowlands
Salamander	Northern Dusky Salamander	<i>Desmognathus fuscus fuscus</i>	Apparently Secure	Secure	Uncommon	Sandy Streambeds
Salamander	Northern Slimy Salamander	<i>Plethodon glutinosus</i>	Apparently Secure	Secure	Common	Hardwood Uplands
salamander	Four-toed salamander	<i>Hemidactylium scutatum</i>	Imperiled	Secure	Rare	Mature Forest with wetlands
Salamander	Redback Salamander	<i>Plethodon cinereus</i>	Apparently Secure	Secure	Common	Hardwood Uplands
Salamander	Northern Zigzag Salamander	<i>Plethodon dorsalis dorsalis</i>	Apparently Secure	Secure	Rare	Mature Forest with wetlands
Salamander	Red-spotted Newt	<i>Notophthalmus viridescens viridescens</i>	Apparently Secure	Secure	Common	All Habitats
Toads	American Toad	<i>Bufo americanus americanus</i>		Secure	Common	Wet Lowlands and Hardwood Uplands
Toads	Fowler's Toad	<i>Bufo woodhousii fowleri</i>	Apparently Secure	Secure	Common	Wet Lowlands and Hardwood Uplands
Frogs	Blanchard's Cricket Frog	<i>Acris crepitans blanchardi</i>			Common	Marsh Edges of Water
Frogs	Western Chorus Frog	<i>Pseudacris triseriata</i>	Vulnerable	Secure	Abundant	All Habitats
Frogs	Northern Spring Peeper	<i>Pseudacris crucifer crucifer</i>		Secure	Abundant	Any Water Source
Frogs	Gray Treefrog	<i>Hyla versicolor</i>	Apparently Secure	Secure	Abundant	Hardwood Uplands
Frogs	Crawfish Frog	<i>Rana areolata</i>	Not Ranked	Apparently Secure		Restle Unit (Last Confirmed 1998)
Frogs	Green Frog	<i>Rana clamitans melanota</i>	Apparently Secure	Secure	Abundant	All Permanent Water Sources
Frogs	Bullfrog	<i>Rana catesbeiana</i>	Apparently Secure	Secure	Common	All Permanent Water Sources

Herpetofauna Species That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Status			Habitat in Muscatatuck NWR
			State	Federal	Local	
Frogs	Southern Leopard Frog	<i>Rana utricularia</i>	Apparently Secure	Secure	Common	All Habitats
Frogs	Wood Frog	<i>Rana sylvatica</i>	Apparently Secure	Secure	Common	Hardwood Uplands
Turtles	Common Snapping Turtle	<i>Chelydra serpentina serpentina</i>		Secure	Common	Any Water Source
Turtles	Common Musk Turtle	<i>Sternotherus odoratus</i>	Apparently Secure	Secure	Common	Warm Shallows of Water Source
Turtles	Eastern Box Turtle	<i>Terrapene carolina carolina</i>	Apparently Secure	Secure	Uncommon	Hardwood Uplands
Turtles	Common Map Turtle	<i>Graptemys geographica</i>	Apparently Secure	Secure	Uncommon	Moist Soil Unit #10
Turtles	Ouchita Map Turtle	<i>Graptemys ouachitensis</i>	Not Ranked	Secure	Uncommon	Muscatatuck River
Turtles	Midland Painted Turtle	<i>Chrysemys picta marginata</i>	Apparently Secure	Secure	Abundant	Any Water Source
Turtles	Red-Eared Slider	<i>Trachemys scripta elegans</i>		Secure	Common	Sue Pond Series of Ponds
Turtles	Spiny Softshell	<i>Apalone spinifera</i>	Apparently Secure	Secure	Common	Any Water Source
Lizard	Five-Lined Skink	<i>Eumeces fasciatus</i>			Abundant	Hardwood Uplands and Forest Edge
Snakes	Eastern Gartersnake	<i>Thamnophis sirtalis sirtalis</i>		Not Ranked	Abundant	All Habitats
Snakes	Eastern Ribbonsnake	<i>Thamnophis sauritus sauritus</i>	Apparently Secure	Secure	Abundant	All Moist Habitats
Snakes	Northern Watersnake	<i>Nerodia sipedon sipedon</i>	Apparently Secure	Secure	Abundant	All Water Habitats
Snakes	Northern Copperbelly Watersnake	<i>Nerodia erythrogaster neglecta</i>	Imperiled	Vulnerable	Very Common	Flooded Woodlands
Snakes	Kirtland's Snake	<i>Clonophis kirtlandii</i>	Imperiled	Imperiled	Common	Moist Forests and Edges
Snakes	Midland Brownsnake	<i>Storeria dekayi wrightorum</i>	Apparently Secure	Secure	Common	Moist Forests and Edges
Snakes	Blue/black Racer	<i>Coluber constrictor</i>	Not Ranked	Secure	Common	All Habitats
Snakes	Rough Greensnake	<i>Opheodrys aestivus</i>	Vulnerable	Secure	Common	All Edge Habitats
Snakes	Black Rat Snake	<i>Elaphe obsoleta obsoleta</i>	Apparently Secure	Secure	Common	Hardwood Uplands

Herpetofauna Species That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Status			Habitat in Muscatatuck NWR
			State	Federal	Local	
Snakes	Black Kingsnake	<i>Lampropeltis getula nigra</i>		Secure	Very Common	All Habitats
Snakes	Midwest Worm Snake	<i>Carphophis amoenus helenae</i>	Apparently Secure	Secure	Probably Common	Hardwood Uplands
Snakes	Ring-necked snake	<i>Diadophis punctatus</i>	Not Ranked	Secure		
Snakes	Eastern Hog-nosed Snake	<i>Heterodon platirhinos</i>	Vulnerable	Secure		

Mammal Species That Occur on Muscatatuck NWR

Family	Common Name	Scientific Name	Source	Status	
				State	Federal
Pouched Mammals = <i>Marsupialia</i>	Opossum	<i>Didelphis marsupialis</i>	Recorded		
Insect Eaters = <i>Insectivora</i>	Masked Shrew	<i>Sorex cinereus</i>	Suspected		
Insect Eaters = <i>Insectivora</i>	Southeastern Shrew	<i>Sorex longirostris</i>	Suspected		
Insect Eaters = <i>Insectivora</i>	Least Shrew	<i>Cryptotis parva</i>	Recorded		
Insect Eaters = <i>Insectivora</i>	Shorttail Shrew	<i>Blarina brevicauda</i>	Recorded		
Insect Eaters = <i>Insectivora</i>	Eastern Mole	<i>Scalopus aquaticus</i>	Recorded		
Bats = <i>Chiroptera</i>	Little Brown Myotis	<i>Myotis lucifugus</i>	Recorded	SC	
Bats = <i>Chiroptera</i>	Northern Myotis	<i>Myotis septentrionalis</i>	Recorded	SC	
Bats = <i>Chiroptera</i>	Indiana Myotis	<i>Myotis sodalis</i>	Recorded	E	E
Bats = <i>Chiroptera</i>	Silver-Haired Bat	<i>Lasionycteris noctivagans</i>	Suspected	SC	
Bats = <i>Chiroptera</i>	Eastern Pipistrelle	<i>Pipistrellus subflavus</i>	Recorded	SC	
Bats = <i>Chiroptera</i>	Big Brown Bat	<i>Eptesicus fuscus</i>	Recorded		
Bats = <i>Chiroptera</i>	Red Bat	<i>Lasiurus borealis</i>	Recorded	SC	
Bats = <i>Chiroptera</i>	Hoary Bat	<i>Lasiurus cinereus</i>	Recorded	SC	
Bats = <i>Chiroptera</i>	Evening Bat	<i>Nycticeius humeralis</i>	Recorded	E	
Flesh-eaters = <i>Carnivora</i>	Raccoon	<i>Procyon lotor</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	Least Weasel	<i>Mustela rixosa</i>	Recorded	SC	
Flesh-eaters = <i>Carnivora</i>	Longtail Weasel	<i>Mustela frenata</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	Mink	<i>Mustela vison</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	River Otter	<i>Lutra canadensis</i>	Recorded	SC	
Flesh-eaters = <i>Carnivora</i>	Badger	<i>Taxidea taxus</i>	Suspected	SC	
Flesh-eaters = <i>Carnivora</i>	Striped Skunk	<i>Mephitis mephitis</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	Coyote	<i>Canis latrans</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	Red Fox	<i>Vulpes fulva</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	Gray Fox	<i>Urocyon cinereoargenteus</i>	Recorded		
Flesh-eaters = <i>Carnivora</i>	Bobcat	<i>Lynx rufus</i>	Recorded	SC	

Mammal Species That Occur on Muscatatuck NWR (Continued)

Family	Common Name	Scientific Name	Source	Status	
				State	Federal
Gnawing Mammals = <i>Rodentia</i>	Woodchuck	<i>Marmota monax</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Southern Flying Squirrel	<i>Glaucomys volans</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Eastern Chipmunk	<i>Tamias striatus</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Eastern Gray Squirrel	<i>Sciurus carolinensis</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Eastern Fox Squirrel	<i>Sciurus niger</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Beaver	<i>Castor canadensis</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Deer Mouse	<i>Peromyscus maniculatus</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	White-Footed Mouse	<i>Peromyscus leucopus</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Southern Bog Lemming	<i>Synaptomys cooperi</i>	Suspected		
Gnawing Mammals = <i>Rodentia</i>	Meadow Vole	<i>Microtus pennsylvanicus</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Prairie Vole	<i>Microtus ochrogaster</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Pine Vole	<i>Pitymys pinetorum</i>	Suspected		
Gnawing Mammals = <i>Rodentia</i>	Muskrat	<i>Ondatra zibethica</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	Norway Rat	<i>Rattus norvegicus</i>	Recorded		
Gnawing Mammals = <i>Rodentia</i>	House Mouse	<i>Mus musculus</i>	Recorded		
	Eastern Cottontail	<i>Sylvilagus floridanus</i>	Recorded		
Deer = <i>Cervidae</i>	Whitetail Deer	<i>Odocoileus virginianus</i>	Recorded		

Mussel Species Found on Muscatatuck NWR

Subfamily	Common Name	Scientific Name	Status (State)	Status (Federal)
	Asiatic Clam	<i>Corbicula fluminea</i>	SNA	NNA
Anodontinae	Cylindrical Papershell	<i>Anodontoides ferussacianus</i>	Vulnerable	Secure
Anodontinae	White Heelsplitter	<i>Lasmigona complanata</i>	Apparently Secure	Secure
Anodontinae	Giant Floater	<i>Pyganodon grandis</i>	Apparently Secure	Secure
Anodontinae	Flutedshell	<i>Lasmigona costata</i>	Apparently Secure	Secure
Anodontinae	Paper Pondshell	<i>Utterbackia imbecillis</i>	Apparently Secure	Secure
Unioninae	Threeridge	<i>Amblema plicata</i>	Apparently Secure	Secure
Unioninae	Spike	<i>Elliptio dialata</i>	Vulnerable	Secure
Unioninae	Wabash Pigtoe	<i>Fusconaia flava</i>	Apparently Secure	Secure
Unioninae	Elephantear	<i>Elliptio crassidens</i>	Apparently Secure	Secure
Unioninae	Washboard	<i>Megaloniaias nervosa</i>	Apparently Secure	Secure
Unioninae	Pimpleback	<i>Quadrula pustulosa</i>	Apparently Secure	Secure
Unioninae	Mapleleaf	<i>Quadrula quadrula</i>	Apparently Secure	Secure
Unioninae	Pistolgrip	<i>Tritogonia verrucosa</i>	Apparently Secure	Apparently Secure/ Secure
Unioninae	Pondhorn	<i>Uniomerus tetralasmus</i>	Possibly Extirpated	Secure
Lampsilinae	Plain Pocketbook	<i>Lampsilis cardium</i>	Apparently Secure	Secure
Lampsilinae	Fatmucket	<i>Lampsilis siliquoidea</i>	Apparently Secure	Secure
Lampsilinae	Deertoe	<i>Truncilla truncata</i>	Vulnerable	Secure
Lampsilinae	Yellow Sandshell	<i>Lampsilis teres</i>	Imperiled	Secure
Lampsilinae	Fragile Papershell	<i>Leptodea fragilis</i>	Apparently Secure	Secure

Mussel Species Found on Muscatatuck NWR

Subfamily	Common Name	Scientific Name	Status (State)	Status (Federal)
Lampsilinae	Pondmussel	<i>Ligumia subrostrata</i>	Critically Imperiled	Secure
Lampsilinae	Pink Heelsplitter	<i>Potamilus alatus</i>	Apparently Secure	Secure
Lampsilinae	Lilliput	<i>Toxolasma parvus</i>	Imperiled	Secure
Lampsilinae	Little Spectaclecase	<i>Villosa lienosa</i>	Imperiled	Secure

The Fishes of Muscatatuck NWR

Common Name	Scientific Name	Federal	State	Family	Exotic
bowfin	<i>Amia calva</i>	Secure	Apparently Secure	Amiidae	
pirate perch	<i>Aphredoderus sayanus</i>	Secure	Apparently Secure	Aphredoderidae	
brook silverside	<i>Labidesthes sicculus</i>	Secure	Apparently Secure	Atherinopsidae	
river carpsucker	<i>Carpiodes carpio</i>	Secure	Apparently Secure	Catostomidae	
quillback	<i>Carpiodes cyprinus</i>	Secure	Apparently Secure	Catostomidae	
highfin carpsucker***	<i>Carpiodes velifer</i>	Apparently Secure	Apparently Secure	Catostomidae	
white sucker	<i>Catostomus commersonii</i>	Secure	Apparently Secure	Catostomidae	
creek chubsucker	<i>Erimyzon oblongus</i>	Secure	Apparently Secure	Catostomidae	
northern hogsucker	<i>Hypentelium nigricans</i>	Secure	Apparently Secure	Catostomidae	
smallmouth buffalo	<i>Ictiobus bubalus</i>	Secure	Apparently Secure	Catostomidae	
bigmouth buffalo	<i>Ictiobus cyprinellus</i>	Secure	Apparently Secure	Catostomidae	
spotted sucker	<i>Minytrema melanops</i>	Secure	Apparently Secure	Catostomidae	
silver redhorse	<i>Moxostoma anisurum</i>	Secure	Apparently Secure	Catostomidae	
river redhorse***	<i>Moxostoma carinatum</i>	Apparently Secure	Vulnerable	Catostomidae	
black redhorse	<i>Moxostoma duquesnei</i>	Secure	Apparently Secure	Catostomidae	
golden redhorse	<i>Moxostoma erythrurum</i>	Secure	Apparently Secure	Catostomidae	
shorthead redhorse	<i>Moxostoma macrolepidotum</i>	Secure	Apparently Secure	Catostomidae	
rock bass	<i>Ambloplites rupestris</i>	Secure	Apparently Secure	Centrarchidae	
flier	<i>Centrarchus macropterus</i>	Secure	Apparently Secure	Centrarchidae	
green sunfish	<i>Lepomis cyanellus</i>	Secure	Apparently Secure	Centrarchidae	
pumpkinseed sunfish	<i>Lepomis gibbosus</i>	Secure	Apparently Secure	Centrarchidae	
warmouth	<i>Lepomis gulosus</i>	Secure	Apparently Secure	Centrarchidae	
bluegill	<i>Lepomis macrochirus</i>	Secure	Apparently Secure	Centrarchidae	
longear sunfish	<i>Lepomis megalotis</i>	Secure	Apparently Secure	Centrarchidae	
redear sunfish	<i>Lepomis microlophus</i>	Secure	Apparently Secure	Centrarchidae	
redspotted sunfish	<i>Lepomis miniatus</i>	Secure	Vulnerable	Centrarchidae	
smallmouth bass	<i>Micropterus dolomieu</i>	Secure	Apparently Secure	Centrarchidae	

The Fishes of Muscatatuck NWR (Continued)

Common Name	Scientific Name	Federal	State	Family	Exotic
spotted bass	<i>Micropterus punctulatus</i>	Secure	Apparently Secure	Centrarchidae	
largemouth bass	<i>Micropterus salmoides</i>	Secure	Apparently Secure	Centrarchidae	
white crappie	<i>Pomoxis annularis</i>	Secure	Apparently Secure	Centrarchidae	
black crappie	<i>Pomoxis nigromaculatus</i>	Secure	Apparently Secure	Centrarchidae	
gizzard shad	<i>Dorosoma cepedianum</i>	Secure	Apparently Secure	Clupeidae	
central stoneroller minnow	<i>Campostoma anomalum</i>	Secure	Apparently Secure	Cyprinidae	
goldfish***	<i>Carassius auratus</i>	Secure	Apparently Secure	Cyprinidae	Exotic
spotfin shiner	<i>Cyprinella spiloptera</i>	Secure	Apparently Secure	Cyprinidae	
steelcolor shiner	<i>Cyprinella whipplei</i>	Secure	Apparently Secure	Cyprinidae	
carp	<i>Cyprinus carpio</i>	SNA	SNA	Cyprinidae	Exotic
silverjaw minnow	<i>Ericymba buccata</i>	Secure	Apparently Secure	Cyprinidae	
streamline chub ^b	<i>Erimystax dissimilis</i>	Apparently Secure	Apparently Secure	Cyprinidae	
Mississippi silvery minnow	<i>Hybognathus nuchalis</i>	Secure	Apparently Secure	Cyprinidae	
bigeye chub	<i>Hybopsis amblops</i>	Secure	Imperiled	Cyprinidae	
common shiner ^b	<i>Luxilus cornutus</i>	Secure	Apparently Secure	Cyprinidae	
striped shiner	<i>Luxilus chrysocephalus</i>	Secure	Apparently Secure	Cyprinidae	
redfin shiner	<i>Lythrurus umbratilis</i>	Secure	Apparently Secure	Cyprinidae	
silver chub ^b	<i>Macrhybopsis storeriana</i>	Secure	Apparently Secure	Cyprinidae	
golden shiner	<i>Notemigonus crysoleucas</i>	Secure	Apparently Secure	Cyprinidae	
emerald shiner	<i>Notropis atherinoides</i>	Secure	Apparently Secure	Cyprinidae	
bigeye shiner	<i>Notropis boops</i>	Secure	Apparently Secure	Cyprinidae	
silver shiner	<i>Notropis photogenis</i>	Secure	Apparently Secure	Cyprinidae	
rosyface shiner***	<i>Notropis rubellus</i>	Secure	Apparently Secure	Cyprinidae	
sand shiner***	<i>Notropis stramineus</i>	Apparently Secure	Apparently Secure	Cyprinidae	
mimic shiner ^b	<i>Notropis volucellus</i>	Secure	Apparently Secure	Cyprinidae	
suckermouth minnow	<i>Phenacobius mirabilis</i>	Secure	Apparently Secure	Cyprinidae	
bluntnose minnow	<i>Pimephales notatus</i>	Secure	Apparently Secure	Cyprinidae	

The Fishes of Muscatatuck NWR (Continued)

Common Name	Scientific Name	Federal	State	Family	Exotic
fathead minnow***	<i>Pimephales promelas</i>	Secure	Apparently Secure	Cyprinidae	
bullhead minnow	<i>Pimephales vigilax</i>	Secure	Apparently Secure	Cyprinidae	
blacknose dace	<i>Rhinichthys atratulus</i>	Secure	Apparently Secure	Cyprinidae	
creek chub	<i>Semotilus atromaculatus</i>	Secure	Apparently Secure	Cyprinidae	
grass pickerel ^b	<i>Esox americanus vermiculatus</i>	Secure	?	Esocidae	
northern pike	<i>Esox lucius</i>	Secure	Apparently Secure	Esocidae	
muskellunge	<i>Esox masquinongy</i>	Secure	Apparently Secure	Esocidae	
northern studfish ^a	<i>Fundulus catenatus</i>	Secure	Imperiled	Fundulidae	
blackstripe topminnow	<i>Fundulus notatus</i>	Secure	Apparently Secure	Fundulidae	
black bullhead	<i>Ameiurus melas</i>	Secure	Apparently Secure	Ictaluridae	
yellow bullhead	<i>Ameiurus natalis</i>	Secure	Apparently Secure	Ictaluridae	
brown bullhead	<i>Ameiurus nebulosus</i>	Secure	Apparently Secure	Ictaluridae	
channel catfish	<i>Ictalurus punctatus</i>	Secure	Apparently Secure	Ictaluridae	
mountain madtom	<i>Noturus eleutherus</i>	Apparently Secure	Apparently Secure	Ictaluridae	
stonecat ^b	<i>Noturus flavus</i>	Secure	Apparently Secure	Ictaluridae	
tadpole madtom	<i>Noturus gyrinus</i>	Secure	Apparently Secure	Ictaluridae	
brindled madtom	<i>Noturus miurus</i>	Secure	Vulnerable	Ictaluridae	
flathead catfish	<i>Pylodictis olivaris</i>	Secure	Apparently Secure	Ictaluridae	
longnose gar	<i>Lepisosteus osseus</i>	Secure	Apparently Secure	Lepisosteidae	
shortnose gar***	<i>Lepisosteus platostomus</i>	Secure	Apparently Secure	Lepisosteidae	
eastern sand darter	<i>Ammocrypta pellucida</i>	Vulnerable	Vulnerable	Percidae	
mud darter	<i>Etheostoma asprigene</i>	Apparently Secure	Apparently Secure	Percidae	
greenside darter	<i>Etheostoma blennioides</i>	Secure	Apparently Secure	Percidae	
rainbow darter	<i>Etheostoma caeruleum</i>	Secure	Apparently Secure	Percidae	
fantail darter	<i>Etheostoma flabellare</i>	Secure	Apparently Secure	Percidae	
harlequin darter	<i>Etheostoma histrio</i>	Secure	Vulnerable	Percidae	
johnny darter	<i>Etheostoma nigrum</i>	Secure	Apparently Secure	Percidae	
orangethroat darter	<i>Etheostoma spectabile</i>	Secure	Apparently Secure	Percidae	
yellow perch	<i>Perca flavescens</i>	Secure	Apparently Secure	Percidae	

The Fishes of Muscatatuck NWR (Continued)

Common Name	Scientific Name	Federal	State	Family	Exotic
logperch	<i>Percina caprodes semifasciata</i>	Secure	Apparently Secure	Percidae	
blackside darter	<i>Percina maculata</i>	Secure	Apparently Secure	Percidae	
slenderhead darter	<i>Percina phoxocephala</i>	Secure	Apparently Secure	Percidae	
dusky darter	<i>Percina sciera</i>	Secure	Apparently Secure	Percidae	
chestnut lamprey	<i>Ichthyomyzon castaneus</i>	Apparently Secure	Apparently Secure	Petromyzontidae	
American brook lamprey	<i>Lampetra appendix</i>	Apparently Secure	Vulnerable	Petromyzontidae	
mosquitofish	<i>Gambusia affinis</i>	SNA	SNA	Poeciliidae	Exotic
freshwater drum	<i>Aplodinotus grunniens</i>	Secure	Apparently Secure	Sciaenidae	
central mudminnow	<i>Umbra limi</i>	Secure	Apparently Secure	Umbridae	
Total of 93 species					
^a Historic record believed to now be extirpated					
^b Historic record that may no longer persist in the system					
***Species suspected but not verified					

Appendix D: Regional Conservation Priority Species at Muscatatuck NWR

Regional Conservation Priority Species at Muscatatuck NWR

Species or Group	Scientific Name	Habitat	Concerns
Birds^a			
American Bittern	<i>(Botaurus lentiginosus)</i>	Palustrine, Grasslands	Uncommon/declining
Least Bittern	<i>(Ixobrychus exilis)</i>	Palustrine	Uncommon/declining
Black-crowned Night-Heron	<i>(Nycticorax nycticorax)</i>	Lacustrine, Palustrine, Riverine	Rare/declining
Double Crested Cormorant	<i>(Phalacrocorax auritus)</i>	Lacustrine, Riverine (large rivers, shorelines), Forests (islands)	“Nuisance” (management plan available)
Snow Goose	<i>(Chen caerulescens)</i>	Lacustrine, Palustrine	Recreational/economic value, “Nuisance” (management plan in preparation)
Canada Goose – Resident	<i>(Branta canadensis)</i>	Lacustrine, Palustrine	Recreation/nuisance
Canada Goose – Migrant Populations	<i>(Branta canadensis)</i>	Lacustrine, Palustrine	Recreation
Trumpeter Swan	<i>(Cygnus buccinator)</i>	Lacustrine, Palustrine, Riverine	Recreational/ economic value
Wood Duck	<i>(Aix sponsa)</i>	Palustrine, Riverine, Forests	Recreation
American Black Duck	<i>(Anas rubripes)</i>	Lacustrine, Palustrine (shrub/scrub)	Recreation/economic value
Mallard	<i>(Anas platyrhynchos)</i>	Palustrine, Forests	Recreation
Blue-winged Teal	<i>(Anas discors)</i>	Palustrine, Grasslands	Recreational/economic value
Northern Pintail	<i>(Anas acuta)</i>	Palustrine, Grasslands	Recreational/economic value. Declining
Canvasback	<i>(Aythya valisineria)</i>	Lacustrine, Palustrine, Riverine	Recreational/economic value
Lesser Scaup	<i>(Aythya affinis)</i>	Lacustrine, Palustrine, Riverine (large rivers, shorelines)	Recreational/economic value, Declining
Bald Eagle	<i>(Haliaeetus leucocephalus)</i>	Lacustrine, Riverine, Forests	Economic value
Northern Harrier	<i>(Circus cyaneus)</i>	Palustrine, Grasslands	Uncommon/declining
Yellow Rail	<i>(Coturnicops noveboracensis)</i>	Palustrine (wet meadow)	Uncommon/declining
King Rail	<i>(Rallus elegans)</i>	Palustrine	Rare/declining
Common Moorhen	<i>(Gallinula chloropus)</i>	Palustrine	Uncommon/declining
Whooping Crane – Eastern Population	<i>(Grus americana)</i>	Palustrine	Experimental population
Upland Sandpiper	<i>(Bartramia longicauda)</i>	Grasslands	Rare/declining

Regional Conservation Priority Species at Muscatatuck NWR (Continued)

Species or Group	Scientific Name	Habitat	Concerns
Stilt Sandpiper	<i>(Calidris himantopus)</i>	Lacustrine, Palustrine, Riverine	Uncommon/declining
Short-billed Dowitcher	<i>(Limnodromus griseus)</i>	Lacustrine, Palustrine, Riverine	Uncommon/declining
American Woodcock	<i>(Scolopax minor)</i>	Palustrine, Forests (early successional)	Recreation, economic value. Declining
Wilson's Phalarope	<i>(Phalaropus tricolor)</i>	Lacustrine, Palustrine	Uncommon/declining
Common Tern - Great Lakes Population	<i>(Sterna hirundo)</i>	Lacustrine	Uncommon/declining (status assessment under way)
Forster's Tern	<i>(Sterna forsteri)</i>	Lacustrine, Palustrine	Uncommon/declining
Least Tern - Interior Population	<i>(Sterna antillarum)</i>	Palustrine	Endangered
Black Tern	<i>(Chlidonias niger)</i>	Lacustrine, Palustrine	Uncommon/declining (status assessment completed and conservation needs identified)
Black-billed Cuckoo	<i>(Coccyzus erythrophthalmus)</i>	Forests, Shrublands	Uncommon/declining
Barn Owl	<i>(Tyto alba)</i>	Grasslands	Rare/declining
Long-eared Owl	<i>(Asio otus)</i>	Forests	Rare/declining (status unknown)
Short-eared Owl	<i>(Asio flammeus)</i>	Grasslands	Rare/declining
Chuck-will's-widow	<i>(Caprimulgus carolinensis)</i>	Forests	Rare/declining
Whip-poor-will	<i>(Caprimulgus vociferus)</i>	Forests	Uncommon/declining
Red-headed Woodpecker	<i>(Melanerpes erythrocephalus)</i>	Forests	Rare/declining
Northern Flicker	<i>(Colaptes auratus)</i>	Forests	Fairly common/declining
Olive-sided Flycatcher	<i>(Contopus cooperi)</i>	Forests (coniferous)	Uncommon/declining
Acadian Flycatcher	<i>(Empidonax virescens)</i>	Forests	Uncommon/declining
Loggerhead Shrike	<i>(Lanius ludovicianus)</i>	Grasslands, Shrublands	Rare/declining
Bell's Vireo	<i>(Vireo bellii)</i>	Palustrine, Shrublands	Uncommon/declining
Bewick's Wren	<i>(Thryomanes bewickii)</i>	Shrublands, Forests (early successional)	Rare/declining
Sedge Wren	<i>(Cistothorus platensis)</i>	Palustrine (wet meadows)	Uncommon/declining
Wood Thrush	<i>(Hylocichla mustelina)</i>	Forests	Uncommon/declining
Blue-winged Warbler	<i>(Vermivora pinus)</i>	Shrublands, Forests (early successional)	Uncommon/declining
Golden-winged Warbler	<i>(Vermivora chrysoptera)</i>	Shrublands, Forests (early successional)	Uncommon/declining

Regional Conservation Priority Species at Muscatatuck NWR (Continued)

Species or Group	Scientific Name	Habitat	Concerns
Prairie Warbler	<i>(Dendroica discolor)</i>	Shrublands, Forests (early successional)	Uncommon/declining
Cerulean Warbler	<i>(Dendroica cerulea)</i>	Forests	Uncommon/declining
Prothonotary Warbler	<i>(Protonotaria citrea)</i>	Forests (bottomland)	Fairly Common/declining
Worm-eating Warbler	<i>(Helmitheros vermivorus)</i>	Forests	Uncommon/declining
Louisiana Waterthrush	<i>(Seiurus motacilla)</i>	Riverine, Forests	Uncommon/declining
Kentucky Warbler	<i>(Oporornis formosus)</i>	Forests	Uncommon/declining
Canada Warbler	<i>(Wilsonia canadensis)</i>	Forests (mixed)	Uncommon/declining
Field Sparrow	<i>(Spizella pusilla)</i>	Grasslands, Shrublands	Fairly common/declining
Grasshopper Sparrow	<i>(Ammodramus savannarum)</i>	Grasslands	Uncommon/declining
Henslow's Sparrow	<i>(Ammodramus henslowii)</i>	Grasslands	Rare/declining?
Le Conte's Sparrow	<i>(Ammodramus leconteii)</i>	Palustrine (wet meadows), Grasslands	Uncommon/declining
Nelson's Sharp-tailed Sparrow	<i>(Ammodramus nelsoni)</i>	Palustrine (marshes)	Uncommon/declining
Dickeissel	<i>(Spiza americana)</i>	Palustrine	Fairly common/declining
Bobolink	<i>(Dolichonyx oryzivorus)</i>	Grasslands	Fairly common/declining
Eastern Meadowlark	<i>(Sturnella magna)</i>	Grasslands	Uncommon/declining
Rusty Blackbird	<i>(Euphagus carolinus)</i>	Forests	Uncommon/declining
Orchard Oriole	<i>(Icterus spurius)</i>	Forests (early successional), Palustrine	Fairly common/declining?
Mammals			
Indiana Bat	<i>(Myotis sodalist)</i>	Caves, Mines, Forests	Endangered
Reptiles			
Copperbelly water snake - Southern population	<i>(Nerodia erythrogaster neglecta)</i>	Palustrine (swamps), Forests (upland, bottomland)	Rare/declining
Fish			
Eastern sand darter	<i>(Ammocrypta pellucida)</i>	Riverine (streams, main channels)	Rare/declining
Mussels			
Threeridge	<i>(Amblema plicata)</i>	Riverine (mud/sand/gravel in small to large rivers and impoundments)	Recreational/economic value
Washboard	<i>(Megalonaias nervosa)</i>	Riverine (mud/sand/gravel in medium to large rivers)	Recreational/economic value

Regional Conservation Priority Species at Muscatatuck NWR (Continued)

Species or Group	Scientific Name	Habitat	Concerns
Pimpleback	<i>(Quadrula pustulosa pustulosa)</i>	Riverine (mud/sand/gravel in medium to large river)	Recreational/economic value (commercial)
Pistolgrip	<i>(Tritogonia verrucosa)</i>	Riverine (mud/sand/gravel in medium to large rivers)	Rare/declining (range overlaps commercial harvested areas)
Asiatic clam	<i>(Corbicula fluminea)</i>	Riverine	“Nuisance”
Plants			
N/A			

a. In December 2008 the RCPS bird list was updated from the original January 2002 version.

Appendix E: Compliance Requirements

Appendix E / Compliance Requirements

Rivers and Harbor Act (1899) (33 U.S.C. 403)

Section 10 of this Act requires the authorization by the U.S. Army Corps of Engineers prior to any work in, on, over, or under a navigable water of the United States.

Antiquities Act of 1906. 16 U.S.C. 431 et seq.

Authorizes the scientific investigation of antiquities on Federal land and provides penalties for unauthorized removal of objects taken or collected without a permit.

Migratory Bird Treaty Act, 16 U.S.C. 703 et seq.

Designates the protection of migratory birds as a Federal responsibility. This Act enables the setting of seasons, and other regulations including the closing of areas, Federal or non Federal, to the hunting of migratory birds.

Migratory Bird Conservation Act, 16 U.S.C. 715 et seq.

Establishes procedures for acquisition by purchase, rental, or gift of areas approved by the Migratory Bird Conservation Commission.

Fish and Wildlife Coordination Act 16 U.S.C. 661 et seq. (1934)

Requires that the Fish and Wildlife Service and State fish and wildlife agencies be consulted whenever water is to be impounded, diverted or modified under a Federal permit or license. The Service and State agency recommend measures to prevent the loss of biological resources, or to mitigate or compensate for the damage. The project proponent must take biological resource values into account and adopt justifiable protection measures to obtain maximum overall project benefits. A 1958 amendment added provisions to recognize the vital contribution of wildlife resources to the Nation and to require equal consideration and coordination of wildlife conservation with other water resources development programs. It also authorized the Secretary of Interior to provide public fishing areas and accept donations of lands and funds.

Migratory Bird Hunting Stamp Act. Also known as the Duck Stamp Act, 16 U.S.C. 718 et seq. (1934)

Requires every waterfowl hunter 16 years of age or older to carry a stamp and earmarks proceeds of the Duck Stamps to buy or lease waterfowl habitat. A 1958 amendment authorizes the acquisition of small wetland and pothole areas to be designated as 'Waterfowl Production Areas,' which may be acquired without the limitations and requirements of the Migratory Bird Conservation Act.

Historic Sites, Buildings and Antiquities Act. Also known as the Historic Sites Act of 1935, 16 U.S.C. 461 et seq.

Declares it a national policy to preserve historic sites and objects of national significance, including those located on refuges. Provides procedures for designation, acquisition, administration, and protection of such sites.

Refuge Revenue Sharing Act, 16 U.S.C. 715s (1935)

Requires revenue sharing provisions to all fee-title ownerships that are administered solely or primarily by the Secretary through the Service.

Transfer of Certain Real Property for Wildlife Conservation Purposes Act, 16 U.S.C. 667b-667d (1948)

Provides that upon a determination by the Administrator of the General Services Administration, real property no longer needed by a Federal agency can be transferred without reimbursement to the Secretary of Interior if the land has particular value for migratory birds, or to a State agency for other wildlife conservation purposes.

Federal Records Act of 1950, 44 U.S.C. 31

Directs the preservation of evidence of the government's organization, functions, policies, decisions, operations, and activities, as well as basic historical and other information.

Fish and Wildlife Act of 1956, 16 U.S.C. 742a et seq.

Established a comprehensive national fish and wildlife policy and broadened the authority for acquisition and development of refuges.

Refuge Recreation Act, 16 U.S.C. 460k et seq. (1962)

Allows the use of refuges for recreation when such uses are compatible with the refuge's primary purposes and when sufficient funds are available to manage the uses.

Wilderness Act of 1964, 16 U.S.C. 1131 et seq.

Directed the Secretary of Interior, within 10 years, to review every roadless area of 5,000 or more acres and every roadless island (regardless of size) within National Wildlife Refuge and National Park Systems and to recommend to the President the suitability of each such area or island for inclusion in the National Wilderness Preservation System, with final decisions made by Congress. The Secretary of Agriculture was directed to study and recommend suitable areas in the National Forest System.

Land and Water Conservation Fund Act of 1965, 16 U.S.C. 460 et seq.

Uses the receipts from the sale of surplus Federal land, outer continental shelf oil and gas sales, and other sources for land acquisition under several authorities.

National Wildlife Refuge System Administration Act of 1966, 16 U.S.C. 668dd, 668ee

Defines the National Wildlife Refuge System and authorizes the Secretary to permit any use of a refuge provided such use is compatible with the major purposes for which the refuge was established. The Refuge Improvement Act clearly defines a unifying mission for the Refuge System; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation and photography, or environmental education and interpretation); establishes a formal process for determining compatibility; established the responsibilities of the Secretary of Interior for managing and protecting the System; and requires a Comprehensive Conservation Plan for each refuge by the year 2012. This Act amended portions of the Refuge Recreation Act and National Wildlife Refuge System Administration Act of 1966.

National Historic Preservation Act, 16 U.S.C. 470 et seq. (1966)

Establishes as policy that the Federal Government is to provide leadership in the preservation of the nation's prehistoric and historic resources. Section 106 requires Federal agencies to consider impacts their undertakings could have on historic properties; Section 110 requires Federal agencies to manage historic properties, e.g., to document historic properties prior to destruction or damage; Section 101 requires Federal agencies to consider Indian tribal values in historic preservation programs, and requires each Federal agency to establish a program leading to inventory of all historic properties on its land.

Architectural Barriers Act of 1968, 42 U.S.C. 4151 et seq.

Requires federally owned, leased, or funded buildings and facilities to be accessible to persons with disabilities.

National Environmental Policy Act of 1969, 42 U.S.C. 4321 et seq.

Requires the disclosure of the environmental impacts of any major Federal action significantly affecting the quality of the human environment.

Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, 42 U.S.C. 4601 et seq.

Provides for uniform and equitable treatment of persons who sell their homes, businesses, or farms to the Service. The Act requires that any purchase offer be no less than the fair market value of the property.

Endangered Species Act of 1973, 16 U.S.C. 1531 et seq.

Requires all Federal agencies to carry out programs for the conservation of endangered and threatened species.

Rehabilitation Act of 1973, 29 U.S.C. 701 et seq.

Requires programmatic accessibility in addition to physical accessibility for all facilities and programs funded by the Federal government to ensure that anybody can participate in any program.

Archaeological and Historic Preservation Act 16 U.S.C.469-469c

Directs the preservation of historic and archaeological data in Federal construction projects.

Clean Water Act of 1977, 33 U.S.C. 1251

Requires consultation with the Corps of Engineers (404 permits) for major wetland modifications.

Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1201 et seq.

Regulates surface mining activities and reclamation of coal-mined lands. Further regulates the coal industry by designating certain areas as unsuitable for coal mining operations.

Executive Order 11988 (1977)

Each Federal agency shall provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by the floodplains.

Executive Order 11990

Executive Order 11990 directs Federal agencies to (1) minimize destruction, loss, or degradation of wetlands and (2) preserve and enhance the natural and beneficial values of wetlands when a practical alternative exists.

Executive Order 12372 (Intergovernmental Review of Federal Programs)

Directs the Service to send copies of the Environmental Assessment to State Planning Agencies for review.

American Indian Religious Freedom Act, 42 U.S.C. 1996, 1996a (1976)

Directs agencies to consult with native traditional religious leaders to determine appropriate policy changes necessary to protect and preserve American Indian religious cultural rights and practices.

Fish and Wildlife Improvement Act of 1978, 16 U.S.C. 742a

Improves the administration of fish and wildlife programs and amends several earlier laws including the Refuge Recreation Act, the National

Wildlife Refuge System Administration Act, and the Fish and Wildlife Act of 1956. It authorizes the Secretary to accept gifts and bequests of real and personal property on behalf of the United States. It also authorizes the use of volunteers on Service projects and appropriations to carry out a volunteer program.

Archaeological Resources Protection Act of 1979, 16 U.S.C. 470aa et seq.

Protects materials of archaeological interest from unauthorized removal or destruction and requires Federal managers to develop plans and schedules to locate archaeological resources.

Farmland Protection Policy Act, Public Law 97-98, 7 U.S.C. 4201 (1981)

Minimizes the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses.

Emergency Wetlands Resources Act of 1986, 16 U.S.C. 3901 et seq.

Promotes the conservation of migratory waterfowl and offsets or prevents the serious loss of wetlands by the acquisition of wetlands and other essential habitats.

Federal Noxious Weed Act of 1974, 7 U.S.C. 2801 et seq.

Requires the use of integrated management systems to control or contain undesirable plant species, and an interdisciplinary approach with the cooperation of other Federal and State agencies.

Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001 et seq. (1990)

Requires Federal agencies and museums to inventory, determine ownership of, and repatriate cultural items under their control or possession.

Americans with Disabilities Act of 1990, 42 U.S.C. 12101 et seq.

Prohibits discrimination in public accommodations and services.

Executive Order 12898 (1994)

Establishes environmental justice as a Federal government priority and directs all Federal agencies to make environmental justice part of their mission. Environmental justice calls for fair distribution of environmental hazards.

Executive Order 12996 Management and General Public Use of the National Wildlife Refuge System (1996)

Defines the mission, purpose, and priority public uses of the National Wildlife Refuge System. It also presents four principles to guide management of the System.

Executive Order 13007 Indian Sacred Sites (1996)

Directs Federal land management agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, avoid adversely affecting the physical integrity of such sacred sites, and where appropriate, maintain the confidentiality of sacred sites.

National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd

Considered the “Organic Act of the National Wildlife Refuge System. Defines the mission of the System, designates priority wildlife-dependent public uses, and calls for comprehensive refuge planning. Section 6 requires the Service to make a determination of compatibility of existing, new and changing uses of Refuge land; and Section 7 requires the Service to identify and describe the archaeological and cultural values of the refuge.

National Wildlife Refuge System Volunteer and Community Partnership Enhancement Act of 1998, 16 U.S.C. 742a Amends the Fish and Wildlife Act of 1956 to promote volunteer programs and community partnerships for the benefit of national wildlife refuges, and for other purposes.

National Trails System Act, 16 U.S.C. 1241 et seq. (1968)

Assigns responsibility to the Secretary of Interior and thus the Service to protect the historic and recreational values of congressionally designated National Historic Trail sites.

Treasury and General Government Appropriations Act, Pub. L. 106-554, §1(a)(3), Dec. 21, 2000, 114 Stat. 2763, 2763A–125

In December 2002, Congress required federal agencies to publish their own guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information that they disseminate to the public (44 U.S.C. 3502). The amended language is included in Section 515(a). The Office of Budget and Management (OMB) directed agencies to develop their own guidelines to address the requirements of the law. The Department of the Interior instructed bureaus to prepare separate guidelines on how they would apply the Act. The U.S. Fish and Wildlife Service has developed “Information Quality Guidelines” to address the law.

Cultural Resources and Historic Preservation

The National Wildlife Refuge System Improvement Act of 1997, Section 6, requires the Service to make a determination of compatibility of existing, new and changing uses of Refuge land; and Section 7 requires the Service to identify and describe the archaeological and cultural values of the refuge.

The National Historic Preservation Act (NHPA), Section 106, requires Federal agencies to consider impacts their undertakings could have on historic properties; Section 110 requires Federal agencies to manage historic properties, e.g., to document historic properties prior to destruction or damage; Section 101 requires Federal agencies consider Indian tribal values in historic preservation programs, and requires each Federal agency to establish a program leading to inventory of all historic properties on its land.

The Archaeological Resources Protection Act of 1979 (ARPA) prohibits unauthorized disturbance of archeological resources on Federal and Indian land; and other matters. Section 10 requires establishing “a program to increase public awareness” of archeological resources. Section 14 requires plans to survey lands and a schedule for surveying lands with “the most scientifically valuable archeological resources.” This Act requires protection of all archeological sites more than 100 years old (not just sites meeting the criteria for the National Register) on Federal land, and

requires archeological investigations on Federal land be performed in the public interest by qualified persons.

The Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) imposes serious delays on a project when human remains or other cultural items are encountered in the absence of a plan.

The American Indian Religious Freedom Act (AIRFA) iterates the right of Native Americans to free exercise of traditional religions and use of sacred places.

EO 13007, Indian Sacred Sites (1996), directs Federal agencies to accommodate access to and ceremonial use, to avoid adverse effects and avoid blocking access, and to enter into early consultation.

Restle Unit Deed Restrictions

The property shall be known and posted as the Restle Wildlife Management Area.

Grantee shall perpetually manage the real estate as a wetland habitat for native wildlife and plant enhancement and protection.

In order to further wetland habitat development, the construction of dams, levees, spillways and associated water level and flow control devices shall be permitted, as well as plantings appropriate to their maintenance. Water level manipulation for wetland management purposes shall be permitted, even though some native plants and animals may be damaged by such management.

Control of woody vegetation is permitted.

No timbering, burning, hunting, trapping, or fishing shall be permitted, except that plant harvesting or controlled burning for the protection of the wetland or research into the protection of wetlands are permitted. Wildlife harvesting within the levee constructed by the Fish and Wildlife Service in 1990 is also permitted for the protection of the wetland within the levee. The permitted activities specified in this paragraph are to be conducted only by personnel of the grantee or their designees for that specific purpose.

No herbicides or insecticides shall be used on the real estate, except that if the native plant or animal habitat is threatened by the excessive growth of native species or the invasion or excessive growth of species alien to the area, herbicides or insecticides may be used for the limited purposes of controlling such populations.

No construction of buildings shall be permitted except for observation blinds and wildlife study structures, nesting boxes, and other animal habitat improvement structures.

No general access of the public to the area shall be permitted. Barbara Restle, her children and their spouses, and her grandchildren will continue to have access to the property for wildlife observation purposes. Access to persons other than grantee's agents, officers, and employees shall be permitted by the grantee on y on written application for educational, research, or habitat development purposes deemed consistent with the goals of this grant.

No commercial sale of any resources from the property shall be permitted.

The Sassafras Chapter of the National Audubon Society shall be allowed to review management of the property on an annual basis. To this end, a representative of the Sassafras Audubon Society, as designated by the Sassafras Audubon Society Board of Directors must be allowed to enter the property at least once very three months. Prior to entering the project the Sassafras Audubon Society representative will notify the Fish and Wildlife Service at least one week in advance of the date of the inspection of the property.

Appendix F: Compatibility Determinations

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COMPATIBILITY DETERMINATION

Use: Farming and Haying

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? Farming and Haying. Farming and haying are not priority public uses of the National Wildlife Refuge System.

Where is the use conducted? Farming and haying occurs on existing farm fields confined to the west side of the Refuge. Farming acres comprise less than 5% of total Refuge acreage.

When is the use conducted? Farming occurs in accordance with farming schedules and practices identified in the Station's Cropland Management Plan. Cropping takes place during the growing season, and associated field work takes place in the spring and fall. Haying is restricted until after July 15.

How is the use conducted? Management of all farming activities is conducted by cooperative farmers. All cooperators' requirements are documented in cooperative agreements based on the Station's Cropland and Grassland Management Plans. Haying on Refuge properties will be conducted on an as needed basis in accordance with the Grassland Management Plan. Herbicide use will be approved by the Refuge Manager only as a last resort, and specific herbicides will be approved by the Regional IPM coordinator.

Why is the use proposed? The Refuge uses farming as a low cost means to maintain open habitat and add diversity to a mostly forested refuge. Canada geese, waterfowl, sandhill cranes, wintering raptors and resident species forage on the Refuge share of the crop. The fields also create good wildlife viewing along Refuge roads and the auto tour route.

Availability of Resources:

Current staffing levels/funding are available to manage this activity. This-use will not require significant increase in staff maintenance or expenditures. The Service will not have to provide special equipment.

Anticipated Impacts of the Use:

Refuge croplands attract migratory waterfowl, help control noxious weeds, reduce depredation to neighboring farmlands and provide a high energy food source for migratory birds during extreme weather conditions. Re-sprouting grain, cover crops and Refuge haylands provide green browse and invertebrate sources for a variety of species requiring habitat in this early successional stage. While Refuge farming may have positive impacts to some wildlife species (Wintering waterfowl, cranes, some raptor species, and resident wildlife), resulting forest fragmentation may have negative impacts to declining species of forest-dependent migratory birds. Continued monitoring of these wildlife populations will help further define anticipated impacts of continuing this management practice. Using approved herbicides only as a last resort will minimize potential impacts to surface and groundwater resources.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public notification and review includes a notice of availability published in the Federal Register, 30-day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility with the purposes of the Refuge and the mission of the National Wildlife Refuge System, farming and haying can only occur with the following stipulations:

- Cooperative fanning practices and crop rotations will take place in accordance with the Station's approved cropland management plan. These shall be clearly identified in signed cooperative agreements, and be closely monitored by the Refuge Manager.
- Annual review of all farming and haying operations will take place to ensure compliance with all laws, regulations and policies.
- No herbicide use will take place without the prior approval of the Refuge Manager/Regional IPM coordinator.
- Haying will not take place on Refuge haylands prior to Sept. 1 to avoid impacts to ground nesting birds.
- Minimum tillage-techniques will be required to avoid impacts to water, soil, and any potential archeological resources.
- Only existing farm fields on the west side of the Refuge will be farmed, previously abandoned or disturbed sites will not be farmed.

Justification:

Cooperative farming and haying will result in annual, short-term disturbances, but there will be long-term benefits to resident and migratory

wildlife and increased appreciation of wildlife. Croplands provide a winter food resource for migrating waterfowl and reduce to some degree depredation impacts to surrounding farmlands. This also facilitates wildlife observation, one of the priority public uses, and will encourage increased appreciation of wildlife.

Signature:

Refuge Manager _____
(Signature and Date)

Concurrence:

Regional Chief _____
(Signature and Date)

Mandatory 10- or 15-year Re-Evaluation Date:

COMPATIBILITY DETERMINATION

Use: Wild Food/Shed Antler Collecting

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? Wild food and shed antler collecting Wild food and shed antler collecting are not priority public uses of the National Wildlife Refuge System.

Where is the use conducted? Wild food and shed antler collecting will occur on approximately 90 percent of the nearly 8,000 acre Refuge. Collecting will not be allowed on the remaining 10 percent which includes the waterfowl sanctuary area in the southwest portion of the Refuge that is closed to the public.

When is the use conducted? In accordance with Refuge hours, 1 hour before sunrise to 1 hour after sunset, year-round.

How is the use conducted? Hand collection of natural food items including mushrooms, fruits and nuts, but not living roots or green plant material for personal consumption only will be allowed. No digging of root materials such as ginseng, yellow root, or blood root will be allowed.

Why is the use being proposed? This use has historically been allowed on the Refuge and has become a custom of the local community. The Refuge is open to the public during the time periods that the use is allowed so no additional disturbance is created by allowing this use. Gathering allows the public to build a connection to the Refuge through personal outdoor experiences that engage the senses and foster an appreciation of the outdoors. The Refuge along with the nearby Hoosier National Forest, state fish and wildlife areas, and state forest are public lands located in the area that provide the public this type of use. Otherwise opportunities exist on private lands where access is limited for the public.

Availability of Resources:

Existing funding levels are adequate to manage this activity. Public use facilities will be routinely maintained to meet the needs of the visiting public and will be used incidentally by that portion of the public involved in this activity. This use will not require significant increase in staff maintenance or expenditures. The Service will not have to provide special equipment.

Anticipated Impacts of the Use:

Historically, public participation in the collection of wild foods and shed antlers has been low to moderate and is expected to remain so in the future. The amount and frequency of hand collecting of wild foods and shed antlers is not expected to result in significant wildlife disturbance, nor diminish wildlife food sources, or jeopardize wildlife survival. Short-term disturbance to wildlife may occur during these activities, but will be insignificant.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public

notification and review includes a notice of availability published in the Federal Register, 30-day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility with the purposes of the Refuge and the mission of the National Wildlife Refuge System, wild food and shed antler collecting can only occur with the following stipulations:

- Collection can occur only within the specified area of the Refuge.
- Items collected are for personal use and cannot be sold.
- Digging of roots, and collection of living green plant material or food plant material is prohibited.
- Tapping or damaging trees is prohibited.
- No threatened or endangered species, or parts thereof may be harvested.
- Annually review all collection activities and operations to ensure compliance with all laws, regulations and policies.
- Use of motorized vehicles and bicycles is limited to public vehicle roads and parking areas.
- Overnight use and fires are prohibited.

Justification:

This use has been determined compatible as it will not materially interfere with or detract from Refuge purposes, provided the above stipulations are implemented. This use will not diminish the primary purposes of the refuge for migratory birds: This use will meet the mission of the National Wildlife Refuge System by providing renewable resources for the benefit of the American public while conserving fish, wildlife and plant resources on these lands.

Signature:

Refuge Manager _____
(Signature and Date)

Concurrence:

Regional Chief _____
(Signature and Date)

Mandatory 10- or 15-year Re-Evaluation Date:

COMPATIBILITY DETERMINATION

Use: Hunting

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? Hunting of rabbit, squirrel, quail, deer and turkey. The use is a priority public use.

Where is the use conducted? Deer and turkey hunting will occur on approximately 75 percent of the Refuge. Rabbit, quail and squirrel hunting will occur on approximately 20 percent of the Refuge located in the southeastern portion of the Refuge.

When is the use conducted? Deer hunting will occur during the State archery seasons. (Hunting during the early archery will commence no sooner than the first Saturday following National Wildlife Refuge Week and late archery season will commence the day following the State muzzleloader season.) A special muzzleloader permit hunt will

occur during the State muzzleloader season. Turkey hunting will occur during the State spring season. All hunting will occur within state-regulated hunting hours.

How is the use conducted? State regulations will apply, except where Refuge regulations are more restrictive. A special permit will be issued to each hunter selected in a random drawing conducted by the State for the special muzzleloader deer hunt and the spring turkey hunt. Authorized weapons will include conventional shotgun, muzzleloader and bow and arrow for turkey. Authorized weapons for deer are bow, muzzleloader during the permit hunt and crossbow as approved for handicapped hunters. Only shotguns with non-toxic shot shells will be allowed for squirrel, rabbit and quail hunting. No check-in or check-out of deer hunters will be required, however successful deer hunters are requested to fill out a harvest card when leaving the Refuge. Successful turkey hunters are required to check-out at the Refuge headquarters. No check-in, or out or reporting of harvest is required for squirrel, rabbit, or quail.

Why is the use being proposed? Hunting is a priority general public use of the Refuge System that is also an important wildlife management tool. The Service recognizes hunting as a healthy, traditional outdoor pastime, deeply rooted in the American heritage (USFWS 2006). Hunting can instill a unique understanding and appreciation of wildlife, their behavior, and their habitat needs. Hunting programs can promote understanding and appreciation of natural resources and their management on lands and waters in the Refuge System. Public hunting opportunities are also available near the Refuge at Big Oaks National Wildlife Refuge, Hoosier National Forest, Atterbury and Crosley Fish and Wildlife Areas, the Jackson-Washington and Selmer State Forests, Brush Creek and Hardy Lake Reservoirs, Starve Hollow Recreation Area, and Brown County State Park (deer only).

Availability of Resources:

Existing funding levels are adequate to manage this activity. This use will require some increase in staff time and expenditures for sign maintenance and law enforcement. The Service will not have to provide special equipment.

Anticipated Impacts of the Use:

There will be no adverse impacts to threatened and endangered species resulting from this program. Hunting causes mortality and temporary disturbance to wildlife; however, harvesting wildlife populations to the carrying capacity of their habitats ensures the continued health and survival of Refuge wildlife populations. Disturbance to waterfowl will be minimal. Conflict with other public uses on the Refuge will be minimal. The Visitor Center, Office and most hiking trails are in an area closed to hunting. This tends to separate hunting activities from most other public uses.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public notification and review includes a notice of availability published in the Federal Register, 30-day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility with the purposes of the Refuge and the mission of the National Wildlife Refuge System, hunting only occurs with the following stipulations:

- State hunting regulations apply, except when Refuge regulations are more restrictive; for example permits are required for deer hunting during the muzzleloader season and for turkey hunting.
- All shot used for rabbit, quail and squirrel hunting shall be non-toxic.

- Hunting is allowed only within specified areas of the Refuge.
- Dog running on the Refuge is limited to the use of them during rabbit and quail hunting; however, they must be under the control of the handler.
- Use of motorized vehicles and bicycles is limited to public vehicle roads and parking areas.
- Overnight use and fires are prohibited.
- The Refuge Manager shall annually review all hunting activities and operations to ensure compliance with all laws, regulations and policies.

Justification:

Hunting is priority public use of the NWRS and a vital management tool to protect Refuge habitat. This use will meet the mission of the NWRS by providing renewable resources for the benefit of the American public while conserving fish, wildlife and plant resources on these lands.

Signature:

Refuge Manager _____
(Signature and Date)

Concurrence:

Regional Chief _____
(Signature and Date)

Mandatory 10- or 15-year Re-Evaluation Date:

U. S. Fish and Wildlife Service, 2006. Wildlife-Dependent Recreation: Hunting. 605 FW 2. National Wildlife Refuge System, Department of Interior.

COMPATIBILITY DETERMINATION

Use: Interpretation and Environmental Education

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? Interpretation and environmental education. These uses are a priority public uses. Formal programs include activities prepared, scheduled, and organized for school-aged children and organized groups by U.S. Fish and Wildlife Service Staff and Volunteers. Informal programs include self-guided auto tour routes and nature trails, impromptu presentations and discussions of wildlife conservation issues the NWRs With interested citizens, casual visitors and unscheduled groups. This use also includes the development and maintenance of indoor interpretive areas/exhibits within the Refuge Visitor Center and Conservation Learning Center. Educational programs also include activities

conducted during International Migratory Bird Day weekend, National Fishing Week, National Public Lands Day, and National Wildlife Refuge Week.

Where is the use conducted? Refuge Visitor Center, Conservation Learning Center and all areas of the Refuge, except those closed to public use, unless permitted by special use permit.

When is the use conducted? In accordance with Refuge hours, 1 hour before sunrise to 1 hour after sunset, year-round.

How is the use conducted? Formally and informally for individuals and groups in conjunction with staff and volunteers.

Why is the use conducted? Interpretation and environmental education are priority general public uses of the National Wildlife Refuge System. The programs promote understanding and appreciation of natural and cultural resources and their management on all lands and waters of the Refuge System. Interpretation and environmental education opportunities are also available nearby at the Hoosier National Forest, Starve Hollow Recreation Area, and the Clifty Falls and Brown County State Parks.

Availability of Resources:

Current staffing and funding levels are adequate to conduct existing activities. A limited number of programs are provided to visiting groups by Refuge personnel and volunteers.

Anticipated Impacts of the Use:

The overall impacts to the Refuge and its associated wildlife populations from this use will be minimal. There will be some disturbance to wildlife and vegetation, but at levels that will not likely materially interfere with or detract from Refuge purposes. School buses and personal vehicles will utilize developed roads and parking areas to access trails which are already in place. Large events may sometimes create temporary traffic problems which will be managed by Refuge staff.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public notification and review includes a notice of availability published in the Federal Register, 30-day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility with the purposes of the Refuge and the mission of the National Wildlife Refuge System, interpretation and environmental education can occur with the following stipulations:

- The Refuge is open to public access year-round, 1 hour before sunrise to 1 hour after sunset.
- Any exception to normal Refuge regulations concerning special events must be approved by Refuge manager, and may require issuance of a special use permit.

Justification:

This use has been determined to be compatible provided the above stipulations are implemented. The level of these uses is moderate and generally concentrated in the developed public-use areas (roads, parking lots visitor center/conservation learning center and trails). The associated disturbance to wildlife is temporary and minor. Interpretation and environmental education are priority public uses and helps fulfill the mission of the Refuge.

Signature:

Refuge Manager _____
(Signature and Date)

Concurrence:

Regional Chief _____
(Signature and Date)

Mandatory 10- or 15-year Re-Evaluation Date:

COMPATIBILITY DETERMINATION

Use: Wildlife Observation and Photography (including the means of access such as automobile, hiking, biking, jogging/running, canoeing, boating, and the incidental use of picnicking).

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose "...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds" derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? Wildlife Observation and Photography.

Where is the use conducted? Wildlife observation and photography are allowed year-round, except in closed areas of the Refuge.

When is the use conducted? In accordance with Refuge hours, 1 hour before sunrise to 1 hour after sunset, year-round.

How is the use conducted? Allowable forms of access for these uses include automobile, hiking, biking, jogging and running, canoeing, and boating.

Canoeing and boating are allowed year-round, but are limited to Stanfield Lake and Richart Lake as facilities permit. The only motorized watercraft permitted on the Refuge are boats powered by electric motors on Stanfield Lake. Picnicking occurs as an incidental use to wildlife observation and photography and picnic sites are available for visitors at the Refuge Visitor Center.

Why is the use being proposed? Wildlife observation and photography are priority general public uses of the Refuge System. Wildlife observation and photography programs can promote understanding and appreciation of natural resources and their management on lands and waters in the Refuge System. There are also opportunities to observe and photograph wildlife nearby at Big Oaks National Wildlife Refuge, Hoosier National Forest, Atterbury and Crosley Fish and Wildlife Areas, the Jackson-Washington and Selmer State Forests, Brush Creek and Hardy Lake Reservoirs, Starve Hollow Recreation Area, Brown County and Clifty Falls State Parks, and Muscatatuck County Park.

Availability of Resources:

Existing funding levels are adequate to manage this activity at present levels. The Refuge has developed parking areas, a wildlife auto tour route, boat ramp, observation deck, overlook structure, hiking trails, boardwalk, roads, and picnic tables that are used for wildlife observation/photography; however, maintenance of these facilities will require staff resources. The Refuge will maintain these facilities with the existing staff. Vehicle parking/boat launching facilities are needed at Richart Lake to support this activity.

Anticipated Impacts of the Use:

Wildlife observation and photography as proposed will not materially interfere with, or detract from Refuge purposes. Access is typically by individuals or small groups and the impact to the land and water is minimal. Most hikers, joggers, and runners stay on hiking trails or roads and the damage to the habitat is minimal and temporary. Automobiles and bicycles are confined to public vehicle roads. There is some temporary disturbance

to wildlife due to human activity on the land, but that is inherent in these activities and is generally not malicious or damaging. Any unreasonable harassment of wildlife would be grounds for the manager to close the area to these uses or restrict the uses to minimize harm.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public notification and review includes a notice of availability published in the Federal Register, 30-day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility with the purposes of the Refuge and the mission of the National Wildlife Refuge System, wildlife observation and photography can only occur with the following stipulations:

- Motorized vehicles and bicycles will be limited to public vehicle roads, and parking lots.
- Overnight use and fires are prohibited.
- Non-motorized boating is restricted to Stanfield Lake.
- No photo or viewing blinds may be left overnight.
- The activity can only take place during the Refuge's regular hours of 1 hour before sunrise to 1 hour after sunset.

Justification:

This use has been determined compatible because wildlife viewing and photography will not materially interfere with or detract from Refuge purposes. The associated disturbance to wildlife is temporary and minor. Wildlife observation and photography are priority public uses with the National Wildlife Refuge System and provide visitors with opportunities to enjoy and learn about our lands and wildlife.

Signature:

Refuge Manager _____
(Signature and Date)

Concurrence:

Regional Chief _____
(Signature and Date)

Mandatory 10- or 15-year Re-Evaluation Date:

COMPATIBILITY DETERMINATION

Use: Recreational Fishing

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? Recreational Fishing. The use is a priority public use.

Where is the use conducted? Richart Lake. Stanfield Lake, Sand Hill Ponds, Persimmon Ponds. Lake Linda, Lake Sheryl, and the Muscatatuck River are open to bank fishing and wading year-round. All fishing is in accordance with State regulations. Boating is restricted to Stanfield Lake. The only motorized watercraft permitted on the Refuge are boats powered by electric motors on Stanfield Lake. A Refuge-sponsored “Take A Kid Fishing Day” will be offered once a year. Office Pond will be available for use this day, and only to children participating in the event.

When is the use conducted? In accordance with State regulations and Refuge hours of 1 hour before sunrise to 1 hour after sunset year-round.

How is the use conducted? In accordance with State regulations for fishing and boating, except the taking of frogs and turtles is prohibited.

Why is the use being proposed? Fishing is a priority general public use of the Refuge System. The Service recognizes fishing as a traditional outdoor pastime, deeply rooted in the American heritage (USFWS 2006). Fishing programs promote understanding and appreciation of natural resources and their management on all lands and waters in the Refuge System. Public fishing opportunities are also available nearby at Big Oaks National Wildlife Refuge, Hoosier National Forest, Atterbury and Crosley Fish and Wildlife Areas, the Jackson-Washington and Selmer State Forests, Brush Creek and Hardy Lake Reservoirs, Starve Hollow Recreation Area, Brown County and Clifty Falls State Parks, Muscatatuck County Park, Cypress Lake, and the Muscatatuck and White Rivers.

Availability of Resources:

Existing funding levels should be adequate to manage this activity.

Anticipated Impacts of the Use:

There is an abundant fisheries resource on the Refuge which is considered sufficient for both wildlife consumption and public recreational fishing. No significant wildlife disturbance will occur with this activity. Fishing areas are monitored for litter/water pollution and violation of fishing regulations. Littering by fisherman is considered the most significant impact. Fish populations will be monitored by the Refuge in Stanfield Lake to facilitate management.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public notification and review includes a notice of availability published in the Federal Register, 30-

day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

To ensure compatibility with the purposes of the Refuge and the mission of the National Wildlife Refuge System, fishing ;and boating can only occur with the following stipulations:

- All State and Federal regulations shall apply.
- The harvesting of frogs and turtles is prohibited.
- Fishing allowed year-round in public fishing areas noted, 1 hour before sunrise to 1 hour after sunset.
- Boats are allowed on Stanfield Lake only. Electric trolling motors are allowed, but gasoline-powered motors cannot be used or attached to boats. No use of gasoline-powered boat motors by the public is permitted on the property.
- All fishing is hook and line only. No trot lines, limb lines, float fishing, bow fishing, or spear fishing is allowed.
- Littering shall be prohibited
- Annually review all fishing and boating activities to ensure compliance with all laws, regulations, and policies.

Justification:

This use has been determined compatible as it will not materially interfere with or detract from Refuge purposes, provided the above stipulations are implemented. This use will provide an excellent recreational opportunity for visitors with minimal disturbance to wildlife. This use will not diminish the primary purposes of the Refuge for migratory birds. Fishing has been identified as a primary public use, helping to fulfill the mission of the NWRS by providing renewable resources for the benefit of the American public while conserving fish, wildlife and plant resources on these lands.

Signature:

Refuge Manager _____
(Signature and Date)

Concurrence:

Regional Chief _____
(Signature and Date)

Mandatory 10- or 15-year Re-Evaluation Date:

U. S. Fish and Wildlife Service. 2006. Wildlife-Dependent Recreation: Fishing. 605 FW 3. National Wildlife Refuge System, Department of Interior.

COMPATIBILITY DETERMINATION

Use: Research projects by third parties

Refuge Name: Muscatatuck National Wildlife Refuge (Refuge)

Establishing and Acquisition Authority:

The Refuge was established and land was acquired under authority of the Migratory Bird Conservation Act (16 U.S.C. 7.14-714r). The Refuge was officially established on October 6, 1966. Acquisition funds were derived from federal duck stamp sales.

Refuge Purpose:

The Refuge purpose “...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds” derives from the Migratory Bird Conservation Act.

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. (National Wildlife Refuge System Administration Act of 1966, as amended (16U.S.C. 668dd-668ee).

Description of Use:

What is the use? The Refuge allows research investigations on a variety of biological, physical, archeological, and social components to address Refuge management information needs or other issues not related to Refuge management. Studies are or may be conducted by federal, state, and private entities, including the U.S. Geological Survey, state departments of natural resources, state and private universities, and independent researchers and contractors. This is not a wildlife-dependent use.

Examples of past biological research include:

- copper-bellied water snakes
- Emerald ash borer

- Indiana bat

Where would the use be conducted? Sites for this use would depend on the particular study being conducted and could occur in a variety of habitat types. Access would be restricted by Special Use Permit to only the study sites needed to meet the objectives of the research.

When would the use be conducted? The timing of research activities would depend on the individual project, but currently most research occurs during the growing season. The entire Refuge is open for allowed research activities throughout the year in conjunction with the issuance of a Special Use Permit. The timing and number of visits by researchers may be restricted by Special Use Permit.

How would the use be conducted? Any research study sites, sampling locations, and transects can be temporarily marked by highly visible wooden or metal posts and must be removed when research ceases. Access to study sites is by foot, truck, all-terrain vehicle, boat, airboat, canoe, and other watercraft. Vehicle use is allowed on Refuge roads, trails, and parking lots normally open to the public.

Why is this use being proposed? Most research by third parties is done to address Refuge management information needs or to contribute to a larger knowledge base about resources of concern to the Refuge.

Availability of Resources:

Facilities and staff are currently available to provide access, maintain roads, parking lots, secondary access roads, as well as to issue Special Use Permits for research projects. Staff resources are deemed adequate to manage this use at anticipated use levels.

Access points, boats, vehicles, miscellaneous equipment, and limited logistical support are available on the Refuge. Housing is not available.

Anticipated Impacts of the Use:

Short-term impacts:

Research activities may disturb fish and wildlife and their habitats. For example, the presence of researchers can cause waterfowl to flush from resting and feeding areas, cause disruption of birds and turtles on nests or breeding territories, or increase predation on nests and individual animals as predators follow human scent or trails. Efforts to capture animals can cause disturbance, injury, or death to groups of wildlife or to individuals. In addition, some projects require the collection of animals and plants for study. To wildlife, the energy cost of disturbance may be appreciable in terms of disruption of feeding, displacement from preferred habitat, and the added energy expended to avoid disturbance.

Sampling activities can cause compaction of soils and the trampling of vegetation, the establishment of temporary foot trails and boat trails through vegetation beds, disruption of bottom sediments, and minor tree damage when temporary observation platforms are built or when tree climbers access bird nests.

The removal of vegetation or sediments by core sampling methods can cause increased localized turbidity and disrupt non-target plants and animals. Installation of posts, equipment platforms, collection devices and other research equipment in open water may present a hazard if said items are not adequately marked and/or removed at appropriate times or upon completion of the project.

Long-term impacts:

Long-term effects should generally be beneficial by gaining information valuable to Refuge management. No long-term negative impacts are expected and the Refuge Manager can control the potential for long-term impacts through Special Use Permits.

Cumulative impacts:

Cumulative impacts would occur if multiple research projects were occurring on the same resources at the same time or the duration of the research is excessive. No cumulative impacts are expected and the Refuge Manager can control the potential for cumulative impacts through Special Use Permits. Managers retain the option to prohibit research on the Refuge which does not contribute to

the purposes of the Refuge or the mission of the Refuge System, or causes undo resource disturbance or harm.

Public Review and Comment:

This compatibility determination is part of the Muscatatuck Draft Comprehensive Conservation Plan and environmental assessment. Public notification and review includes a notice of availability published in the Federal Register, 30-day comment period, local media announcements, and a public meeting near the Refuge. Comments received and agency responses will be included in the final version of the Muscatatuck Comprehensive Conservation Plan.

Determination:

- Use is Not Compatible
- Use is Compatible with the following stipulations.

Stipulations Necessary to Ensure Compatibility:

- Prior to conducting investigations, researchers will obtain Special Use Permits from the Refuge that make specific stipulations related to when, where, and how the research will be conducted. Managers retain the option to prohibit research on the Refuge which does not contribute to the purposes of the Refuge or the mission of the Refuge System, or causes undo resource disturbance or harm.
- Researchers must possess all applicable state and federal permits for the capture and possession of protected species, for conducting regulated activities in wetlands, and for other regulated activities.
- Archeological researchers must obtain an Archeological Resource Protection Act permit from the Regional Director prior to obtaining a special use permit from the Refuge Manager.
- Researchers will submit annual status reports and a final report concerning Refuge research to the Refuge Manager.

Justification:

Research by third parties may play an integral role in Refuge management by providing information needed to manage the Refuge on a sound scientific basis. Investigations into the

biological, physical, archeological, and social components of the Refuge provide a means to analyze management actions, impacts from internal and outside forces, and ongoing natural processes on the Refuge environment.

Adverse impacts of research that cause localized vegetation trampling or disruption of wetland bottom sediments are often short-term and would be minimized through stipulations above. Any research equipment that remains in the field for the duration of the project would be clearly marked to avoid potential hazards presented to other Refuge users and/or Refuge staff.

Signature:

Refuge Manager _____

(Signature and Date)

Concurrence:

Regional Chief _____

(Signature and Date)

Mandatory 10-Year Re-Evaluation Date:

Appendix G: Deferred Maintenance and Improvement Projects and New Projects

Project Number	Deferred Maintenance & Improvement Projects	Description	Estimated Cost
Deferred Maintenance & Improvement			
2005230736	R3 DM 99 Muscatatuck Levee MSU 1 General Rehab	Seasonally Flooded Const. Impoundments	\$10,755
2005230751	R3 DM 99 Muscatatuck Levee MSU 2 General Rehab	Seasonally Flooded Const. Impoundments	\$8,892
2005230769	R3 DM 99 Muscatatuck Levee MSU 4 General Rehab	Seasonally Flooded Const. Impoundments	\$10,438
2005230778	R3 DM 99 Muscatatuck Levee MSU 4 North General Rehab	Seasonally Flooded Const. Impoundments	\$27,369
2005230786	R3 DM 99 Muscatatuck Levee MSU 5 General Rehab	Seasonally Flooded Const. Impoundments	\$21,592
2005230953	R3 DM 99 Muscatatuck Levee Sheryl General Rehab	Fishing	\$26,486
2005230984	R3 DM 99 Muscatatuck Levee Endicott South General Rehab	Seasonally Flooded Const. Impoundments	\$47,616
2005230987	R3 DM 99 Muscatatuck Levee Sand Hill Ponds General Rehab	Fishing	\$13,122
2005232382	R3 DM 99 Muscatatuck Levee Persimmon Ponds General Rehab	Fishing	\$15,451
2005232398	DM Child Repair Erosion on M-7 Masher Dike	Seasonally Flooded Const. Impoundments	\$52,000
2005232414	R3 DM 99 Muscatatuck Levee Lake Linda General Rehab	Fishing	\$58,511
2005232420	R3 DM 99 Muscatatuck Road Service to Shop Area General Rehab	Observation & Photog.	\$33,621
2005232429	R3 DM 99 Muscatatuck Levee Pfaffenburger Ms-6 General Rehab	Seasonally Flooded Const. Impoundments	\$38,151
2005232511	R3 DM 99 Muscatatuck Levee Sue Pond General Rehab	Migratory Waterbirds	\$51,586
2005241814	R3 DM 99 Muscatatuck WCS Richart General Rehab	Fishing	\$7,646
2005241831	R3 DM 99 Muscatatuck WCS M4 to Storm Creek General Rehab	Seasonally Flooded Const. Impoundments	\$8,583
2005241839	R3 DM 99 Muscatatuck WCS M5 to Storm Creek General Rehab	Seasonally Flooded Const. Impoundments	\$8,583
2005241844	R3 DM 99 Muscatatuck WCS M6 Outlet General Rehab	Seasonally Flooded Const. Impoundments	\$12,379
2006402270	R3 DM 99 Muscatatuck WCS Moss Lake General Rehab	Seasonally Flooded Const. Impoundments	\$16,359
2006402682	DM Child Bridge Mutton Creek General Rehab	Public Access Roads	\$20,000
2006402685	DM Child Bridge StormCreek General Rehab	Public Access Roads	\$20,000

Project Number	Deferred Maintenance & Improvement Projects	Description	Estimated Cost
2006402686	R3 DM 99 Muscatatuck Bridge Public M3 (Storm 500 N)	Public Access Roads	\$8,105
2006402687	DM Child Bridge M4 West Entrance Decking Replacement	Public Access Roads	\$20,000
2006403233	R3 DM 99 Muscatatuck Dam Low Hazard Richart	Fishing	\$13,939
2006403235	R3 DM 99 Muscatatuck Dam Low Hazard Stanfield	Fishing	\$8,307
2006403238	R3 DM 99 Muscatatuck Dam Low Hazard Moss Lake	Seasonally Flooded Const. Impoundments	\$19,385
2006410096	R3 DM 99 Muscatatuck Observation Deck Endicott General Rehab	Observation & Photog.	\$8,997
2006410097	R3 DM 99 Muscatatuck Pavillon Haackman Overlook General Rehab	Observation & Photog.	\$6,385
2006410098	R3 VFE 99 Muscatatuck Fishing Pier Lake Linda General Rehab	Fishing	\$5,851
2007744088	R3 RRP Muscatatuck Preliminary Engineering (Rte 010)	Public Access Roads	\$260,000
2007744089	R3 RRP Muscatatuck County Line Road (Rte 010)	Public Access Roads	\$304,103
2007744090	R3 RRP Muscatatuck 400N Road (Rte 011)	Public Access Roads	\$230,894
2007744091	R3 RRP Muscatatuck 500N Road (Rte 102)	Public Access Roads	\$76,589
2007744094	R3 RRP Muscatatuck Visitor Center FHWA Rte 901	Public Access Roads	\$5,346
2007744095	R3 RRP Muscatatuck Check Station Loop A FHWA Rte 904	Public Access Roads	\$10,499
2007744101	R3 RRP Muscatatuck Visitor Center FHWA Rte 902	Public Access Roads	\$13,347
2007744104	R3 RRP Muscatatuck Stanfield Lake Boat Ramp FHWA Rte 906	Fishing	\$5,621
2007744105	R3 RRP Muscatatuck Myers Cabin South Roadside FHWA Rte 910	Public Access Roads	\$1,544
2007744107	R3 RRP Muscatatuck Road Public FHWA Rte 010 Hwy 50 to VC	Public Access Roads	\$57,723
2007744108	R3 RRP Muscatatuck Turkey Trail FHWA Rte 912	Public Access Roads	\$7,170
2007744109	R3 RRP Muscatatuck Stanfield Lake Loop FHWA Rte 917	Public Access Roads	\$4,949
2007744115	R3 RRP Muscatatuck Stanfield Lake Loop FHWA Rte 917	Public Access Roads	\$1,737
2007744121	R3 RRP Muscatatuck Bird Trail FHWA Rte 921	Public Access Roads	\$3,443
2008866101	R3 FY09 Trails Muscatatuck Richart Trail	Observation & Photog.	\$10,000
2008866107	R3 FY09 Trails Muscatatuck Bird Trail	Observation & Photog.	\$15,000
2008866110	R3 FY09 Trails Muscatatuck Turkey Trail	Observation & Photog.	\$32,000
2008867009	R3 DM 99 Muscatatuck Public Fishing Peir / Dock, Stanfield Lake	Fishing	\$7,527
2008867341	R3 DM 99 Muscatatuck Dike - Wood Duck 320' General Rehab	Seasonally Flooded Const. Impoundments	\$7,759

Project Number	Deferred Maintenance & Improvement Projects	Description	Estimated Cost
2008867388	R3 DM 99 Muscatatuck Dike, MSU - 3 GENERAL Rehab	Seasonally Flooded Const. Impoundments	\$25,928
2008867411	R3 DM 99 Muscatatuck Dike- S Wagner GENERAL Rehab	Seasonally Flooded Const. Impoundments	\$6,405
2008867418	R3 DM 99 Muscatatuck Dike- W Wagner General Rehab	Seasonally Flooded Const. Impoundments	\$5,103
2008867431	R3 DM 99 Muscatatuck Dike - Monroe County General Rehab	Seasonally Flooded Const. Impoundments	\$11,497
2008867452	R3 DM 99 Muscatatuck Dike, McDonald South General Rehab	Seasonally Flooded Const. Impoundments	\$5,475
2008867560	R3 RRP Muscatatuck Road Public Route 103 - 1225 E	Public Access Roads	\$72,187
2008867851	R3 RRP Muscatatuck Signs - Trail Public Hiking	Observation & Photog., & Interpretation	\$13,964
			\$1,795,918

Project Number	New and Construction Projects	Description	Estimated Cost
2007718327	Designs to Improve Moist Soil and Green Tree Habitat CIEG CHILD	Bottomland Hardwood Forest	\$80,000
2007718329	Improve Moist Soil and Green Tree Habitat CINCCHILD	Bottomland Hardwood Forest	\$900,000
2007741744	R3 VFE Child Muscatatuck Construct Visitor Center Pavilian Roof	Interpretation	\$82,000
2007741749	R3 VFE Muscatatuck Install Restle Unit Interpretive Signs and Observation Deck Repair	Observation & Photog.	\$15,000
2007741750	R3 VFE Muscatatuck Hackman Overlook Structure Improvements	Observation & Photog.	\$10,000
2007742988	R312 VFE CINC Muscatatuck Construct Kiosks at Four Locations	Observation & Photog., & Interpretation	\$40,000
2008863562	Construct 8-Person Fire Bunkhouse	Support for all Goals	\$450,000
	Tree Planting (Approx.) 670 Acres over the life of the CCP	Upland & Bottlomland Hardwood Forests	\$77,000
	Timber Stand Improvement on (Approx.) 5,000 Acres over the life of the CCP, add one Biological Technician.	Upland & Bottlomland Hardwood Forests	\$132,000
	General Shoreline Improvements to Fishing Areas and Boat Launching Ramp	Fishing	\$100,000
	Accessible Wildlife Viewing Platform/Deck at the "Shop Field"/Crane Viewing Area	Observation & Photog., & Interpretation	\$100,000
	Conduct a Hydrological Survey of the Seep Springs RNA	Seep Springs RNA	\$70,500
	Conduct Refuge-wide Invasive Plant Surveys Every 5 Years	Invasive Plant Species	\$180,000
	Close West Entrance (Cty. Rd. 400 N.), Move Gate, Add Turn-around Circles, (Rte.011)	Public Access Roads	\$150,000
	Expand Environmental Education and Volunteer Staffing	Visitor Services Staffing	\$95,000
	Hydrologic Study of Southern Moist Soil Units	Hydrologic Study	\$80,000
	Manage Invasive Plant Control Program and Expand Staffing	Invasives Management	\$252,000
	Expanded Wildlife Monitoring	Wildlife Monitoring	\$181,000
Total			\$2,994,500

Appendix H: Literature Cited

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Appendix I: List of Preparers

List of Preparers

Refuge Staff

- Marc Webber, Refuge Manager
- Susan Knowles, Wildlife Refuge Specialist
- Donna Stanley, Outdoor Recreation Planner
- Dan Wood, Wildlife Biologist
- Frank Polyak, Park Ranger

Regional Planning Staff

- Jared Bowman, Wildlife Biologist
- Gabriel DeAlessio, Wildlife Biologist/
Cartographer
- Jane Hodgins, Technical Writer/Editor
- John Schomaker, Refuge Planner (retired)

