

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

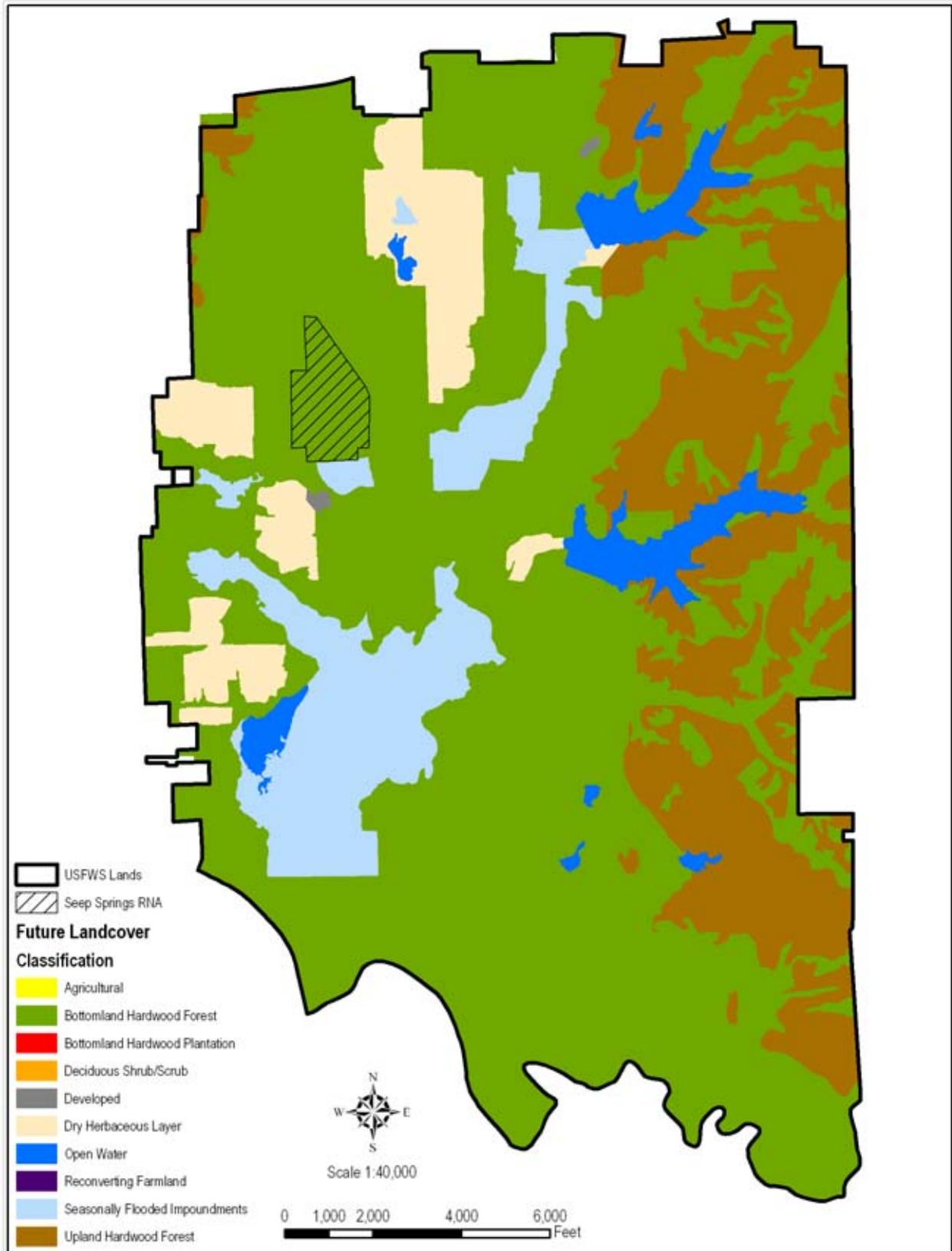
more actively manage and restore upland forest habitat to benefit forest-dependent wildlife, especially certain species of migratory waterfowl, neotropical migratory birds, and mammals (e.g. Indiana bat, southern flying squirrel).

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

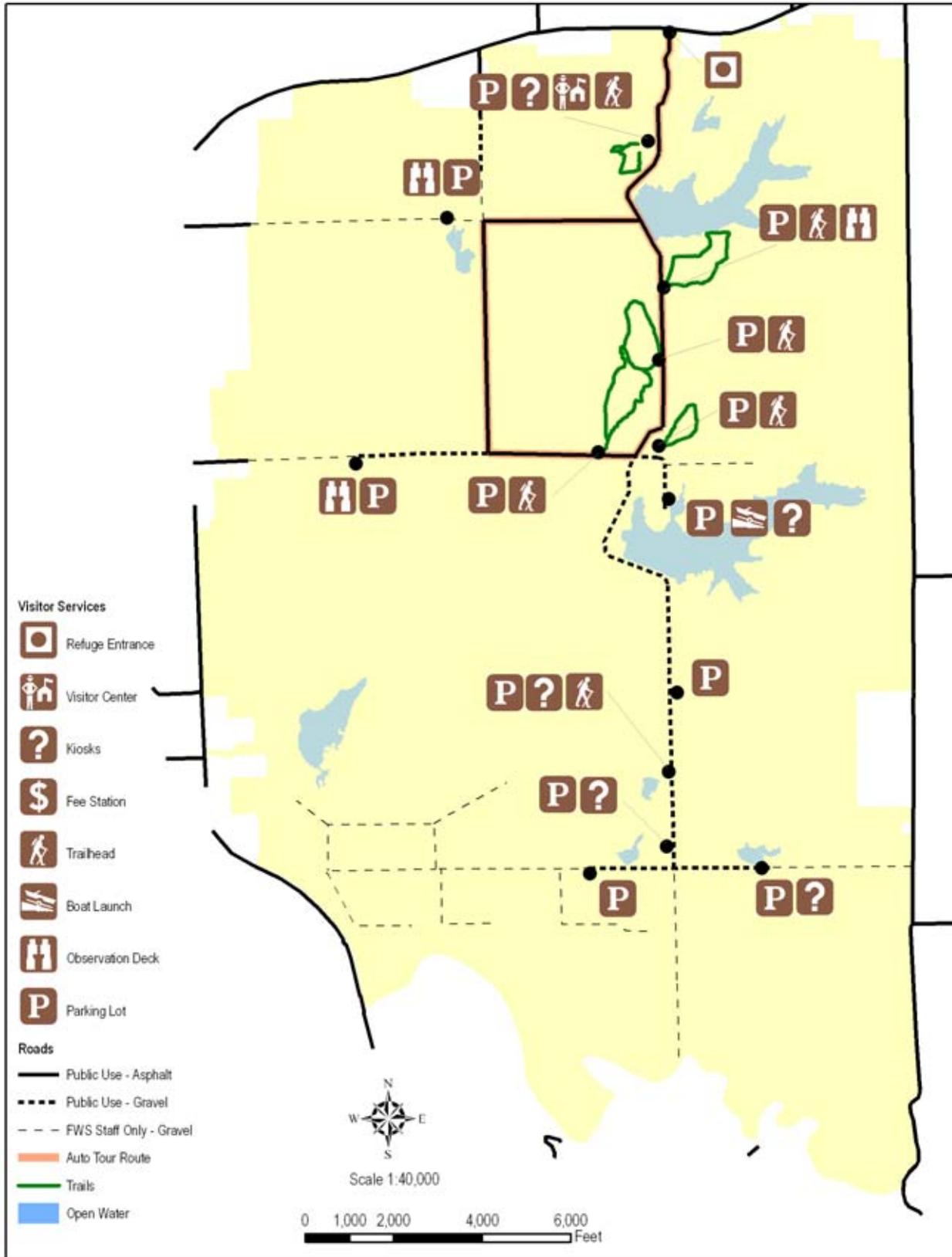
Participants will experience quality interpretive and environmental education opportunities at or above the 2008 level.

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.