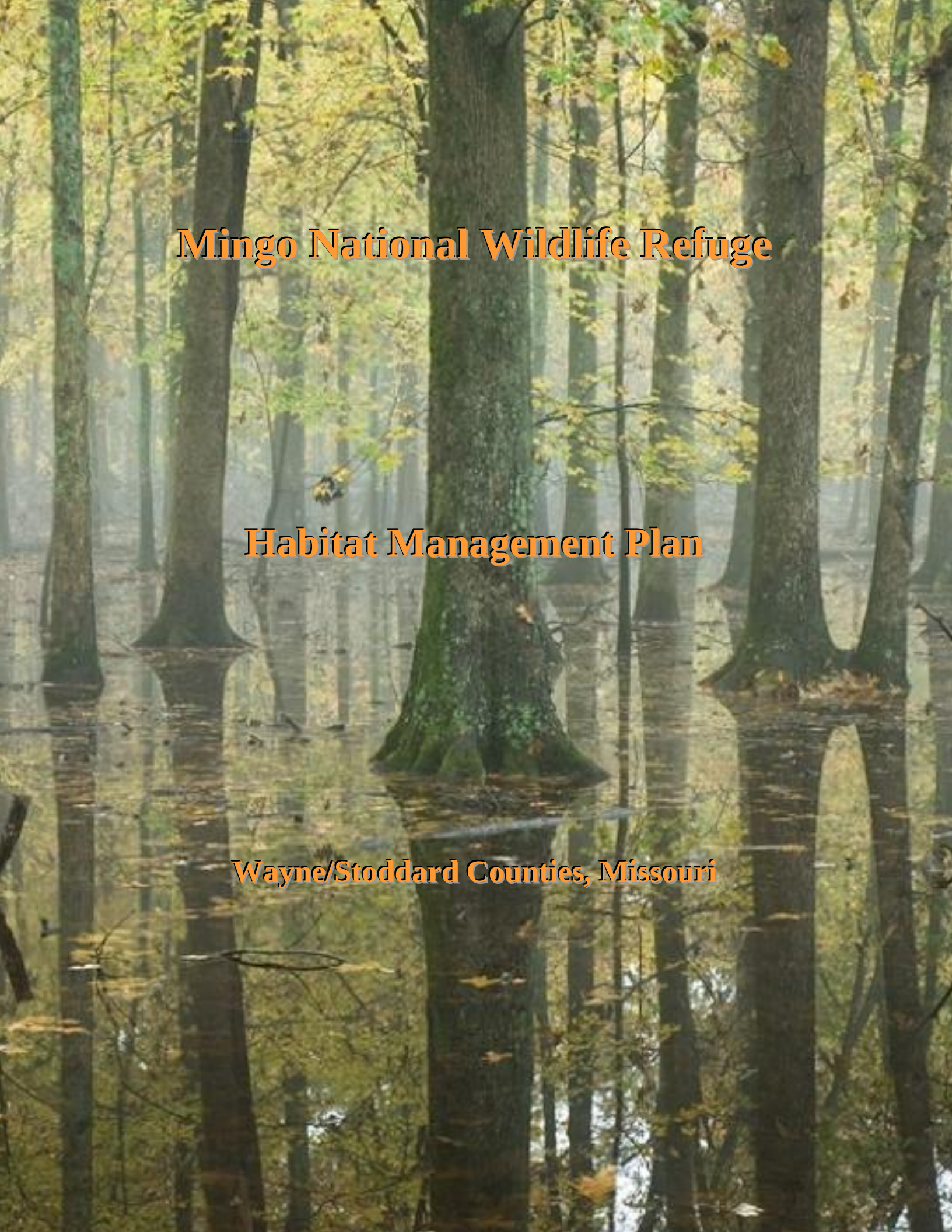
Mingo National Wildlife Refuge Habitat Management Plan

Submitted by: Project Leader: _____ 6/28/11
(Signature and Date)

Concurrence: Refuge Supervisor: _____ 7/27/11
(Signature and Date)

Concurrence: Regional Natural Resources Chief: _____ 7/27/11
(Signature and Date)

Approved: Regional Chief: Rick Schwalt 7/28/11
(Signature and Date)



Mingo National Wildlife Refuge

Habitat Management Plan

Wayne/Stoddard Counties, Missouri

Table of Contents

Mingo National Wildlife Refuge Habitat Management Plan

Submitted by: Project Leader:_____
(Signature and Date)

Concurrence: Refuge Supervisor:_____
(Signature and Date)

Concurrence: Regional Natural Resources Chief: _____
(Signature and Date)

Approved: Regional Chief:_____
(Signature and Date)

I. Introduction

A. Scope and rationale

The purpose of the Mingo National Wildlife Refuge (NWR) Habitat Management Plan (HMP) is to provide specific direction and long-term management guidance for the refuge. In accordance with 620 FW 1 Sec 1.10A of the Service manual, this plan and the direction set forth herein have been developed subsequent to the Mingo, Pilot Knob, Ozark Cavefish National Wildlife Refuge Comprehensive Conservation Plan (CCP). This document has been developed in detail through a set of goals, objectives, and strategies that will mesh with the CCP and will direct refuge management for the next 15 years.

B. Legal Mandates

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 over 552 refuges covering more than 150 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, and insects. As a result of international treaties for migratory bird conservation as well as other legislation, such as the Migratory Bird Conservation Act of 1929, many refuges have been established to protect migratory waterfowl and their migratory flyways from their northern nesting grounds to southern wintering areas. Refuges also play a vital role in preserving endangered and threatened species. Among the most notable is Aransas National Wildlife Refuge in Texas, which provides winter habitat for the whooping crane. Likewise, the Florida Panther Refuge protects one of the nation's most endangered predators, and the Mississippi Sandhill Crane Refuge an endangered, non-migratory species of the sandhill crane.

Refuges also provide unique opportunities for people. When it is compatible with wildlife and habitat conservation, they are places where people can enjoy wildlife-dependent recreation such as hunting, fishing, wildlife observation, photography, environmental education, and interpretation. Many refuges have visitor centers, wildlife trails, automobile tours, and environmental education programs. Nationwide, approximately 41 million people visit national wildlife refuges a year.

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 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 mission of the 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.

The Refuge System's goals 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 a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.

- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).

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

Mingo National Wildlife Refuge

Beginning in 1944, land was acquired for Mingo NWR with the approval of the Migratory Bird Conservation Commission. The purpose of the Refuge derives from the Migratory Bird Conservation Act, "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds" (16 U.S.C. 715d). In acquiring the first tract for the Refuge, the land was identified as "urgently needed for the protection and conservation of migratory waterfowl and other wildlife." In a 1954 presentation to the Migratory Bird Conservation Commission, the Refuge was described as an "important unit in the Mississippi Flyway" and "an important wintering ground for many species of waterfowl."

One tract of the Refuge was acquired with Bureau of Outdoor Recreation funds. The purpose associated with this funding derives from the Refuge Recreation Act and includes lands "...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ..." 16 U.S.C. 460k-1 (Refuge Recreation Act (16 U.S.C. 460k-460k-4), as amended).

An additional purpose was identified when Congress designated the 7,730 acre Mingo Wilderness in 1976. The establishing legislation for the Wilderness (Public Law 94-557) states that "wilderness areas designated by this Act shall be administered in accordance with the applicable provisions of the Wilderness Act…." The purposes of the Wilderness Act are additional purposes of that part of the Refuge that is within the Mingo Wilderness. The purposes of the Wilderness Act are to secure an enduring resource of wilderness, to protect and preserve the wilderness character of areas within the National Wilderness Preservation System (NWPS), and to administer the NWPS for the use and enjoyment of the American people in a way that will leave these areas unimpaired for future use and enjoyment as wilderness. (USFWS 2007)

Mingo National Wildlife Refuge protects a remnant of the bottomland hardwood and cypress-tupelo swamp ecosystem that once formed a 2.5 million-acre contiguous natural landscape throughout the Mississippi River basin. The 21,592-acre Refuge represents the largest area in southeast Missouri of remaining habitat for numerous native and threatened plant and animal species. The Refuge touches the southeast boundary of the Ozark Plateau and slopes abruptly from an upland oak-hickory forest to bottomland hardwood forest, lower marsh, and expansive swamp and ditch system. Since the beginning of the 20th century, these lands have been drained and deforested for agricultural purposes, which has highly modified the natural landscapes and ecosystem functions. Guided by legal mandates, the Refuge has successfully pioneered techniques that maintain a delicate balance of preservation and active management strategies for reforestation and hydrological integrity of the natural systems for the benefit of migratory birds, other wildlife, and wildlife-dependent public use. The Refuge is located in a community that appreciates both the natural diversity and the rich biological integrity of the Refuge and the surrounding public and private lands that add to the core network of the natural landscape.

Applying proven and innovative management practices, Refuge personnel will continue to ensure the protection of the Refuge ecosystems, including the preservation of the 7,730-acre Wilderness Area, designated in 1976. Active management of non-Wilderness lands will utilize adaptive management strategies to maintain a high quality, sustainable, and highly diverse ecosystem. These strategies will include traditional and accepted practices to protect the Refuge and surrounding lands from additional threats to the system, such as air quality and hydrological threats. The Refuge staff will continue to develop regeneration techniques and manage water levels to ensure the health and vitality of Refuge habitats.

Adaptive strategies will also assure continued consideration of the values and preservation of cultural resources where appropriate and consistent with natural resources management. Priority public-use opportunities will be provided and enhanced for the more than 120,000 annual visitors, in harmony with healthy habitats and sustainable wildlife populations.

This vision will be accomplished by continuing and expanding efforts to partner with state and federal agencies and the surrounding community, including neighboring landowners, stakeholders, supporters, and friends.

Mingo National Wildlife Refuge has a long and extensive history of research and partnerships with academia, the public, and with state and federal agencies. Mingo has partnered with the now closed Gaylord Memorial Laboratories and has served as a research location for many decades. This tradition will continue and grow as Mingo continues to be a location open for researches and students from across the country.

C. Relationship to other plans

The Mingo NWR Habitat Management Plan provides guidance aimed at fulfilling the habitat objectives outlined for the Mississippi Alluvial Valley (MAV) Migratory Bird Initiative, including significant benefits for waterfowl, shorebirds, and neotropical migratory birds. With the implementation of this plan, there will be significant habitat benefits to migratory bird species by increasing and enhancing breeding, wintering, and migration habitat for wetland-dependent migratory bird species. This plan has been developed to dovetail with the objectives of the Mingo Comprehensive Conservation Plan (CCP), Lower Mississippi Valley Joint Venture (LMVJV) of the North American Waterfowl Management Plan, the Partners in Flight (PIF) - MAV Habitat Conservation Plan, the PIF The Ozark/Ouachitas (O/O) and MAV Bird Conservation Plans, the United States Shorebird Conservation Plan - Lower Mississippi Valley, Upper Mississippi Valley/ Great Lakes Regional Shorebird Conservation Plan, the Missouri Comprehensive Wildlife Conservation Strategy, Restoration, Management and Monitoring of Forest Resources in the MAV, and provides integrated migratory bird management objectives in a landscape-level, biologically-driven framework.

II. Background

A. Inventory and description of habitat

1. Location

Established in 1944 under authority of the Migratory Bird Treaty Act, the 21,592-acre Mingo NWR is located in Stoddard and Wayne counties in southeast Missouri. A shallow basin, the Refuge lies in an abandoned channel of the Mississippi River bordered on the west by the Ozark Plateau and on the east by Crowley's Ridge. The Refuge contains approximately 16,000 acres of bottomland and upland hardwood forest, 3,000 acres of marsh and water, 1,800 acres of cropland and moist soil units, and 170 acres of grassy openings. It is located approximately 150 miles south of St. Louis and 170 miles north of Memphis, TN (Figure 1).

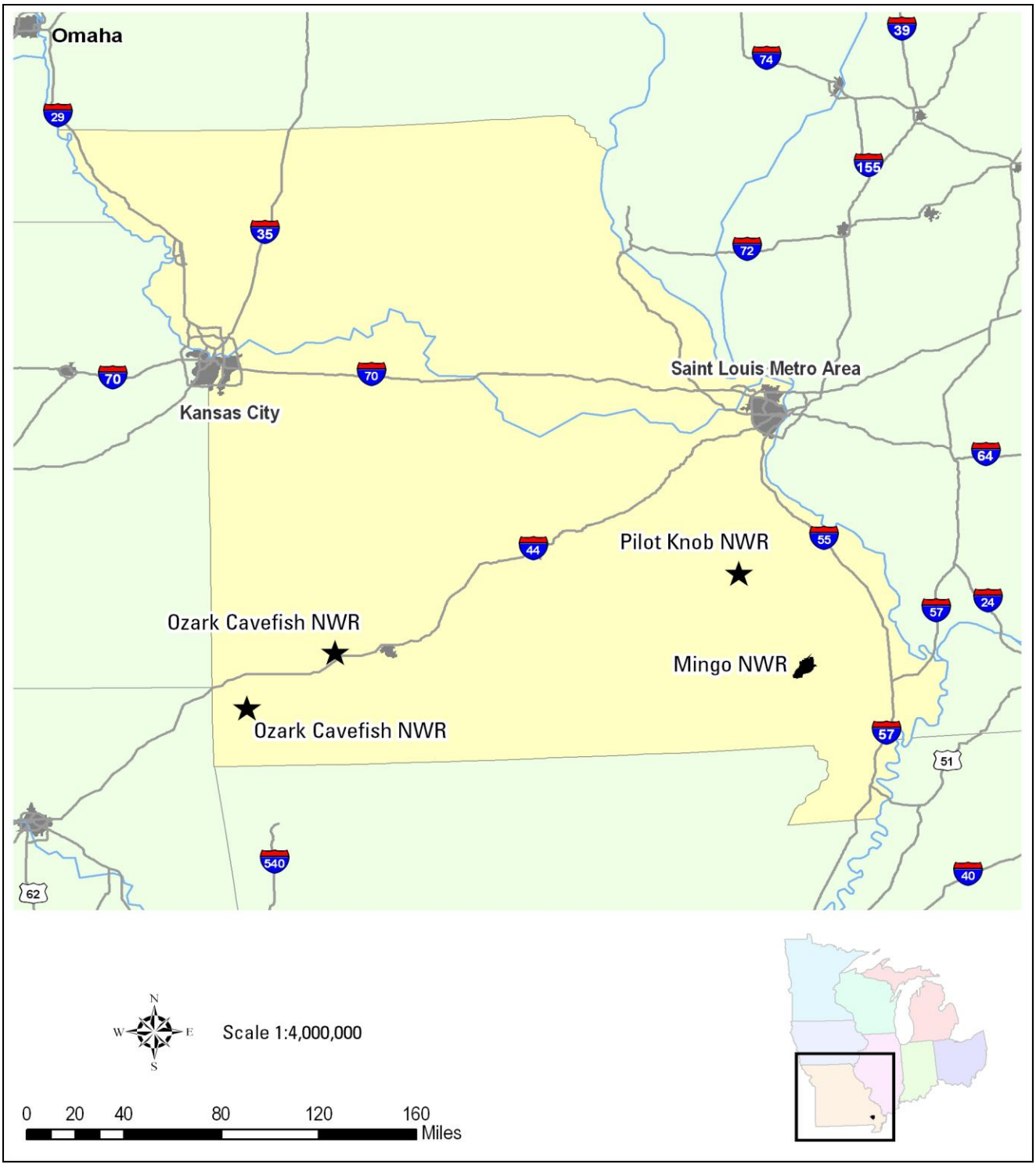


Figure 1. Vicinity Map including Mingo NWR, Ozark Cave Fish NWR, and Pilot Knob NWR. Ozark Cave Fish NWR and Pilot Knob NWR are not included in this document and are shown for reference only.

2. Management units

Mingo NWR comprises many different habitat types. Due to the layout of the refuge, management units are separated into geographic blocks or by habitat management types to provide clear management objectives for each unit on the refuge. The refuge is divided into 8 management unit types with sub-units in most units (Table 1). Each unit represents a specific habitat type and most occur across refuge lands (Figure 2). This diversity and juxtaposition of habitat types serve to enhance biodiversity on the refuge, and each management unit provides a unique set of resources that are necessary for target wildlife to complete their respective life cycles. The Mingo Wilderness area overlaps many of the habitat units and will be addressed in each appropriate unit.

Table 1: Management Units at Mingo NWR

Unit Name	Acres
Monopoly Marsh	2008
Rockhouse Marsh	903
Green Tree Reservoirs (GTRs)	6308
Bottomland Hardwood Units (BLH)	8861
Upland Forest	1315
Moist Soil Units	800
Openings, Croplands, Food Plots	804
Open Water	387 acres of open water including 77 miles of streams, rivers, and ditches.

Note: Other balance of refuge acres are roads, parking lots, buildings, etc.

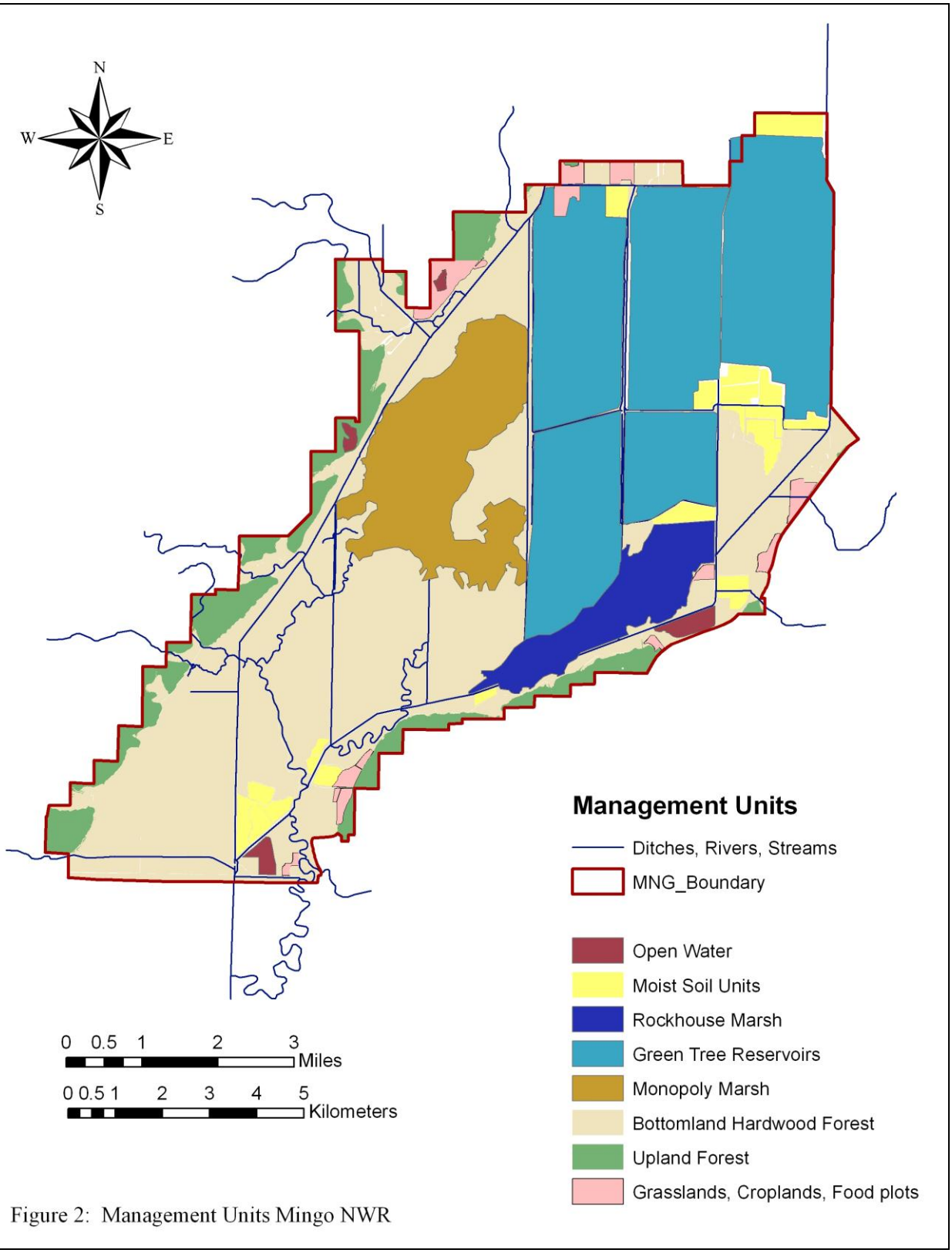


Figure 2: Management Units Mingo NWR

3. Physical and geographic setting

The MAV is a 24 million-acre, relatively flat, weakly dissected alluvial plain, comprised of natural levees, basins and flats, point bar formations, terraces, tributary floodplains, and depressional wetlands. The refuge lies in the physiographic province of the North Mississippi River Alluvial Valley. This portion of the MAV overlays the New Madrid fault line with the potential for earthquakes. The MAV is among the most heavily modified physiographic areas in the southeastern U.S. but still supports the largest forested floodplain in North America (Twedt et al. 1999). Excluding the bluffs along the periphery of the refuge, elevation across the basin varies less than 10 feet, rising from 335' to 344' above mean sea level (MSL). (Heitmeyer et al. 2006)

Mingo National Wildlife Refuge is located in an area known as the Bootheel region of southeast Missouri. Once an expansive swamp of bottomland hardwoods, the Bootheel was converted to agriculture during the last century and today is largely farmed for row crops. Waters from the refuge flow south to the St. Francis River via Mingo ditch and a series of drainage ditches.

4. Historic condition

About 25,000 years ago, the Mississippi River ran between the Ozark Mountains and Crowley's Ridge. Approximately 18,000 years ago, the river shifted, slicing its way through Crowley's Ridge to join the Ohio River farther north. The abandoned river bed developed into a rich and fertile swamp (Heitmeyer et al. 2006).

Native Americans were attracted to the swamp because of the abundant wildlife. Most likely, Native American occupation was seasonal and related to hunting opportunities in the swamp. White-tailed deer, wild turkey, ruffed grouse, and timber wolves were common on the edges of the swamp and nearby bluffs.

In 1804, the Louisiana Purchase acquired this territory for the United States. At that time, the population of Missouri's entire Bootheel was very low and the swamp area that is now the refuge was considered inaccessible. When Missouri became a state in 1821, all of the counties in southeast Missouri had settlers, except Stoddard and Dunklin counties, although Cape Girardeau was one of the most important river towns in Missouri.

Settlers first approached the swamp because of its extensive old-growth cypress and tupelo forests. The giant cypress trees were the first to be felled and converted into railroad ties and building lumber. The T.J. Moss Tie Company was a large Bootheel lumbering operation headquartered in Puxico. By 1888, T.J. Moss was the largest tie contractor in the state, and many of their ties were cut from trees taken from Mingo Swamp. A large sawmill was operated just north of Puxico on land now within Mingo NWR. Production of the Bootheel lumber industry peaked between 1900 and 1910. During its peak, the Bootheel was consistently the leading lumber-producing area of Missouri. However, by 1935 most of the large operations had ceased. The giant trees had been removed and it was necessary to find suitable lumber in other places.

Yet the powerful and wealthy lumber companies had not lost interest in the Bootheel. If the swampy land could be drained it could once more become an important source of revenue. The size of the projects remained small because of the expense involved. The lumber companies had considerable capital to invest, but demanded large grants of land for the drainage and were frequently more interested in the land than in efficiency of their drainage ditches. The State Legislature passed an act that allowed the formation of drainage districts, financed by long-term bonds. For the first time, drainage projects could be adequately financed and many drainage districts were created in the Bootheel (USFWS 2007).

In 1914, more than 20 drainage districts existed in Stoddard County. One of them was the Mingo Drainage District, a small district in the Advance Lowlands near Puxico. More than $1 million was spent to make Mingo Swamp suitable for farming. A system of seven major north-south ditches was constructed to drain water from the swamp into the St. Francis River, about 10 miles south of Puxico. Except for the narrow southern extension of the district south of Puxico, the District's boundary and the Mingo NWR boundary are essentially the same. The ditches constructed by the District are used today by the refuge for water control and management (USFWS 2007).

During the Great Depression, land values plummeted and many of the large landholders (lumber companies) defaulted on payment of taxes rather than continue to maintain unprofitable investments in the land. Throughout the Bootheel, many drainage districts were unable to meet financial obligations and defaulted on bond payments, largely because they couldn't absorb the loss of revenue created by the large landholders. Mingo District was one of these.

Drainage attempts at Mingo had not been completely successful, at least in part because of the overflow from the St. Francis River. Also, the soil was not as productive as in other areas of the Bootheel. During the 1930’s the Mingo District became insolvent.

The remaining timber was cut by anyone without regard to ownership. The area had become open range country, with cattle and hogs roaming freely across the entire swamp. To maintain this grassy condition, the land was burned frequently, as much as several times a year. Hogs and cattle became so numerous that they overflowed into the small towns near the swamp. Indiscriminate shooting of waterfowl was common. Other wildlife species were also not faring well. Beaver and deer had disappeared and wild turkey had nearly been extirpated from the swamp.

In 1944, the U.S. Fish and Wildlife Service purchased 21,592 acres of the Mingo Swamp and established the Mingo National Wildlife Refuge. The condition of the land and its living resources was deplorable. Over the previous half-century, humans had reduced a beautiful swamp, lush with the growth of plants and alive with animals, into a burned and eroded wasteland. Through careful management, most of the natural plants and animals were restored. Native trees have replaced much of the brush and briers, and a canoe trip down the Mingo River will now reveal little to the casual observer of the abuses to which this land was subjected in years past. Deer, wild turkey, bobcat and beaver are once again plentiful. The refuge is now able to pursue its primary purpose: providing food and shelter for migratory birds (USFWS 2007).

5. Current condition

Hydrology

Hydrologic conditions drive the ecology of Mingo NWR. The refuge is within the lower portion of the St. Francis River basin, and acts as a reservoir during periods of flooding. Water enters from all directions until runoff is complete and water levels stabilize. Water flow within the refuge is complex and varies depending on water depths within each of the pools. Poor drainage within the basin is slowed further by the dikes, levees, and ditches across the refuge. Water exits the refuge and flows south to the St. Francis River.

The current spillway elevation and location prevents efficient and adequate removal of water from the refuge. The current spillway elevation has a flowline approximately 332' MSL. This elevation is approximately 6 ft too high. This results in inadequate ability to drain critical habitats within the refuge such as GTR, BLH and moist soil units. It also results in increased sedimentation of Rockhouse and Monopoly marshes, as well as the ditch system.

The St. Francis River flows 225 miles from Iron County in Missouri to the Arkansas/Missouri border, and another 207 miles through Arkansas until it joins with the Mississippi River. Hydrology of the St. Francis River and entire Bootheel region has been drastically altered. Extensive networks of ditches and levees drain the floodplain, and control seasonal flooding that once predominated (USFWS 2007).

Plant Communities

Refuge vegetation may be broadly divided into wetlands, comprised mainly bottomland of mixed hardwood forests and upland forest.

Wetlands

With the exception of the bluffs on either side of the refuge, most of the area is subject to seasonal flooding and is wet during at least a portion of each year. Vegetation varies along a narrow elevation gradient that corresponds to duration of flooding. Four community types are delineated within the refuge based on dominant species, elevation, and inundation.

a. Terrace Bottoms Community – Terrace or second bottoms are located at the base of lower slopes, flat banks, and watercourse margins. These well-drained and rarely flooded transitional areas support a mixture of upland and flood plain woody species. Major trees are:

Sugar Maple (*Acer saccharum*), Northern Red Oak (*Quercus rubra*), Shagbark Hickory (*Carya ovata*), Bitternut Hickory (*Carya cordiformis*), Sweetgum (*Liquidambar styraciflua*), American Elm (*Ulmus americana*), Hackberry (*Celtis occidentalis*), Box Elder (*Acer negundo*), Chinkapin Oak (*Quercus muehlenbergii*), Blackgum (*Nyssa*

sylvatica), Black Walnut (*Juglans nigra*), Butternut (*Juglans cinerea*), Black Cherry (*Prunus serotina*), Bur Oak (*Quercus macrocarpa*), Southern Red Oak (*Quercus falcata*)

b. Oak Hardwood Bottoms Community – The most extensive bottomland forest type is the Oak Hardwood Bottoms. These Pin Oak flats occupy shallowly inundated areas along the banks between drainage ditch levees, and the low floodplains surrounding Rockhouse and Monopoly Marshes. Major trees are:

Pin Oak (*Quercus palustris*), Willow Oak (*Quercus phellos*), Overcup Oak (*Quercus lyrata*), Green Ash (*Fraxinus pennsylvanica var. subintegerrima*), Slippery Elm (*Ulmus rubra*), American Elm, Red Maple (*Acer rubrum*), Sweetgum, Cherrybark Oak (*Quercus pagoda*), Swamp Chestnut Oak (*Quercus michauxii*), Swamp White Oak (*Quercus bicolor*), Box Elder, Sugarberry (*Celtis laevigata*), Persimmon (*Diospyros virginiana*)

c. Mixed Soft-Hardwood Levees Community – This community type exists along drainage ditch levees, stream margins, roadside embankments, and other watercourse borders. Tree species include:

Black Willow (*Salix nigra*), Cottonwood (*Populus deltoides*), Silver Maple (*Acer saccharinum*), Sycamore (*Platanus occidentalis*), River Birch (*Betula nigra*)

Later successional species occurring in this community are similar to the Oak Hardwood Bottoms community.

d. Shallow Swamp Community – This community type occupies inundated areas such as Monopoly Marsh, Rockhouse Marsh, Mingo Creek, and Stanley Creek. The predominant species in these wooded swamps are:

Bald Cypress (*Taxodium distichum*), Swamp Blackgum (*Nyssa sylvatica var. biflora*), Swamp Cottonwood (*Populus hetrerophylla*), Red Maple (*Acer rubrum*), Pumpkin Ash (*Fraxinus tomentosa*), Black Willow, Water Locust (*Gleditsia aquatica*), Green Ash and Water Hickory (*Carya aquatica*)

Upland Forests

Oak-hickory forest type predominates on the cherty upland areas. Three community types are recognized.

a. Upland Old Fields Community – These areas include scattered woodland clearings, abandoned fields or pastures, and ridge roadsides which are reverting to an oak-hickory forest. Principal trees and shrubs are:

Sassafras (*Sassafras albidum*), Persimmon, Honey Locust (*Gleditsia triacanthos*), Sumac (*Rhus spp.*), Elm (*Ulmus spp.*), Black Walnut, Red Cedar (*Juniperus virginiana*), Blackberry (Rubus allegheniensis), Dewberry (*Rubus spp.*), Coralberry (*Symphoricarpos orbiculatus*), Multiflora Rose (*Rosa spp.*)

b. Xeric Ridge Crests Community – The driest and most exposed forest community exists on ridge crests, bluff tops, and upper slopes on thin, excessively drained soils. Over-story trees include:

Black Oak (*Quercus velutina*), Post Oak (*Q. stellata*), White Oak *(Q. alba),* Black Hickory (*Carya texana),* Mockernut Hickory (*C. tomentosa*), Elm and White Ash (*Fraxinus americana*)

Understory trees and shrubs are:

Serviceberry (*Amelanchier spp*.), Winged Elm (*Ulmus alata*), Big Tree Plum (*Prunus mexicana*), Sparkleberry (*Vaccinium arboreum*), Hawthorn (*Crataegus spp*.), Southern Blackhaw (*Viburnum spp*.), Sumac, Blueberry (*Vaccinium spp*.), St. Andrew's Cross (*Ascyrum hypericoides*)

c. Mesic Slopes Community – Great species diversity occurs on the middle to lower slopes because of improved temperature-moisture conditions. Important trees and shrubs include:

White Oak, Mockernut Hickory, Shagbark Hickory, Chinkapin Oak, White Ash, Sassafras, Flowering Dogwood *(Cornus florida),* Mulberry *(Morus spp*.), Pawpaw (*Asimina triloba*), Bladdernut (*Staphylea trifolia),* Spicebush *(Lindera spp.*), Devil's Walking Stick (*Aralia spinosa*), Wild Hydrangea (*Hydrangea arborescens*)

Invasive species

There are numerous invasive plant species on the refuge (Table 2). Plant invasions are a major threat to biodiversity worldwide (Yates et al. 2004). There is growing concern that invasive species, as defined by Richardson et al. (2000), are one of the greatest threats to biodiversity conservation (Wilcove et al., 1986 and Coblentz, 1990), second only to habitat loss and fragmentation (Lee and Macdonald, 1997). These species are controlled using integrated pest management practices that include physical, cultural, biological and chemical management strategies. Recent surveys of refuge indicate that approximately 24% of the refuge has some level of infestation. These are mostly in previously disturbed areas.

Table 2. Commonly Occurring Invasive Plants on Mingo NWR.

Scientific Name	***Common Name***
Ailanthus altissima	tree of heaven
Carduus nutans	nodding plumeless thistle
Cirsium vulgare	bull thistle
Elaeagnus umbellata	autumn olive
Lespedeza cuneata	Sericea lespedeza
Ligustrum vulgare	European privet
Lonicera japonica	Japanese honeysuckle
Microstegium vimineum	Nepalese browntop
Paulownia tomentosa	princesstree
Phalaris arundinacea	reed canary grass
Phragmites australis	common reed
Polygonum cuspidatum	Japanese knotweed
Rosa multiflora	multiflora rose
Securigera varia	crownvetch
Sesbania herbacea	coffee weed
Sorghum halepense	Johnsongrass

Geology and Soils

The refuge lies in an abandoned channel of the Mississippi River known as the Advance Lowlands, bounded by the limestone bluffs of Crowley's Ridge to the south and east, and the Ozark Escarpment to the north and west. The St. Francis River flows from the Ozark Hills into the Advance Lowlands just south and west of the refuge. When the Mississippi River shifted course, joining the Ohio River farther north approximately 18,000 years ago, an alluvial fan built up where the St. Francis River entered the lowlands. The Castor River, north and east of the refuge, developed a similar alluvial fan. These alluvial fans act as natural levees, slowing drainage through the basin.

Several small sand ridges interrupt the otherwise level basin. The ridges, which vary in shape, may be ancient sand bars deposited by the Mississippi River or sand forced to the surface by earthquakes. The refuge is in the heart of the New Madrid seismic zone, the source of some of the most powerful earthquakes in North America.

Prior to the Mississippi River moving through the Bell City-Oran gap, streams originating from the Ozark Escarpment including the Castor, St. Francis, and Black Rivers flowed into the Mississippi River along the Advance Lowland and formed small deltas or alluvial fans at the confluence points. After the Mississippi River changed course and abandoned the Advance Lowland, these Ozark-derived rivers scoured new southern channels through the "soft" alluvial deposits and developed large alluvial fans where the Castor and St. Francis Rivers exited the Ozarks. These alluvial fans essentially dammed the southwest and northeast parts of the

Advance Lowland between these rivers and created the current Mingo Basin. (Heitmeyer et al. 2006)

Bottomland Soils

The most extensive soil type is Waverley Silt Loam, with a grayish brown silt loam surface layer and gray silt loam subsoil that is mottled throughout. A poorly drained acidic soil formed under wet conditions and a high water table, it occupies approximately 50 to 60 percent of the refuge. Falaya Silt Loam occupies a small part of the bottom in areas such as Stanley Creek and Lick Creek. It also borders the upland and the channel of Mingo Creek. Falaya soils have brown silt loam surface layers over grayish brown silt loam underlain at about 40 inches by fray silty clay loam. This soil is somewhat poorly drained, acidic, and subject to flooding or ponding. Organic soils occupy 800 to 900 hundred acres in Rockhouse and Monopoly marshes and consist of dark colored soils derived from organic matter. They were formed under wet marshy conditions in some of the lowest elevations.

Upland Soils

The cherty soils of the steep slopes and stone outcropping along the west side of the refuge are of the Doniphan series. Doniphan soils have light brown cherty silt loam surface layers and red clay subsoils. The ridgetops above Doniphan cherty silt loam are narrow and undulating and have about three feet of loess deposits. The soil is Union Silt Loam. The moderately well-drained Union soils have dark grayish brown silt loam surface horizons that are underlain by brown silty clay loam subsoils. They have fragipan layers at depths of 2.0 or 3.0 feet. On the moderate slopes of the uplands, especially along Highway 51 north of Puxico, there are deep, well-drained soils developed in thick lows. These soils are Loring Memphis Silt Loams and have brown silt loam surface layers and brown silt loam subsoils.

Wilderness and Research Natural Areas (RNA)

Congress designated the western portion of the Refuge as the Mingo Wilderness Area in 1976. The 7,730-acre wilderness is one of 71 such areas managed by the U.S. Fish and Wildlife Service. In 1964, Congress passed and the president signed the Wilderness Act, which established the National Wilderness Preservation System. The legislation set aside certain federal lands as wilderness areas. The act says that they are areas, "…where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Four federal agencies of the United States government administer the National Wilderness Preservation System, which includes 662 designated areas and more than 105 million acres.

In 1970, seven research natural areas were established on the Refuge; six are within the Mingo Wilderness Area (Table 3). The RNA were established as representative areas for each of their respective habitat types. These areas were considered rare and disappearing in the 1970s and efforts were made to set aside each area so that it could continue to represent the increasingly rare forest stand.

Each research natural area is part of a national network of reserved areas under various ownerships intended to represent the full array of North American ecosystems with their biological communities, habitats, natural phenomena, and geological and hydrological formations. The designation is employed by a number of federal land management agencies including the U.S. Fish and Wildlife Service, Forest Service, Bureau of Land Management, and National Park Service.

In research natural areas, as in designated wilderness, natural processes predominate without human intervention. Under certain circumstances, deliberate manipulation may be used to maintain the unique features for which the research natural area was established. Activities such as hiking, bird watching, hunting, fishing, wildlife observation, and photography are permissible, but not mandated, in research natural areas. Research natural areas may be closed to all public use if such use is determined to be incompatible with primary Refuge purposes.

Table 3: Mingo NWR Research Natural Areas

Research Natural Area	Primary Cover Type	Acres
Cherrybark	Cherrybark Oak-Swamp Chestnut Oak	60
Cypress-Tupelo	Bald Cypress-Water Tupelo	80
Elm-Ash-Maple	Black Ash-American Elm-Red Maple	80
Oak-Hickory	White Oak-Red Oak-Hickory	140
Overcup Oak	Overcup Oak	45
Pin Oak	Pin Oak-Sweet Gum	180
Willow Oak	Willow Oak-Sweet Gum	40
Total		**625**

6. Habitat changes from historic to current condition

Prior to settlement, about 2.4 million acres of bottomland hardwood forest and associated habitats covered most of southeast Missouri including the Mingo Basin (Korte and Fredickson 1977, MacDonald et al. 1979). Currently, less than 80,000 acres of BLH remains; the largest contiguous block (ca.17,000 acres) is within the 28,000 acre Mingo Basin (Heitmeyer et al. 2006, Twedt and Loesch 1999). From 1880 to 1920, lumbering dominated the economy of Southeast Missouri and about 900,000 acres of BLH were cleared (Heitmeyer et al. 2006).

When surface water rose in the Mingo Basin, it overtopped small natural levees along sloughs and natural drainages and moved across depressions and BLH flats in a "sheetflow manner". Eventually, the rising water connected most of the Mingo Basin. Restoring sheetflow in the basin is important in conjunction with the restoring flow corridors so that energy and nutrients can be transported and cycled in the basin, resources can be made available to animals, and prolonged flooding and shifts in vegetation communities to wetter types can be avoided. Many opportunities exist to improve sheetflow and drainage (Heitmeyer et al. 2006).

In the early 1900's interests turned from lumber to converting the lands to agriculture. In 1907, the Little River Drainage District (LRDD) was formed. The LRDD had a large impact to the hydrology of what is now Mingo NWR and the surrounding area. These activities included levee construction that restricted the flow of the Mississippi and more locally, the Castor River. Both of these systems prevented water from flowing into the basin as it had during past flood events. The LRDD also constructed over 2,000 miles of drainage ditches in Southeast Missouri (Heitmeyer et al. 2006).

The Drainage district that initially impacted the Mingo Basin was the Mingo Drainage District (MDD) which was formed in 1914. By 1920, a system of seven north-south ditches and four intersecting lateral ditches were constructed to drain water from the basin into the St. Francis River. The Mingo River was leveed for road crossings and became cut off from its natural drainage. The ditches were only partially successful and after the depression of the 1920's, the MDD became insolvent in the mid-1930's (Heitmeyer et al. 2006). The series of ditches and levees still control the water flow on the refuge and currently help provide habitat for wildlife.

In the late 1930's and early 1940's, following the collapse of the MDD, discussions began on acquiring lands for a National Wildlife Refuge. One of the first projects was the construction of a spillway and water-control structure in the southwestern part of the refuge. An earthen plug was installed across Ditch 11 near Ditch 5 to back water up throughout the system (Heitmeyer et al 2006). This was the beginning of modern day efforts to control water on the refuge to benefit wildlife species, specifically waterfowl.

III. Resources of Concern

A. Identification of refuge resources of concern

To meet the objectives as stated in the refuge's establishing legislation, the resources of concern must be a top priority in the development of this HMP. Management on Mingo NWR involves providing diverse habitats to meet the needs of waterfowl, as well as a wide variety of other migratory birds and other wildlife.

1. Migratory Waterfowl

The primary purpose of Mingo NWR is to provide an inviolate sanctuary and habitat for wintering waterfowl and other migratory birds. The refuge serves as an important migratory and wintering ground for thousands of migratory waterfowl and lies in the heart of the Mississippi Flyway. This plan will focus on providing quality habitats and

meeting the needs of waterfowl in support of ecosystem, regional, national, and international goals and objectives established under conservation partnership plans. Target waterfowl include a variety of ducks and geese that utilize the Mississippi Flyway.

2. Threatened and Endangered Species

There is one federally listed species that is known to occur on the refuge: the Indiana bat (*Myotis sodalis*). It is currently listed as endangered, is potentially present on the refuge from April through October. The main habitat type for Indiana bats at Mingo are summer roost trees.

The gray bat (*Myotis grisescens)* has been documented in Wayne County, Missouri. No gray bats have been confirmed on Mingo NWR. There is a slight chance gray bats may occasionally forage or use caves located on the South or West side of the refuge.

3. Migratory Landbirds

Migratory landbirds (e.g. hawks, kites, cuckoos, and songbirds) have suffered long-term declines in continental populations due in part to the loss of BLH in the MAV and upland hardwoods in the Central Hardwoods BCR. To help address this issue, Hunter et al. (1993) developed the PIF species prioritization scheme, which ranks birds based on parameters that indicate their vulnerability to local and global extinction, including global abundance, global extent of breeding and non-breeding distributions, threats during breeding and non-breeding periods, population trends, and the importance of the area under consideration for conservation of the species. Under the PIF prioritization scheme, a score is assigned to each species with the higher score indicating a greater need for management (Carter et. al 2000). This scheme was used to develop a priority species list for the PIF MAV and Ozark/Ouachitas Conservation Plans (Twedt et al. 1999). Associated priority landbird species, based on habitat types, are listed in Table 4.

Table 4**.** Migratory landbird species (Scientific name in Appendix A) of management priority across habitat types on Mingo NWR from Partners in Flight priority bird species in the MAV and Central Hardwood Bird Conservation Plans (Species criteria ranking of 1a or 1b) and the USFWS Region 3 Priority Bird Species List.

Habitat Type	**Priority Landbird Species**
Mature Forest	Swainson's warbler[a,b], cerulean warbler[a,b], **prothonotary warbler**[a,b,] , **red-headed woodpecker**[a,b,] , **northern parula**[a], **Kentucky warbler**[a,b], **yellow-billed cuckoo**[a], **wood thrush**[a], **Acadian flycatcher**[b], worm-eating warbler[a,b], **Louisiana waterthrush**[b], **whip-poor-will** [b]
Early Successional Forest	**orchard oriole**[a,b], **Bell's Vireo**[a,b] , **white-eyed vireo**[a]

a= MAV BCR, b=Central Hardwoods BCR, **Bold** denotes species nesting on refuge

4. Shorebirds and Waterbirds

Fifty-seven species of shorebirds and waterbirds have been recorded on Mingo NWR, with 45 species occurring on a regular basis (Appendix A) (USFWS 2007). Shorebirds find suitable habitats on the refuge for feeding and resting during spring and fall migrations. Some shorebirds can be found throughout the year in this region, but it is during migration that the greatest abundance and diversity of shorebirds are present. Many species of waterbirds such as wading birds and marsh-birds can be found on the refuge throughout the year. Potential nesting habitat for species such as black rails (*Laterallus jamaicensis*) and king rails (*Rallus elegans*) will be a managed for moist soil and marsh habitats. Waterfowl management activities can easily benefit both of these groups of birds.

5. Aquatic Resources

The refuge has 77 miles of flowing water and 387 acres of total open water bodies. The dynamic nature of this flooding regime along with the associated creeks, sloughs, marshes, ditches and ponds provide a constant and renewable fisheries resource within the numerous aquatic features on the refuge.

In 2007, alligator gars with transmitters were released on the refuge in an effort to re-establish the species. When flooding occurs in the spring, these areas provide excellent nurseries for juvenile fish, along with critical habitat for reptiles and amphibians. Through conservation, restoration, and management of aquatic resources, critical habitats are made available for resting, foraging, and breeding for resident and migratory wetland-dependent and aquatic wildlife species.

Reptile and amphibian populations are high on the refuge. Species such as Western Cottonmouth (*Agkistrodon piscivorus leucostoma*), lesser siren (*Siren intermedia*), and amphiuma (*Amphiuma tridctylum*) are found elsewhere in the state but the refuge is considered a stronghold for these populations.

6. Resident Wildlife

The refuge's bottomland hardwood forests, open marshes, and upland forest support high populations of diverse wildlife. Some species are important game animals, such as fox and gray squirrels, eastern cottontail and swamp rabbits, white-tailed deer, wild turkey, and raccoons. Other species of interest from the general public, such as resident songbirds, small and medium-sized mammals, are critical to the environmental health and biodiversity of the refuge and its ecosystem. In compliance with establishing purposes and partnership conservation plans, sound biological principles are used in the assessment of and when feasible, management for resident wildlife species. Management efforts for priority wildlife species and habitat conditions which were historically found in the MAV and CH should benefit many of these species and species groups.

B. Identification of habitat requirements

1. Migratory Waterfowl

The North American Waterfowl Management Plan identified the Lower Mississippi Valley as one of the priority habitat areas, and the goal focused on providing an adequate quantity, quality, and distribution of habitats on public and private lands to ensure that the Lower Mississippi Valley could support a wintering population of at least 8.7 million ducks and 1.4 million geese. However, it should be noted that other life history needs such as sanctuary, surface-water, cover, molting, and pairing are potentially equally valuable. Therefore, a variety of well-distributed habitats designed to meet these needs are essential for the survival of this group of birds.

Waterfowl have many specific requirements during migration and winter. Surface water in the form of rivers, lakes, oxbows, flooded forests, beaver wetlands, and managed impoundments in the Lower Mississippi Valley is critical to the survival of this group of birds. The temporal and spatial distribution of these habitats must correspond with the migration chronologies of migratory species and meet the year-round needs of resident species. In addition, breeding, loafing, and feeding are equally important. It is critical to the future preservation of this group of gamebirds to provide a sanctuary to escape intense hunting pressures. Specifically, waterfowl need an area where they can find adequate food resources to restore energy and fat reserves lost during migratory flights.

Bottomland hardwood forests are critical to migratory and wintering waterfowl. These forests should provide food resources in the form of mast produced primarily by red oak, white oak, and tupelo. Invertebrates can be extremely abundant in these habitats, and they provide an invaluable food source to waterfowl. Forested wetlands also provide thermal, loafing, and escape cover for waterfowl. Bottomland hardwood acreage in the Lower Mississippi Valley should be maintained or increased to sustain current waterfowl populations. Bottomland hardwood areas must seasonally flood to provide adequate habitat for waterfowl. Specifically, waterfowl utilize these areas during migration and winter, and flood events during these periods are critical.

Moist soil wetlands historically occurred where openings existed in bottomland hardwoods. Forest openings were often caused by high winds, catastrophic floods, beaver, fire, and other causes (NRCS 2001). Early successional moist soil wetlands are critical to many species of wildlife, especially waterfowl. For example, smartweeds, millets, and other natural food producing plants provide a wide array of components necessary to ensure that the basic nutritional needs of waterfowl are fulfilled. These plants occur in abundance where some type of disturbance such as flood events or human actions manipulate wetland soils and interrupt plant succession. Waterfowl feed on seeds, invertebrates, and herbaceous matter in these shallowly flooded habitats. Moist soil wetlands also provide thermal, loafing, and escape cover.

Although cleared of natural vegetation, flooded agricultural fields can provide important

wildlife habitat (Twedt et al. 1999). Agricultural practices coupled with moist soil management provides food resources for waterfowl in the form of waste grain and increases the productivity of moist soil management units by stimulating the growth of desirable annual plants. Grain is a high-energy food that can be quickly consumed by waterfowl. Meeting the minimum waterfowl maintenance objectives can be achieved in part through a successful cropland program. Preferred waterfowl crops include corn, rice, milo, millet, wheat, soybeans, and buckwheat. By planting crops such as corn or millet in areas, their availability to waterfowl can be enhanced through flooding during fall and winter. Waterfowl will also feed on agricultural foods in adjacent uplands.

Shrub/scrub wetlands are typified by willows, buttonbush, other woody species, and perennial herbaceous vegetation. In the MAV, these habitats are often transitional between emergent and forested wetlands. Decaying leaves provide substrate for invertebrates which in turn provides food for waterfowl. Plant seeds provide another important food source for waterfowl. However, the primary value of shrub/scrub habitats to waterfowl is by providing thermal roosting cover (NRCS 2001). These areas are generally created by beaver, catastrophic winds, hydrological changes, or by man.

Important open water areas for waterfowl are usually provided by rivers, sloughs, brakes, and oxbow lakes. These wetlands primarily provide resting and roosting cover for waterfowl. Open water is extremely valuable during dry years (NRCS 2001).

The temporal and spatial distribution of these habitats must correspond with the migration chronologies of waterfowl. Use of the refuge by migratory waterfowl is determined by several factors, including the availability of flooded habitat and food resources, limited disturbance on the refuge, and unfavorable weather and water conditions in the more northern parts of the Mississippi Flyway. A variety of these habitats located in close proximity will ensure each species will meet its physiological requirements at each stage of its life. Studies indicate that a mallard must have all the resources needed for survival within a 12-mile radius (NRCS 2001).

2. Threatened and Endangered Species

Indiana bats were located on the refuge in 2009. In the summer, bats use large diameter trees (9" > Diameter Breast Height, DBH)) with exfoliating bark or snags to roost during the daytime (USFWS 2007a). The female bats may return to the same area to roost each summer and typically form maternal colonies. Numerous bats may be found on the same tree or adjoining trees. The bats forage along stream, rivers and wet areas, but may also utilize upland sites to forage.

Gray bats have not been documented on Mingo NWR but do occur in adjacent areas of Wayne County. Gray bats utilize caves throughout the year. In winter, gray bats hibernate in loose clusters within a cave. In the summer, the bats spread out and migrate to summer caves near their foraging areas. The bats forage along shorelines and may travel many miles in a night before returning to their roost cave.

3. Migratory Landbirds

Many migratory landbird species in the MAV and CH BCRs require large tracts of contiguous forest to survive. Managed forest acreage objectives listed previously are essential to the health and survival of this group of birds. While structural diversity is necessary to support source populations of priority species (Twedt et al. 1999), each species requires a different set of habitat components to meet life history needs. Thus, a landscape matrix of habitats comprised of forest, giant cane (*Arundinaria gigantea*), early successional habitats, and grassland are critical to the survival of this group of birds. In bottomland hardwoods, a variety of tree species are adapted to specific zones based on factors such as soil composition, elevation, and hydroperiod (Twedt et al. 1999). Slight differences can change the overlying plant communities. As a result, bottomland hardwood forests contain a great variety of trees, shrubs, and vines often growing close together. The plants are different in many ways such as height, branch pattern, fruit, foliage thickness, and shade tolerance (Harris 1984). This rich complexity provides diverse habitat which meets the needs of many forest dwelling migratory landbirds. These forests combined with small openings comprised of other habitats will enhance the overall landscape for meeting habitat requirements for all priority landbird species.

In Missouri, 27,000 acres of shrub/scrub were identified in 1992 (Twedt et al. 1999). Habitat objectives for early succession habitats in the MAV call for the provision of 2.5 million acres of shrub/scrub and forest edge habitat. A portion of these objectives can be met through reforestation activities and regeneration of abandoned or converted farm fields on Mingo NWR. Roughly 700 acres of early successional forest have been planted or allowed to convert on Mingo NWR.

Prior to European settlement, about 2.4 million acres of BLH and associated habitats covered most of southeast Missouri including the Mingo Basin (Korte and Fredrickson 1977, MacDonald et al. 1979, Heitmeyer et al. 2006). Currently, less than 80,000 acres of BLH remains; the largest contiguous block (ca. 17,000 acres) is within the Mingo Basin (Twedt and Loesch 1999, Heitmeyer et al. 2006). Management of bottomland hardwoods on Mingo NWR for migratory landbirds will primarily focus on meeting the needs of migratory landbird species with the highest priority based on the Partners in Flight concern score for species in the MAV Bird Conservation Plan (1999), the Priority Landbird Species in the Central Hardwoods BCR (2000) and the USFWS Region 3 Priority Bird Species List (Table 4). Thus, management efforts centered around providing critical habitats needs for high priority species should provide benefits for many of the other migratory landbird species.

Neither specific population goals nor habitat objectives have been established for upland oak-hickory hardwoods within the Mississippi Alluvial Valley. However, in order of priority general habitat objectives are: to maintain existing upland oak-hickory forests, to reforest gaps and intrusions within larger patches of upland forest, to connect upland forests with adjacent forested wetlands, to consolidate smaller forested blocks into larger ones by reforesting intervening habitat, and to minimize conversion of hardwood forests to managed pine forests (Twedt et al. 1999).

4. Shorebirds and Waterbirds

During migration, the most important consideration for shorebirds in this region is finding relatively undisturbed sites to obtain energy to fuel the next leg of the flight (Elliot and McKnight 2000). Shorebirds occur across a variety of habitat types in Southeast Missouri such as mudflats, shorelines, an array of freshwater wetlands (with water depths <8 inches), and dry grasslands. Roosting sites are primarily limited to shallowly flooded areas free of vegetation (Helmers 1992). Shorebirds feed predominately on invertebrates. The majority of invertebrate prey items eaten by shorebirds are aquatic or semi-aquatic; thus, to maximize biomass of these prey species, standing water or completely saturated soil must be present for a sufficient period for their populations to develop (Eldridge 1992). Generally, optimal prey biomass can be attained by flooding one month prior to the arrival of shorebirds. Different species of shorebirds utilize different habitats primarily dependent upon water depth and vegetation height and density. Water depths range from 0 inches (dry mud) to 8 inches. Vegetation density ranges from no cover to 75% cover. However, the majority of use occurs at sites with less than 25% cover. Shorebirds generally utilize sites where vegetation is less than half the height of the bird but some species will forage in taller vegetation. Grassland habitats maintained by mowing, grazing, or fire provide important habitat for some shorebird species (Helmers 1992). These habitat conditions must be made available at different periods throughout the year but management focus should center on peak migration dates. Spring migration is from March to May and peaks from early-April to early-May, and fall migration is from late July to October and peaks in September.

Waterbirds in this document represent wading birds and marshbirds. This group of birds requires a variety of different wetland habitats in the MAV similar to waterfowl and shorebirds. Wading birds primarily eat fish but are opportunistic and are known to eat a wide variety of animals they can swallow. Waders will utilize almost every wetland habitat in the MAV, plus associated uplands for feeding and loafing. Critical nesting habitats include trees and shrubs which are often surrounded by water. For example, beaver wetlands within bottomland forests often provide excellent nest sites. Wading birds are found in Southeast Missouri throughout the year, but the largest congregations are during summer. Secretive marsh birds (i.e. rails) are also opportunistic feeders eating primarily animal matter but also seeds and other plant matter. Unlike wading birds, rails require more specific wetland habitat conditions in the MAV. The terrain must support a reasonable amount of vegetation. Emergent and floating vegetation interspersed with 50% open water provides optimal habitat for rails (Hunter et al. 2006). This habitat is typically considered emergent marsh. This habitat retains water depths from 6 inches to 3 ft and contains vegetation rooted in soil that emerges above the water surface. Emergent plants often include cattail, bulrush, spikerush, and sedges. These marshes are valuable as nesting and brood rearing habitat for resident wading birds and rails. They also provide feeding, resting, and roosting habitat for wading birds, rails, migratory shorebirds, and waterfowl. Emergent marshes are often managed in rotation with moist-soil areas (NRCS 2001). Later succession moist soil habitats, flooded corn, and

shrub/scrub habitats also provide important components which meet the needs of rails. Water retained in these habitats during spring, summer, and fall will play an important role in meeting the needs for waterbirds.

5. Aquatic Resources

The health of aquatic resources is primarily dependent upon water quality, aquatic habitat, and river and floodplain integrity. All of these components however, are interconnected. For example, river and floodplain integrity is an important component of water quality. Additionally, good water quality is needed for good aquatic habitat. Fishes, reptiles, amphibians, and other aquatic resources are dependent upon maintaining or enhancing the integrity of the watershed. Aquatic resources should benefit from watershed management efforts, plus any restoration efforts of the Mingo and St. Francis Rivers, and utilize bottomland hardwoods and associated wetlands, creeks, sloughs, oxbows, lakes, and chutes. Seasonal flooding of bottomland hardwoods provides shallow areas which serve as breeding habitats and nurseries for many fish such as alligator gar (*Atractosteus spatula*), invertebrates, reptiles, and amphibians.

6. Resident Wildlife

Resident wildlife species require a variety of habitat types mentioned previously. Most resident species benefit more from an array of these habitats provided in close proximity. This would facilitate acquiring life history requirements by expending less energy and could result in an increase in carrying capacity for many resident species. The production of hard and soft mast, crops, invertebrates, fish, and a diversity of animals associated with these habitats will produce food resources necessary to support resident wildlife populations.

C. Potential refuge contributions to the habitat needs of the resources of concern

The current landbase and management activities on the refuge provide significant contributions to natural resources that meet establishing purposes. Improving existing habitat and working with adjacent land managers will increase utilization of the refuge and provide much needed habitat in an altered ecosystem. This management action, coupled with wildlife management techniques, will combat habitat degradation, direct loss of wildlife species, and less desirable land practices that degrade wildlife habitat.

1. Migratory Waterfowl

Bottomland hardwood forests and the GTR on Mingo NWR consist of 15,169 acres and are composed primarily of red oaks, overcup oak, bald cypress, water tupelo, sweetgum, and red maple. These forested tracts provide crucial food resources such as hard mast, soft mast, and invertebrates that are utilized by waterfowl during flood events that occur during winter and spring.

Moist soil habitats on Mingo NWR are capable of producing food resources such as

millets (*Echinichloa spp*.), sprangletop (*Leptochloa spp*.), smartweeds (*Polygonum spp*.), sedges (*Carex spp.),* panic grass (*Panicum spp.),* crops, and a host of other beneficial herbaceous plant species. The refuge currently provides approximately 800 acres of these moist-soil habitats and plays a key role in the migration patterns of mid-continent waterfowl.

Additionally, the refuge provides approximately 4000 acres of sanctuary consisting of bottomland hardwood forest, marshes, and moist soil units (Figure 3) for waterfowl and other wildlife. This area is closed to public activity and supports the purpose for which the refuge was established and contributes to the long-term survival of waterfowl.

Agricultural crops play another important role in the scheme of waterfowl management because they provide a source of high energy carbohydrates needed during periods of cold weather. Typically, the refuge supplies 253 acres of crops that are rotated into moist soil units or are produced on the higher elevations adjacent to managed wetlands to assure that wildlife has a readily available food source and to meet refuge objectives set forth in the Mingo CCP. Under the cooperative farming agreement, acreage is divided by a 66% to 33% farmer to refuge ratio, with the refuge usually receiving its portion on the lower areas of the unit. The refuge, in cooperation with the Mingo Swamp Friends, plants approximately 73 acres of food plots to provide green browse for waterfowl and other wildlife for enhanced viewing opportunities.

There are approximately 427 acres of wet shrub/scrub habitats in the form of beaver wetlands, Red Mill Pond, and a portion of Gum Stump Pool. These areas, along with open water habitats scattered across the refuge, facilitate dispersion and distribution of waterfowl and required resources.

2. Threatened and Endangered Species

Bottomland hardwood forests and the GTR on Mingo NWR consist of 15,169 acres and are composed primarily of red oaks, overcup oak, bald cypress, water tupelo, sweetgum, and red maple. Many of these trees are relatively mature and may provide suitable roosting habitat for Indiana bats in the form of snags and exfoliating bark.

Indiana bats forage along waterways, lakes, and rivers. Mingo NWR has 387 acres of open water bodies and 3000 acres of seasonally flooded marsh habitats provide numerous areas for feeding activities adjacent to roosting areas.

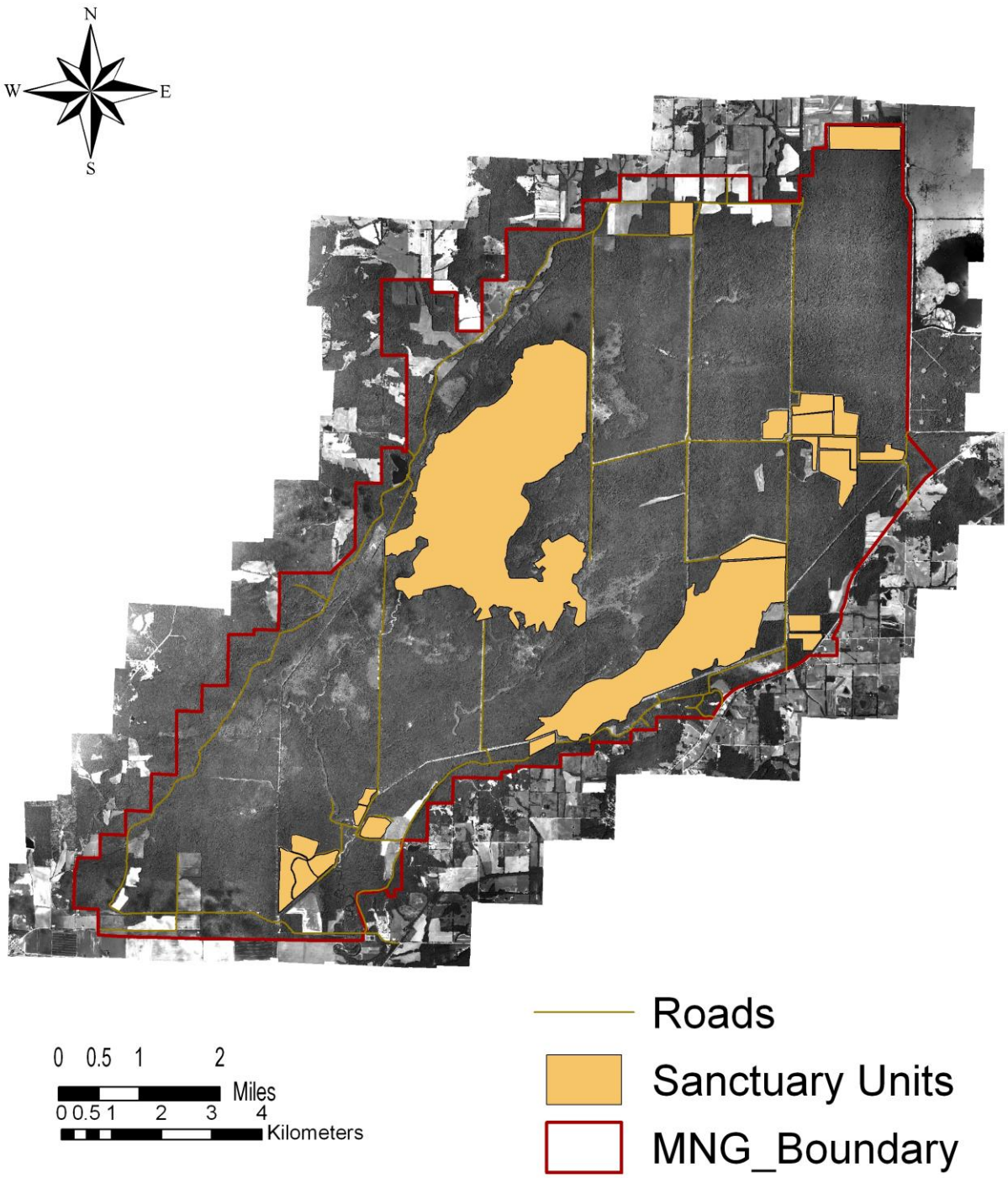


Figure 3: Sanctuary at Mingo NWR

3. Migratory Landbirds

The 15,169 acres of bottomland hardwood forest (including green tree reservoirs) on the refuge provide critical habitat necessary for forest dwelling migratory landbirds. Bottomland hardwoods are of particular importance because several species can co-occupy different components of the vegetation or divergent structural niches. The refuge is currently providing quality habitats for priority species on approximately 765 acres of early successional habitats. The 1315 acres of upland forest provide habitat and act as a buffer to bottomland hardwoods and benefit a variety of priority species.

4. Shorebirds and Waterbirds

Refuge contributions for shorebirds and waterbirds are similar to those mentioned previously for waterfowl and migratory landbirds. The sanctuary, which includes Rockhouse and Monopoly Marshes and the moist soil units will likely be the most widely used area by both shorebirds and waterbirds (Figure 3). Marshes will be managed to provide an array of habitat conditions with varying water levels at different periods throughout the year to encompass the needs of waterfowl, shorebirds, and other waterbirds. Other early successional wetlands and margins of open water areas should also benefit shorebirds and waterbirds. In addition, wading birds will utilize almost every habitat type on the refuge.

5. Aquatic Resources

Refuge management should benefit water quality and hydrology in this portion of the St. Francis River watershed. Partnership efforts with Duck Creek Conservation Area are underway to restore and enhance the watershed. Land restoration and management activities on the refuge should enhance aquatic resources including reptiles and amphibians.

6. Resident Wildlife

The refuge serves as habitat to numerous species of resident wildlife. All resident wildlife species found in southeast Missouri are known to inhabit the refuge at some point during the year. Current management of the refuge will continue to provide necessary habitats for these species.

D. Reconciling conflicting habitat needs

Habitat management activities inherently create short term conflicts between species and species groups that arise as vegetative, soil, or hydrological manipulations are completed. For example, timber harvest or timber stand improvement activities temporarily change the vertical structure and canopy closure in the forest, which can negatively impact forest interior bird species. Additionally, vegetation management in the open lands can adversely affect existing plant communities in the short term. Disking, mowing, flooding, and prescribed fire essentially decimate the existing plant community and

vertical structure upon which some species depend for food, cover, and breeding habitat. Conversely, these same actions benefit other species as desirable vegetation replaces the undesirable plant species or is rejuvenated from the initial treatment, thereby creating desirable habitat conditions. However, these impacts are typically short term in duration and have long term positive benefits for priority species. Today, active wildlife management practices have become essential as natural ecological processes and habitats have been limited and even eliminated in some cases.

In a normal annual hydrological cycle, Mingo NWR has the capacity to meet the habitat needs for the priority wildlife resources of concern. Each year, a complex of different wetland types is provided, either by natural means or through management decisions and manipulations. The manipulation of impounded wetlands influences plant diversity, seed production, and aquatic invertebrate communities. The use of cooperative farming to set back moist soil units encourages desirable vegetation growth and prevents the expenditure of funds by the refuge to achieve this habitat condition. Forested tracts will be managed through sound silvicultural practices to ensure that the forest provides desirable tree species and structural composition which meet the needs of priority species. Consequently, initial conflicts among species groups are remedied through time and kept to a minimum through unit evaluation, prioritization, and planning.

Refuge actions will be dictated and prioritized by establishing purposes and when appropriate, to support objectives established under conservation partnership plans. Management actions will be based on sound science and the best technology to ensure quality management for target natural resources and provide a model for land management. Management efforts will focus on meeting habitat objectives to fulfill the needs of target natural resources, and any conflicts will be resolved by priority decisions based on establishing purposes. For example, the refuge will provide an inviolate sanctuary for wintering waterfowl and other migratory birds. Additionally, refuge management actions will benefit migratory birds, but will emphasize wintering waterfowl management. Likewise, there are objectives to protect, manage, and enhance the ever diminishing bottomland hardwood forest ecosystem, to protect endangered species, and to protect, manage, and enhance habitat for other species of wildlife and plants, and to provide compatible public use opportunities.

IV. Habitat Goals and Objectives

Goals and objectives in this plan are designed to contribute to the population goals and objectives established in regionally, nationally, and internationally significant ecosystem management plans, including the North American Waterfowl Management Plan, Lower Mississippi Valley Joint Venture Plan, Central Hardwoods Joint Venture Plan, PIF, Shorebird Management Manual, Lower Mississippi River Ecosystem Plan, MDC Comprehensive Wildlife Strategy, and other plans relevant to the Lower Mississippi River Valley.

A. Management Strategies

Goal 1 (Waterfowl): Provide a complex of managed wintering and migration habitats for waterfowl that support the population goals and objectives established in the North American Waterfowl Management Plan, Central Hardwoods and Lower Mississippi Valley Joint Venture Plans, and the MDC Comprehensive Wildlife Strategy.

Provide migration, breeding, and wintering habitats to support, on average, 11 million duck energy days (DEDs[1]) based on a 110 day wintering period, and year-round habitat for resident wood ducks and hooded mergansers across the refuge (J. Tirpak, Pers. Comm., September 17, 2010).

Guidelines for minimum duck energy days were predicted by the use of a series of step-down plans, starting with population objectives developed in the North American Waterfowl Management Plan. These values were stepped down to the Lower Mississippi Valley Joint Venture, which in turn determined minimum foraging requirements that needed to be met to support the established goals of the North American Waterfowl Management Plan, and these foraging requirements were then allocated to each state within the Joint Venture. Within each state, coordination meetings were held to determine who could provide the needed habitat requirements, and where among management units and between public and private lands the needed habitat could best be provided. Taking into account sanctuary and foraging requirements, public land managers determined what potential existed on various managed lands to meet the State objectives. For Mingo NWR, these potential objectives were adjusted based on multi-species duck life history requirements and refuge purposes and capabilities (LMVJV 2007).

Objective 1.1**:** Maintain the current core waterfowl management area (4000 acres) as an inviolate sanctuary (Figure 3) for waterfowl and other migratory birds where little to no disturbance factors are allowed during the critical winter period (November to March). This area includes Monopoly and Rockhouse Marshes, and all of the moist soil units.

Rationale Statement: Current management includes a 4000 acre sanctuary area. This area provides a place for migratory waterfowl to feed and rest without harassment.

Strategy1.1.1: Continue with seasonal closures of the established 4000 acre sanctuary from November to March, and annually conduct maintenance on boundary signs as needed.

[1]A duck energy day (DED) = Food Available (g [dry]) x TME (kcal/g [dry])/Daily Energy Requirements (kcal/day)

Objective 1.2**:** Through water manipulation, planting, mechanical, and chemical treatments provide quality moist soil habitat and high energy food resources for waterfowl. Provide a minimum of 800 acres of managed moist soil units (Figure 2) that annually produce an average of 3 million DEDs in support of the average of 11 million DED objective at Mingo NWR (J. Tirpak, Pers. Comm).

Rationale Statement: Management of moist-soil wetlands is an effective strategy to provide foraging habitat for migrating and wintering waterfowl (Fredrickson and Taylor 1982, Reinecke et al. 1989, Kaminski et al. 2003).

Strategy 1.2.1: Utilizing the refuge cooperative farming program, disturb a portion of the moist soil units by light or heavy disking and/or the planting of agricultural crops on average up to 25% of the moist soil acreage, a minimum of once every three years to maximize seed production in moist soil habitats within the agriculture/moist soil management unit.

Strategy 1.2.2: Annually flood designated impoundments to a depth of 18 inches or less during the period of October through March to ensure available habitat for waterfowl within the agriculture/moist soil management unit.

Strategy 1.2.3: On a rotational basis, shallow flood (< 9 inches in depth) a minimum of 25 acres of designated moist soil habitat within the agriculture/moist soil management unit for teal and other early migrating waterfowl from August to October each year.

Strategy 1.2.4: Annually perform early (March 1 to April 15), mid (April 15 to June 1), or late (June 1 to July 15) season draw-downs within designated moist soil areas to encourage the production of annual beneficial moist soil plants in the production of 3 million DED objective.

Strategy 1.2.5: During the period of June through September each year, use mechanical, fire, or chemical treatments to reduce undesirable plant communities such as cocklebur and sesbania to levels that do not negatively impact seed production of moist soil habitats.

Strategy 1.2.6: Utilizing the refuge cooperative farming program, according to established USDA guidelines, provide unharvested crops within the agriculture/moist soil management unit to support the objective of 3 million DED on average per year.

Strategy 1.2.7: Add/Maintain/Replace water control structures and wells

as need to maintain or enhance the refuge's ability to manage water levels in the moist soil units.

Strategy 1.2.8: Continue to monitor and treat nuisance animal species within the moist soil units following guidance outlined in the Mingo Nuisance Species Plan and subsequent Environmental Assessment. This will allow staff to better manage water levels in the moist soil units and prevent water from standing during growing season or treatment windows. By managing nuisance species to prevent or reduce damage to structures, the structure will have a greater function period and require less maintenance.

Strategy 1.2.9: Monitor water quality and soil conditions in the moist soil units. Water quality measurements should be taken in spring when water is being removed from the units. Soil samples should be taken as needed to determine pH, nutrient levels, and any other pertinent measurements. These levels can be used to determine if there are limiting factors in the production of desirable vegetative conditions within each unit.

Objective 1.3: Within 100-200 years, and on 70% of the refuge BLH, including GTR, achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5' MSL with lowest elevations dominated by bald cypress and water tupelo; low elevations dominated by overcup oak, red maple, green ash and water hickory; intermediate elevations dominated by pin oak, sugarberry, American elm, sweetgum, and willow oak; and high elevations dominated by willow and cherrybark oaks, shagbark and shellbark hickory, sweetgum, post oak, American elm, and green ash (Table 5) (Heitmeyer et al. 2006).

Rationale Statement: Prior to European settlement, about 2.4 million acres of BLH and associated habitats covered most of southeast Missouri including the Mingo Basin (Korte and Fredrickson 1977, MacDonald et al. 1979, Heitmeyer et al. 2006). Currently, less than 80,000 acres of BLH remains; the largest contiguous block (ca. 17,000 acres) is within the Mingo Basin (Twedt and Loesch 1999, Heitmeyer et al. 2006).

Table 5. Desired forest conditions in the MAV (LMVJV 2007).

Habitat Type	Percent of Area	Description
Forest Cover	70-100%	Large (>10,000 acre) contiguous forested areas are desired. At any point in time, a minimum 35% and optimum 50% of the forest should meet the desired stand structure conditions.
Actively Managed Forest	70-95%	Forests that are managed via prescribed silvicultural treatments to meet desired stand conditions.
-Regenerating Forest	< 10%	Forest regeneration on areas > 7 acres (e.g., clearcuts where >80% of overstory has been removed) or forest restoration on agricultural lands (i.e., reforestation). However, achieving increased forest cover via reforestation overrides the 10% limitation.
-Shrub/Scrub	< 5%	Thamnic woody vegetation (hydric or mesic) within bottom-land forests, including forests in early seral (successional) stages.
Passively Managed Forest	5-30%	Forest areas that are not subjected to silvicultural manipulation (e.g., no-cut, wilderness, set-aside, and natural areas).

Objective 1.3.A: Within 15 years, ensure that approximately 20 percent (with a long-term target of 40 percent) of stands in GTR (Figure 2) presently dominated by overcup oak, red maple and their associates are converting to red oak species, willow oak, and their associates based on regeneration surveys. GTR are bottomland hardwood forest that can be actively managed through water control structures. The units are managed to avoid having standing water when trees are actively growing.

Rationale Statement: Red oak species, willow oak, and their associates provide an important food source for wintering waterfowl (Kaminski et al. 2003). Reducing the amount of forest converting to soft mass and less desirable oak species will provide additional forage and cover habitat for waterfowl.

Strategy 1.3.A.1: Conduct forest surveys or inventories every 5 years to monitor changes in health, composition, and structure of bottomland hardwood forests.

Strategy 1.3.A.2: Develop and implement 5-year forest management plan. This plan will include detailed descriptions of techniques, areas, schedules and time frames for forest management within the refuge.

Some techniques that may be utilized to meet objectives outlined in Table 6 include: mid-story removal, select harvest, under-story removal, girdling, chemical, and small patch clear-cuts of one to four acres to resemble large group selection cuts, thereby creating patches of even-aged regeneration that are too small to manage as individual stands (LMVJV 2007). This technique of small patch clear cuts essentially produces an uneven-aged stand that consists of many small, irregularly shaped, even-aged groups. Although patch cutting is a complicated and intensive approach to forest management, it can, if applied properly, produce the biological conditions necessary for the successful establishment and development of bottomland oak reproduction (Meadows and Stanturf 1997). As an uneven-aged system, a series of cutting cycles on a five to ten year basis will be established. The specific cutting interval will be determined for each site based on site conditions.

Clearcutting is the most proven and widely used method of successfully regenerating bottomland oaks species in the South (Clatterbuck and Meadows 1993). However, successful regeneration of oak through clearcutting is normally contingent on three important requirements: (1) the presence of adequate oak advanced reproduction in the stand prior to clearcutting, (2) adequate sprouting potential of stumps from severed oak stems and (3) cutting of all stems, both merchantable and non-merchantable, during the harvest operation (Meadows and Stanturf 1997).

Revegetation by acorn planting or tree planting into areas impacted by natural stochastic events such as tornadoes, storms, and insect induced losses may occur when the opportunity presents itself.

Objective 1.3.B**:** Establish red oak regeneration on areas where a seed source is present through sound silvicultural practices.

Rationale Statement: Red oak species, willow oak, and their associates provide an important food source for wintering waterfowl (Kaminski et al. 2003). Reducing the amount of forest converting to soft mass and less desirable oak species will provide additional forage and cover habitat for waterfowl.

Strategy1.3.B.1: Following the advanced red oak regeneration survey, areas with red oak regeneration, but inadequate advanced regeneration will

be identified. This will also include areas with mature red oaks that do not contain red oak regeneration. A treatment method will be chosen utilizing Table 6 to develop and release red oak regeneration on these sites. This method involves the gradual removal of the entire stand in a series of partial cuttings which extend for a fraction (20 percent or less) of the rotation. The cuttings resemble heavy thinnings and are intended to remove undesirable species leaving desirable red oak species to provide seeds to develop advanced regeneration. Once the advance regeneration is established the remaining overstory is removed.

Objective 1.3.C**:** In the absence of red oak seed sources, red oak regeneration will be established through sound silvicultural practices.

Rationale Statement: Red oak species, willow oak, and their associates provide an important food source for wintering waterfowl (Kaminski et al. 2003). Reducing the amount of forest converting to soft mass and less desirable oak species will provide additional forage and cover habitat for waterfowl.

Strategy 1.3.C.1: Following the advanced red oak regeneration survey, areas without mature red oaks and consequently no red oak regeneration will be identified. One of the following two treatments will be outlined in the forest management plan and implemented on the sites to reestablish red oaks:

1) Under-plant red oak seedlings on areas in which the understory and mid-story may be removed by harvest, mechanical or chemical treatments to provide sunlight for the seedlings; site size will be from three to ten acres. When the seedlings are planted and established the overstory should be removed.

2) Clearcut, prepare site, and plant red oak seedlings in three to ten acre blocks. This is a very intensive method in which all stems down to two inches DBH are removed. Following the cut, control of less desirable species will be needed. Stump and root sprouts along with invasion of species with light seeds will hinder or prevent the development of the red oak seedlings. Prescribed fire, chemical, or mechanical methods will be used to control competing vegetation before and/or after planting red oak seedlings. Prescribed fire will be applied in the late summer through late winter months.

Table 6. Desired stand conditions for bottomland hardwood forests within the Mississippi Alluvial Valley (LMVJV 2007).

Forest Variables[1]	**Desired Stand Structure**	**Conditions That May Warrant Management**
Primary Management Factors		
Overstory Canopy Cover	60-70%	> 80%
Midstory Cover	25-40%	< 20% or > 50%
Basal Area	60-70 ft^2/acre with ≥ 25% in older age classes[2]	> 90 ft^2/acre or ≥ 60% in older age classes
Tree Stocking	60-70%	< 50% or > 90%
Secondary Management Factors		
Dominant Trees[3]	> 2/acre	< 1/acre
Understory Cover	25-40%	< 20%
Regeneration[4]	30-40% of area	< 20% of area
Coarse Woody Debris (>10 inch diameter)	≥ 200 ft^3/acre	< 100 ft^3/acre
Small Cavities (<10 inch diameter)	> 4 visible holes/acre or > 4 "snag" stems ≥ 4 inch dbh or ≥ 2 stems > 20 inch dbh	< 2 visible holes/acre or < 2 snags ≥ 4 inch dbh or < 1 stem ≥ 20 inch dbh
Den Trees/Large Cavities[5] (>10 inch diameter)	1 visible hole/10 acres or ≥ 2 stems ≥ 26 inch dbh (≥ 8 ft^2 BA ≥ 26 inch dbh)	0 visible holes/10 acres or < 1 stem ≥ 26 inch dbh (< 4 ft^2 BA ≥ 26 inch dbh)
Standing Dead and/or Stressed Trees[5]	> 6 stems/acre ≥ 10 inch dbh or ≥ 2 stems ≥ 20 inch dbh (> 4 ft^2 BA ≥ 10 inch dbh)	< 4 stems ≥ 10 inch dbh/acre or < 1 stem ≥ 20 inch dbh (< 2 ft^2 BA ≥ 10 inch dbh)

1 Promotion of species and structural diversity within stands is the underlying principle of management. Management should promote vines, cane, and Spanish moss within site limitations.
2 "Older age class" stems are those approaching biological maturity, (i.e., senescence). We do not advocate aging individual trees but use of species-site-size relationships as a practical surrogate to discern age.
3 Dominants (a.k.a. emergents) should have stronger consideration on more diverse sites, such as ridges and first bottoms.
4 Advanced regeneration of shade-intolerant trees in sufficient numbers (circa 400/acre) to ensure their succession to forest canopy. Areas lacking canopy (i.e., group cuts) should be restricted to < 20% of stand area. 5 Utilizing BA parameters allows the forest manager to maintain this variable in size classes that are most suit-able for the stand instead of using specific size classes noted.

The sum of regeneration cuts for all three sub-strategies should average one percent of the available red oak sites per year. In order to take advantage of years with good acorn crops, up to 750 acres may be treated, with no area being greater than 10 acres, in a year, leaving several years in which no regeneration cuts are made. Priority will be given to advanced red oak regeneration areas, then to areas with insufficient red oak regeneration, and finally to areas which are red oak sites, but without the presence of red oaks either in the overstory or the understory. Following the regeneration cut, a series of intermediate treatments will be employed on a ten year interval to develop the red oak to a mature condition. The intermediate treatments include thinnings and the use of herbicide to remove less desirable stems. Stem removal and mechanical treatments will be conducted in late summer to early fall in order to minimize soil compaction/rutting. Chemical treatment will occur after August through late winter.

Objective 1.3.D**:** Improve refuge staff's ability to control water levels and improve natural flow in bottomland hardwood forest by removing, building, or modifying an existing water control structures, low-water crossing, or ditch impediments to enhance natural flows (Projects in strategies by priority).

Rationale Statement: The ability to control water is the most important management tool for refuge staff. Much of the current infrastructure is undersized, non-functioning, or acts as a barrier to desired hydrologic conditions. The most critical infrastructure need is the completion of a new spillway of proper size and elevation.

Strategy 1.3.D.1: Creation of a low-water crossing between Gum Stump Pool and Monopoly Marsh on Ditch 4 to enhance water management abilities in the pool.

Strategy 1.3.D.2: Installation of a low-water crossing between Gum Stump Pool and Pool 4 to enhance water management abilities in the pools.

Strategy 1.3.D.3: Installation of a water management device at Molly's Curve to allow for water management in the Stanley Creek Impoundment and Monopoly Marsh.

Strategy 1.3.D.4: Evaluate the removal of the Ditch 10 "plug" inventory and monitoring to allow for water management of the Stanley Creek Impoundment.

Strategy 1.3.D.5: Continue to monitor and treat nuisance species within bottomland hardwoods following guidance outlined in the Mingo

Nuisance Species Plan and subsequent Environmental Assessment. This will allow staff to better manage water levels in the bottomland hardwood areas and prevent water from standing in trees during the growing period.

Strategy 1.3.D.6: Evaluate and reconnect natural sloughs on the northeast portion of the refuge where feasible. Techniques to accomplish this may include lowering or removing of levees or roads, bisecting of channels, and clearing and removing debris from slough channels (Heitmeyer et al. 2006).

Strategy 1.3.D.7: Evaluate and restore areas that provide sheetflow across GTR and BLH flats by removing unnecessary roads, levees, and ditches in the refuge (Heitmeyer et al. 2006).

Strategy 1.3.D.8: Add/Maintain/Replace water control structures and wells as needed to maintain or enhance the refuge's ability to manage water levels in the moist soil units.

Objective 1.4**:** Manage four GTR (Pools 4, 5, 7, and 8), totaling 6,308 acres, for no more than 130 consecutive days annually between November and March avoiding the flooding of units prior to tree dormancy. Drain water prior to growing season to encourage regeneration and avoid killing trees. Under dry conditions water may be held in GTR into spring to provide wood duck and hooded merganser breeding habitat. Flooding into spring during dry conditions would not occur more than two consecutive seasons in the same GTR.

Rationale Statement: The ability to control water is critical in the management of GTR. Current conditions such as man-made barriers, non-functioning or undersized structures and nuisance animals all impede the ability to manage water in the GTR.

Strategy 1.4.1: Installation of a low-water crossing between Pool 7 and Gum Stump Pool to enhance water management abilities in the pools.

Strategy 1.4.2: Evaluate and reconnect natural sloughs on the northeast portion of the refuge where feasible. Techniques to accomplish this may include lowering or removing of levees or roads, bisecting of channels, clearing and removing debris from slough channels (Heitmeyer et al 2006).

Strategy 1.4.3: Evaluate and restore areas that provide sheetflow across GTR and BLH flats by removing unnecessary roads, levees, and ditches in the refuge (Heitmeyer et al. 2006).

Strategy 1.4.4: Add/Maintain/Replace water control structures and wells as need to maintain or enhance the refuge's ability to manage water levels in the moist soil units.

Strategy 1.4.5: Continue to monitor and treat nuisance species within bottomland hardwoods following guidance outlined in the Mingo Nuisance Species Plan and subsequent Environmental assessment. This will allow staff to better manage water levels in the GTR and prevent water from standing in trees during the growing period.

Strategy 1.4.6: Use bathymetry and map each GTR to enhance management capabilities for hydrologic control in each unit.

Objective 1.5: Over the next 15 years, maintain 2,008 acres of open marsh habitat within Monopoly Marsh (Figure 2) comprised of a mixture of desirable submergent, floating, and emergent vegetation to produce between 1 and 6 million DEDs per year with higher production in drawdown years. Ensure that summer pool (April-October) is maintained at or below 335' MSL whenever possible.

Rationale Statement: The water management of Monopoly Marsh is highly dependent on rainfall amounts and the timing of those events. If rainfall levels and timing prohibit the planned water level objective for that year, water level plans should be reevaluated and the planned water level for that season should be achieved the following year. For example, if the plan calls for a draw down of Monopoly for the upcoming summer and the refuge receives large amounts of rainfall early in the year, the plan could be changed to a high water year (335' MSL) for that summer and a drawdown should occur the following summer (Table 7).

Strategy 1.5.1: Draw down Monopoly Marsh to the greatest extent possible 2 out of 5 years (Table 7) alternating with drawdowns for Rockhouse Marsh over that time period.

Strategy 1.5.2: Draw down Monopoly Marsh incrementally over 10 years to progressively expose edge habitats allowing for eventual restoration of about 225 acres to bald cypress and water tupelo.

Strategy 1.5.3: Accelerate removal of willow and promote fluctuating water levels via enhanced water level control capability.

Strategy 1.5.4: Conduct vegetation surveys every 5 years to gauge success of reforestation along perimeter of Monopoly Marsh.

Strategy 1.5.5: Conduct vegetation surveys every 2 years to monitor expansion of emergent vegetation in the basin and take appropriate management action using hydrologic manipulation, chemical, mechanical

or fire to control these species if species density and/or composition is not at desired states.

Strategy 1.5.6: Installation of a water management device at Ditch 6 and Ditch 10 to allow for water management capabilities for Monopoly Marsh.

Strategy 1.5.7: Add/Maintain/Replace water control structures as need to maintain or enhance the refuge's ability to manage water levels on Monopoly Marsh.

Strategy 1.5.8: Continue to monitor and treat nuisance species within Monopoly Marsh following guidance outlined in the Mingo Nuisance Species Plan and subsequent Environmental Assessment. This will allow staff to better manage water levels in Monopoly Marsh and prevent water from standing during growing season or treatment windows.

Strategy 1.5.9: Evaluate and if needed, install an emergency spillway at the Ditch 5 structure to allow water management in Monopoly Marsh during high flow events.

Table 7. Example of water regimes on a five year rotation at summer pool for Monopoly and Rockhouse Marshes.

	Rockhouse Marsh	**Monopoly Marsh**
Year 1	334 **(**Dry)	335
Year 2	335.5	333 (Dry)
Year 3	334.5	334.5
Year 4	334 (Dry)	334
Year 5	335	333 (Dry)

Objective 1.6: Over the next 15 years, maintain 903 acres of open marsh habitat within Rockhouse Marsh (Figure 2) comprised of a mixture of desirable submergent, floating, and emergent vegetation to produce between 0.5 and 3.5 million DEDs per year with higher production in drawdown years. Ensure that summer pool (April-October) is maintained at or below 335.5' MSL whenever possible.

Rationale Statement: The water management of Rockhouse Marsh is highly dependent on rainfall amounts and the timing of those events. If rainfall levels and timing prohibit the planned water level objective for that year, water level plans should be reevaluated and the planned water level for that season should be achieved the following year. For example, if the plan called for a draw down of

Rockhouse for the upcoming summer and the refuge receives large amounts of rainfall early in the year, the plan could be changed to a high water year (335.5' MSL) for that summer and a drawdown should occur the following summer (Table 7).

Strategy 1.6.1: Drawdown Rockhouse Marsh to 334' MSL two out of every 5 years (Table 7) to remove woody vegetation (willow) and enhance herbaceous food sources for waterfowl. Alternate this drawdown with Monopoly Marsh drawdown whenever possible to provide habitat every year in at least one marsh. Re-flood the marsh to benefit migrating waterfowl, varying the timing based management objectives and migration timing.

Strategy 1.6.2: Keep Rockhouse Marsh at 335.5' MSL one year out of every 5, alternating high water level with Monopoly Marsh drawdown whenever possible.

Strategy 1.6.3: Accelerate the removal of willow during complete and intermediate drawdown years and promote fluctuating water levels via enhanced water level control capability.

Strategy 1.6.4: Add/Maintain/Replace water control structures as needed to maintain or enhance the refuge's ability to manage water levels.

Strategy 1.6.5: Continue to monitor and treat nuisance species within Rockhouse Marsh following guidance outlined in the Mingo Nuisance Species Plan and subsequent Environmental Assessment. This will allow staff to better manage water levels in the marsh and prevent water from standing during growing season or treatment windows.

Objective 1.7**:** Over the next 15 years, monitor, treat and evaluate invasive and exotic species on 21,592 acres to minimize or remove the impact to waterfowl habitat.

Rationale Statement: Invasive species impact native habitats by outcompeting and replacing native species that are utilized by waterfowl and other species. Through recent surveys it is estimated that 20-25% of the refuge has some level of infestation.

Strategy 1.7.1: Monitor for new and existing populations of invasive and exotic species throughout the refuge. Track all known populations of vegetative invasive species through the use of GIS and a "weeds" database.

Strategy 1.7.2: Use mechanical, chemical, fire, or other appropriate tools to manage or eradicate invasive and exotic species throughout the refuge.

Objective 1.8: Manage open water habitat to facilitate water management on 77 miles of flowing water and 387 acres of water bodies. Ditches play a critical role in maintaining desired hydrological conditions in management units throughout the refuge. The maintenance and improvement of these ditches are critical to waterfowl habitat management.

Rationale Statement: The ditches at Mingo provide the ability to manage water throughout the refuge. These ditches serve as habitat for numerous species and allow the flooding and dewatering of units for proper management.

Strategy 1.8.1: Annually monitor ditches for siltation or debris that could restrict water flow resulting in undesirable hydrologic conditions in management units.

Strategy 1.8.2: Remove debris or siltation as needed in ditches across the refuge to maintain flow and allow water management in all units of the refuge.

Strategy 1.8.3: Drawdown Redmill pond once every 3-5 years to promote desired vegetation production and provide and opportunity to control woody vegetation through mechanical and/or chemical treatments. Drawdown should occur early so that there is a minimal amount of mineral soil exposure during the willow seeding cycle in June.

Strategy 1.8.4: Complete bathymetry analysis and create a map showing elevation and flow for each ditch to aid in hydrologic calculations and use in the water management plan.

Objective 1.9: Replace and change the elevation of the current spillway. The ability to efficiently and adequately move water off of the refuge will improve the hydrological conditions for all water dependent habitat classes.

Rationale Statement: The current spillway is undersized and at an elevation that is 5-6 ft too high. During high rainfall events and during normal drawdowns, the spillway prevents water movement from occurring at optimal efficiency on the refuge and adjoining lands. The replacement of the existing spillway is the priority infrastructure project on the refuge.

Strategy 1.9.1: Replace the existing spillway with a structure at the appropriate elevation and location to allow for improved efficiency and adequateness of water removal.

Goal 2 (Endangered and Threatened Species): Protect, manage, and enhance refuge habitats in a manner that will sustain or increase species' populations.

Enhance, restore, protect, and manage imperiled species' habitat using all available

conservation tools, including habitat management on 21,592 acres of refuge lands.

Part of the USFWS mission is to protect, enhance, and manage habitat for threatened and endangered species, in compliance with the Endangered Species Act. Refuge resource management emphasizes the protection of threatened and endangered species and efforts to protect and manage these habitats will be conducted.

Objective 2.1: Provide habitat to support the recovery of the endangered Indiana bat, through habitat protection and enhancement and through population monitoring.

Rationale Statement: Endangered species recovery and habitat management is part of the USFWS mission and the mission of Mingo NWR. All applicable activity will take Indiana bats into consideration whether intra-agency Section 7 consultation is needed or not. Whenever possible, actions that are recommended in the recovery plan will be implemented.

Strategy 2.1.1: Identify and protect, during summer roost period, large trees (>9" DBH) and snags that are suitable for roosting sites (USFWS 2007a) on the approximately 15,000 acres of bottomland hardwood forest for potential roost habitat.

Strategy 2.1.2: Implement actions outlined in the 2007 Indiana Bat Draft Recovery Plan: First Revision (USFWS 2007a) and in the 5-year Review for Indiana bats (USFWS 2009).

Strategy 2.1.3: Monitor known roost sites and develop and implement a monitoring plan for suitable roost areas refuge-wide.

Goal 3 (Migratory Landbirds): Provide a complex of habitats which meet the breeding, migration, and wintering needs of the species of management concern (Table 4) as identified in the goals and objectives of the PIF plans. (All of the forest management techniques outlined in Objective 1.3a-d are applicable to Migratory Landbird Habitat Management).

Objective 3.1**:** Through management, restoration and protection of up to 21,592 acre block of refuge lands (Figure 4) provide sufficient habitat to support migratory landbirds specifically the species of management concern.

Rationale Statement: Various habitat types are currently available for migratory landbirds at Mingo NWR. As a unit, each habitat type will be managed with migratory bird habitat needs in mind and balanced with the needs of other species.

Strategy 3.1.1**:** Maintain 16,000 acres or more of forested habitats on

Mingo NWR and work with adjoining partners and landowners to protect and expand large blocks of forest where possible. Establish a monitoring program to identify high quality areas on the refuge for priority species.

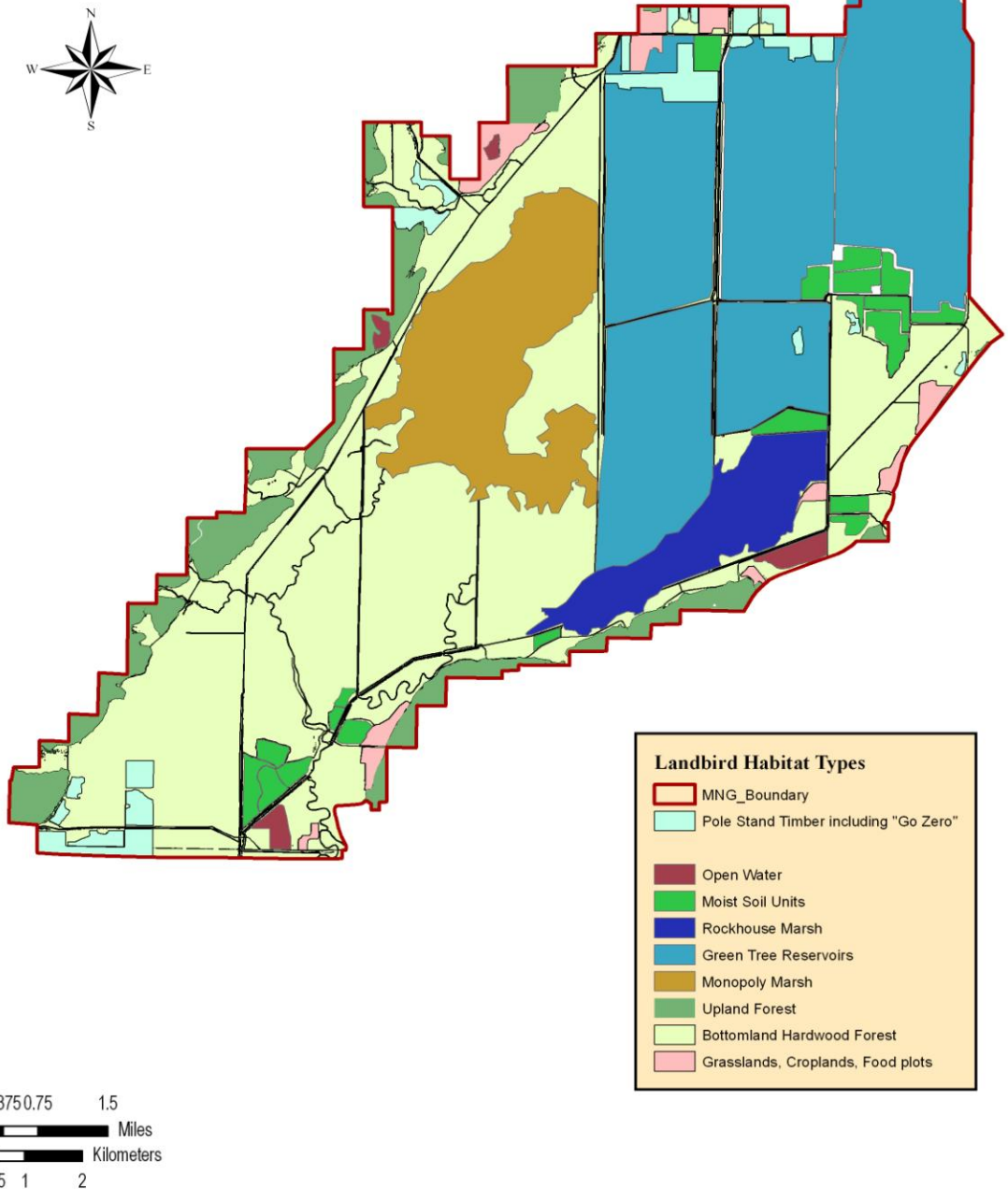


Figure 4: Landbird Habitat Types at Mingo NWR

Objective 3.2: Over the next 15 years, manage, restore and maintain 1,315 acres of upland forests (Figure 4) to provide quality habitat for migratory birds.

Rationale Statement: The upland forests at Mingo NWR are mature and provide habitat for numerous species of migratory birds. Most of the upland forest stands are considered in good health and don't require much active management.

Strategy 3.2.1: Manipulate forest stand composition and structure through reforestation, fire, improvement cuts, thinning, regeneration cuts, and timber stand improvements to create desirable species composition, large trees, and vertical structure for migratory birds.

Strategy 3.2.2: Treat areas infested with autumn olive, multiflora rose and other invasive species to protect and enhance upland forest habitats.

Objective 3.3**:** Establish and expand existing stands of giant cane throughout bottomland hardwood areas of the refuge.

Rationale Statement: There are 21 mapped giant cane stands occurring in small scattered breaks throughout the refuge. Cane stands provide habitat for many important bird species including White-eyed Vireo, Kentucky Warbler, Swainson's Warbler, and Hooded Warbler (Sallabanks et al. 2000). This habitat is considered important for numerous species and will be actively managed on the refuge.

Strategy 3.3.1: Continue to grow, monitor, and transplant cane into suitable habitats on forest edges, fields and in natural and man-made opening within large blocks of forest.

Strategy 3.3.2: Conduct forest thinning projects on existing cane stands to enhance light penetration and improve stand health. This treatment would include removal of mid-story and/or overstory trees in existing cane breaks through the use of chemical, fire, or mechanical treatments.

Objective 3.4: Manage and maintain 765 acres of pole stand (Figure 4) and early successional forested areas through mechanical, chemical and fire treatments.

Rationale Statement: Pole stand timber occurs throughout the refuge and is either

recent tree plantings (Go Zero Program) or is agricultural fields that have been allowed to naturally convert. Most pole stands on the refuge are 1-20 years old. This habitat will be maintained through existing stands or by planting or converting open areas in the future.

Strategy 3.4.1: Maintain and enhance pole stand and early successional stands of forest by prescribe burning, mowing/haying, and/or herbicidal treatments. These actions serve to promote new growth, enhance existing stands, and setback plant succession. Each unit will be treated, pending resource availability, on a 5 to 12 year cycle.

Strategy 3.4.2: Monitor tree survival rates and bird utilization of the 369 acre "Go Zero" parcels (Figure 5). Tree survival should be conducted annually for the first 5 years by surveying twelve, 100 tree plots that are established. Bird utilization surveys will be conducted on annually in years 1-5 and then every five years for the life of the project. This will be accomplished through point counts already set up within the 16 plots.

Objective 3.5: Monitor RNAs for vegetative, noxious or invasive weeds, habitat, nuisance species and/or any additional important ecological and scientific values.

Rationale Statement: Research Natural Areas were established at Mingo NWR in 1970 as representative areas for each of their respective habitat types. These areas were considered rare and disappearing in the 1970s and efforts were made to set aside each area so that it could continue to represent the increasingly rare forest stand. No active management or disturbance will occur on the RNA.

Strategy 3.5.1: Accurately map and mark each corner for each of the seven RNAs.

Strategy 3.5.2: Develop and implement a monitoring plan for each of the seven RNAs within the next 10 years.

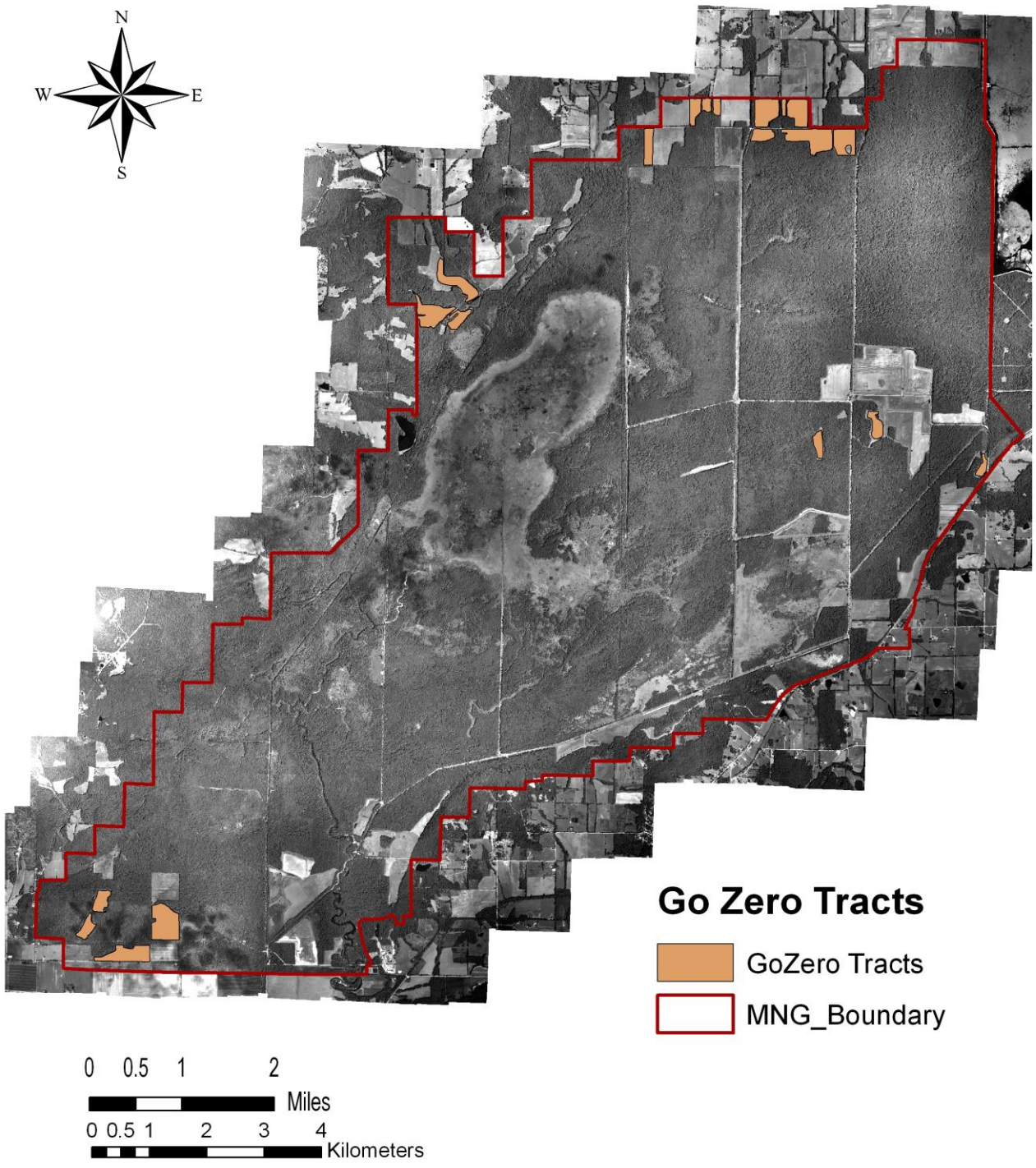


Figure 5: Go Zero Tracts

Goal 4 (Shorebirds and Waterbirds): Provide diverse habitats for shorebirds and waterbirds during critical periods throughout the year to increase bird use on the refuge and develop traditional use site.

Shorebirds annually migrate through the LMRV from the southernmost parts of South America to the northernmost parts of North America. Foraging habitat (mudflats and shallow water areas) objectives were recommended for fall migrating shorebirds by the U.S. Shorebird Working Group and a smaller group of shorebird experts working in the LMRV (Elliott and McKnight 2000). These ecosystem objectives were then stepped down to private and public lands.

Objective 4.1: Time drawdowns of impounded wetlands to provide a minimum of 500 acres of shallowly flooded mudflat habitats with < 25% vegetative cover and varying water levels (< 8 inches in depth) to support shorebirds during spring migration (March to May).

Rationale Statement: Mingo NWR currently provides a minimum of 500 acres of shallowly flooded areas in the moist soil units, Rockhouse Marsh, and Monopoly Marsh. Each year, on a rotational basis, some moist soil units will be drawn down to provide spring habitat based on water levels and disturbance cycles for each unit. These areas will provide feeding and resting areas in the spring for migrating shorebirds.

Strategy 4.1.1: During the spring migratory period, units in the agriculture/moist soil unit (Figure 2) are drawn down slowly ($\leq$ 3 inches per week) to allow for continuous availability of invertebrates. Stagger the initial drawdown dates of identified units across a period of three to six weeks to extend the availability of habitat and provide resources throughout the migratory period. This will also promote a diverse vegetation community within the complex.

Strategy 4.1.2: The drawdown schedule of Monopoly and Rockhouse Marshes will vary on an annual basis (see waterfowl objective 1.1.5 and 6). On complete drawdown years, the minimum 500 acres will be met in other units. On years where a slow, variable drawdown occurs, spring shorebird acreage will be substantially higher than the 500 acre minimum.

Strategy 4.1.3: Maintain stable water levels at 1 to 6 inches across 80 to 90 acres of moist soil units from March through July 31 and encourage a mosaic of moist soil plants such as softstem bulrush (*Schoenoplectus tabernaemontani*), giant cutgrass (*Zizaniopsis miliacea*), prairie cordgrass (*Spartina pectinata*) and cattail (*Typus spp*.) to provide medium height cover (2-6 feet) interspersed with small areas of mud flats and shallow depressions as nesting habitat for King Rails.

Objective 4.2**:** Provide a minimum of 500 acres of shallowly flooded mudflat habitats with < 25% vegetative cover and varying water levels (< 8 inches in depth) to support shorebirds during fall migration (July to October).

Rationale Statement: Mingo NWR currently provides a minimum of 500 acres of shallowly flooded areas in the moist soil units, Rockhouse marsh, and monopoly marsh. Each year moist soil units will be rotated to provide fall habitat based on water levels and disturbance cycles for each unit. These areas will provide feeding and resting areas in the fall for migrating shorebirds.

Strategy 4.2.1: Before fall migration begins (May-June), designate desired area(s) as shorebird habitat units. Shallow disc (2-3 inches) designated areas in mid-summer. Do not disc deep into the soil because this will bury the plant biomass which will reduce the availability of plant material for invertebrate utilization: Shallow flood selected areas to a depth of 4 to 6 inches two to three weeks before fall migration begins to allow invertebrates to re-populate the newly created habitats.

Strategy 4.2.2: Maintain stable water levels of 1 inch or less across 10 to 20 acres of moist soil units from April through August 15, and encourage a vegetative monotype of *Eleocharis* spp. (spikerushes), sedges, or other wetland/wet prairie grasses that provide dense low cover (2 feet or less) interspersed with small areas of mudflats and shallow depressions to provide nesting habitat for Black Rails.

Strategy 4.2.3: Annually disturb the 10 to 20 acres of moist soil managed for Black Rails to remove unwanted vegetation while maintaining level ground capable of providing stable water levels of 1 inch or less.

Objective 4.3: Identify a minimum of 1000 acres of impounded wetlands to provide shallow water feeding areas for wading birds and marshbirds during summer (May-July).

Rationale Statement: Mingo NWR currently provides a minimum of 1000 acres of flooded areas in the moist soil units, ditches, Redmill Pond, Rockhouse Marsh, and Monopoly Marsh. Each year moist soil units will be rotated to provide summer habitat based on water levels and disturbance cycles for each unit. These areas will provide feeding areas in the summer for wading birds.

Strategy 4.3.1: Designate the desired acreage in these Moist Soil units for wading birds, and hold water at a depth of <18 inches on the lower end of selected units through the summer to provide food resources such as fish

and crustaceans.

Strategy 4.3.2: Monopoly and Rockhouse Marshes will provide varying amounts of waterbird habitat depending on the draw down schedule (see waterfowl objective1.5 and 1.6) for the marshes in a given year. Years with complete drawdown, the minimum of 1000 acres will be achieved in other units of the refuge. On years where the marshes are not drawdown completely, 3000 or more acres will be provided for waterbird habitat.

Objective 4.4: Provide a minimum of 200 acres of emergent marsh habitat through water management and by mechanical, chemical or fire disturbances. This habitat will consist of a 50:50 ratio of open water interspersed with vegetation (i.e. "hemi-marsh") to produce desirable conditions for marshbirds. Provide open water conditions throughout the year from 6 inches to 3 ft in depth.

Rationale Statement: Mingo NWR currently provides a minimum of 200 acres of hemi-marsh in Redmill Pond, Rockhouse Marsh, and Monopoly Marsh. Each year, areas will be evaluated and treated in spring for habitat, based on water levels and disturbance cycles for each unit. These areas will provide feeding, nesting and brood rearing areas in the spring and summer for marshbirds.

Strategy 4.4.1: When vegetation increases to greater than 60% coverage to open water, mow and heavy disk to setback plant succession.

Objective 4.5**:** Monitor shorebird and wading bird populations on the refuge to determine trends and habitat usage on the refuge. Monitoring should be used to determine if habitat management is resulting in additional utilization by these species.

Rationale Statement: Currently the refuge does not monitor shorebird or wading birds specifically. It remains unclear how current management techniques are impacting shorebirds, wading birds, and marsh birds.

Strategy 4.5.1: Conduct shorebird and waterbird surveys using the USFWS Intergraded Waterbird Monitoring Protocol.

Strategy 4.5.2: Conduct rookery surveys on the refuge to determine location, utilization, and species composition.

Objective 4.6**:** Monitor, treat and evaluate invasive and exotic species on Mingo NWR to minimize or remove the impact to shorebird and waterbird habitat.

Rationale Statement: Invasive species continue to negatively impact habitats throughout the refuge. By monitoring and treating these areas, we will improve native habitats and provide more areas for feeding and cover.

Strategy 4.6.1: Monitor for new and existing populations of invasive and exotic species throughout the refuge. Track all known populations of vegetative invasive species through the use of GIS and a "weeds" database.

Strategy 4.6.2: Use mechanical, chemical, fire, or other appropriate tools to manage or eradicate invasive and exotic species throughout the refuge.

Goal 5 (Aquatic Resources): Maintain or improve aquatic habitat quantity, quality, and diversity to sustain or increase population levels of aquatic resources on the refuge.

Objective 5.1**:** Conserve, restore, and manage 77 miles of flowing water and 220 acres of open water (e.g., ponds, sloughs, ditches, etc.) and 15,169 acres of seasonally flooded bottomland hardwood forest to provide resting, foraging, and breeding habitats for resident and migratory wetland dependent wildlife species, including native fish and invertebrates; and provide opportunities for recreational harvest of selected fish species on the refuge.

Rationale Statement: The refuge lies within the Mingo Basin, and receives water from the north through Duck Creek Conservation area and through Cow Creek and Stanley Creek from the west. The dynamic nature of this flooding regime and the associated wetland habitats provide diverse and renewable resources within the numerous aquatic features on the refuge. The creeks, sloughs, ditches and ponds within the project areas support a diversity of game and non-game fishes. When flooding occurs in the spring, these areas provide good nurseries for juvenile fish, as well as breeding areas for frogs and toads, and feeding areas for reptiles. Through conservation, restoration, and management of lands and aquatic resources on the refuge, critical habitats are made available for resting, foraging, and breeding for resident and migratory wetland-dependent and aquatic wildlife species.

Strategy 5.1.1: Restore and maintain natural secondary channels, rivers, natural banks, sloughs, and backwater areas that connect to the refuge to the St. Francis/Mingo Ditch drainages.

Strategy 5.1.2: Evaluate and reconnect natural sloughs on the refuge where feasible. Techniques to accomplish this may include lowering or removing of levees or roads, bisecting of channels, clearing and removing debris from slough channels (Heitmeyer et al. 2006).

Strategy 5.1.3: Participate in coordination meetings with Missouri Department of Conservation to discuss the proposed incorporation of measures to restore aquatic habitats and to avoid or minimize adverse

effects of construction plans in the Mingo Basin.

Strategy 5.1.4: Evaluate and reconnect natural sloughs on the northeast portion of the refuge where feasible. Techniques to accomplish this may include lowering or removing of levees or roads, bisecting of channels, and clearing and removing debris from slough channels (Heitmeyer et al. 2006).

Strategy 5.1.5: Removal of the Ditch 10 "plug" to allow for water management of the Stanley Creek Impoundment.

Strategy 5.1.6: Annually protect open water areas, ponds, and sloughs from excessive sedimentation and pollutants through the use of approved forest management, agricultural, and moist soil management techniques.

Objective 5.2: Continue the reintroduction effort of alligator gar and promote favorable habitat conditions for the species.

Rationale Statement: Alligator gars were once common on the refuge and in the surrounding waterway. By reintroducing them into the area, we will be reestablishing a missing element of the natural system on the refuge.

Strategy 5.2.1: Partner with MDC to continue stocking efforts in suitable habitats within the refuge.

Strategy 5.2.2: Assist MDC with population monitoring of alligator gar on an annual basis or as needed.

Objective 5.3: Monitor mercury and other heavy metals throughout the refuge to determine contaminant levels and potential "hotspots" or species that are at elevated risk for detrimental impacts.

Rationale Statement: Contaminants monitoring is currently being conducted on the refuge through an air quality site and through numerous studies evaluating levels in soil, sediment, vegetation, invertebrates and higher organisms. By locating "hot spots" and working to remove or limit the movement of these contaminants, we hope to improve the health of all the biota found on the refuge.

Strategy 5.3.1: Development of a database and map over the next 15 years to documenting contaminant levels across the refuge will require additional workload and partnerships with Contaminants Division of USFWS Environmental Services.

Objective 5.4: Continue in the development of a Water Resources Plan to monitor flows onto, within, and off of the refuge.

Rationale Statement: The development of a Water Resources Plan will improve the ability of refuge staff to manage water and understand the hydrologic relationship of each unit and the surrounding areas. This knowledge will allow us to identify infrastructure needs and help prevent flooding impacts to refuge lands and surrounding areas.

Strategy 5.4.1 Continue to work with partners in the Region 3 FWS to monitor and map water flows entering and leaving the refuge.

Strategy 5.4.2 Work with Region 3 partners to develop a Water Resources Plan to help manage water levels, movement, and controls to better manage hydrologic resources on the refuge.

Strategy 5.4.3 Evaluate and utilize Light Detection and Ranging data (LIDAR), bathymetry, and remote sensing data to better understand water flow, elevation, and habitat connections.

Goal 6 (Resident Wildlife): Provide a complex of habitats suitable for a wide range of resident (endemic) wildlife species, while achieving habitat management objectives and biological integrity with other native flora and fauna.

Objective 6.1: Conserve, restore, and manage up to 21,592 acres of refuge lands to support resident wildlife species and population levels.

Rationale Statement: In keeping with refuge management objectives and establishing purposes, sound biological principles are used in the assessment of, and when feasible, management for resident species. In some resident species' groups, little specifically targeted resource management is performed other than monitoring, protection, and awareness of any species of special concern that may exist on the refuge. However, management for priority habitat conditions often results in good management for a host of resident species. Resident game species lend themselves to active management in the form of hunt management, check station information collection, and biological assessment of harvested individuals. Targeted management efforts directed at resident species focus on maintaining viable populations, rather than favoring certain species, age classes, or sexes.

Strategy 6.1.1: Through annual evaluations of harvest rates, manage hunting opportunity for species of resident wildlife with open hunting periods to maintain population health and stability.

Strategy 6.1.2: The habitat treatments described in the Waterfowl, Endangered and Threatened Species, Migratory Landbirds, Shorebirds and Waterbirds, and Aquatic Resources sections will provide an array of beneficial habitats for resident wildlife species.

Strategy 6.1.3**:** Utilizing the refuge cooperative farming program,

according to established USDA guidelines, provide unharvested crops within the agriculture units to support resident wildlife and viewing opportunities by the public.

B. Management strategy constraints

Objective 1.1**:** Maintain the current core waterfowl management area (4000 acres) as an inviolate sanctuary for waterfowl and other migratory birds where little to no disturbance factors are allowed during the critical winter period (November to March). This area includes Monopoly and Rockhouse Marshes, and all of the moist soil units.

Constraints associated with providing an inviolate sanctuary for waterfowl include having a law enforcement presence to maintain closed areas as sanctuaries as well as opposition from some waterfowl hunters that sanctuaries are counter-productive to waterfowl management and their ability to harvest waterfowl.

Objective 1.2**:** Manage 800 acres of moist soil units (Figure 2) through water manipulation, planting, mechanical, and chemical treatments to provide quality moist soil habitat and high energy food resources for waterfowl. Provide a minimum of 800 acres of managed moist soils that produce an annual average of 3 million DEDs in support of the average of 11 million DED objective at Mingo NWR.

Springtime flooding can prohibit completing early and mid-season drawdowns and delay planting agricultural crops in some portions of the 800-acre management unit. The refuge moist soil management program is in need of repairs to existing structures and requires additional water control structures, development of other dependable water sources (wells and pumps) along with irrigation materials to enhance the current management program. Irrigation materials are needed to efficiently and effectively route water to designated wetland units, but budget constraints could limit the ability for refuge managers to implement this objective. Flooding can persist into June or July, and create less than ideal conditions for corn production. There also appears to be a growing opposition against farming refuge lands by some waterfowl hunters.

Objective 1.3: Over the long-term (100-200 years), on 70% of the refuge BLH, including GTR, achieve a mosaic of bottomland hardwood stands of different age and structural classes distributed across a narrow elevation gradient ranging from 335.5-339.5’ MSL with lowest elevations dominated by bald cypress and water tupelo; low elevations dominated by overcup oak, red maple, green ash and water hickory; intermediate elevations dominated by pin oak, sugarberry, American elm, sweetgum, and willow oak; and high elevations dominated by willow and cherrybark oaks, shagbark and shellbark hickory, sweetgum, sugarberry, post oak, American elm, and green ash (Table 5) (Heitmeyer et al. 2006).

Forest Management Constraints:

As an irreplaceable part of our nation’s heritage, archeological resources will be

protected on Mingo NWR. The Archeological Resources Protection Act of 1979 and the Antiquities Act of 1906, as well as other statutes, require public land managers to prevent the loss and destruction of the sites. It is possible however, that some disruption of an unknown archeological site could occur during forest management practices. The following steps will be taken to prevent soil disturbance of these sites: restriction of logging operations to dry weather months, minimize soil erosion/rutting during road and trail construction, and marking of any newly discovered archeological sites.

As part of the management of endangered and threatened species, listed species will be protected on Mingo NWR. The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. It is possible that impacts to listed species and their habitat could occur during forest management practices. The following steps will be used to minimize impacts to listed species: consultation with the Environmental Services Branch of the FWS when impacts to listed species or habitat can not be avoided, mitigation of these impacts will occur by reduction of impacts through timing, methodology, or management action location.

Congress designated the western portion of the refuge as the Mingo Wilderness Area in 1976. The 7,730-acre wilderness is one of 71 such areas managed by the U.S. Fish and Wildlife Service. The Wilderness Act of 1964 says that these areas are "…where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

Wilderness policy permits hiking, backpacking, fishing, wildlife observation, and environmental education and interpretation. It generally prohibits motorized activities, although tools like chainsaws may be used in wildland fire management, after a Minimal Impact Strategies and Techniques (MIST) analysis. Ditches and levees, specifically excluded from Wilderness designation, help approximate water level fluctuations that once happened naturally.

Many different attitudes exist on forest management techniques. While these techniques may best meet the management objective, the public may view them as unsightly. Some members of the public will be disturbed if any mature timber is removed, while others will be pleased at forest regeneration and active management efforts. Many of the forest stands on Mingo NWR are not adjacent to road or highways. Therefore, visual impact of forestry operations will be minimal to most of the general public. Efforts will still be made to minimize the visual aesthetic impacts of forest management by using buffer zones along high public utilization areas. These areas include roads, navigable waterways, picnic areas, parking areas, and boat-launching areas.

Presently on Mingo NWR, there is a network of ditches and waterways running throughout the refuge property. Because the refuge is inundated with floodwaters almost annually, the access timetable for forest management practices will be limited. Forest management practices requiring heavy equipment will be

restricted to late summer and early fall. This will reduce soil compaction and rutting on Mingo NWR.

From a timber sale standpoint, Mingo NWR is located in a relatively hard area to harvest timber. Due to the location of management units and the size of treatments desired, supplying an adequate amount of surplus forest products to create a merchantable sale may be difficult. Few operations exist that would travel the distance to harvest a small timber sale.

Intensive silvicultural practices to convert stands presently dominated by overcup oak, red maple and their associates to red oak species, could also conflict with the interests of individuals concerned about forest-interior migratory landbirds and maintaining little to no fragmentation or alterations in the existing forest.

Existing available staff at the refuge may limit the ability to carry out this objective. A forester would be needed to conduct, mark and map timber sales; write a forest management plan; monitor disease and pest outbreaks; and monitor short and long-term forest health on the refuge.

Objective 1.4: Manage four GTR (Pools 4, 5, 7, and 8), totaling 6,308 acres, for no more than 130 consecutive days annually between November and March avoiding the flooding of units prior to tree dormancy. Drain water prior to growing season to encourage regeneration and avoid killing trees. Under dry conditions water may be held in GTR into spring to provide wood duck and hooded merganser breeding habitat. Flooding into spring during dry conditions would not occur more than two consecutive seasons in the same GTR.

Management of water levels in Pool 8 may require levels that conflict with those desired by waterfowl hunters. These include not flooding as early as some hunters would like, or lowering levels late in the season resulting in a smaller flooded area in Pool 8.

Objective 1.5: Over the next 15 years, maintain 2,008 acres of open marsh habitat within Monopoly Marsh comprised of a mixture of desirable submergent, floating and emergent vegetation to produce between 1 and 6 million DEDs per year with higher production coming in drawdown years. Convert approximately 225 acres of Monopoly Marsh from open marsh habitat to wet forest dominated by bald cypress and water tupelo. Ensure that summer pool (April-October) is maintained at or below 335’ MSL whenever possible.

The ability to produce desirable vegetative species that are beneficial to waterfowl in Monopoly Marsh requires water fluctuations and periods of complete drawdown during the proposed management cycle. This could conflict with anglers and bird watchers that frequently utilize Monopoly Marsh for these activities. Anglers may see the cyclical drawdowns as an impact to their ability to fish in the marsh, as well as the ability of the marsh to maintain healthy fish populations.

Objective 1.6: Over the next 15 years, maintain 903 acres of open marsh habitat within Rockhouse Marsh comprised of a mixture of desirable submergent, floating and emergent vegetation to produce between 0.5 and 3.5 million DEDs per year with higher production coming in drawdown years. Ensure that summer pool (April-October) is maintained at or below 335.5' MSL whenever possible.

The maintenance of desirable vegetative conditions in Rockhouse Marsh requires water fluctuations and periods of complete drawdown during the proposed management cycle. This could conflict with anglers and bird watchers that frequently utilize Rockhouse Marsh for these activities.

The general public may have a negative response to the appearance of Rockhouse Marsh after woody vegetation is removed. This area is heavily utilized by people viewing wildlife on the refuge.

Objective 1.7: Monitor, treat and evaluate invasive and exotic species on Mingo NWR to minimize or remove the impacts to waterfowl habitat.

The general public may have a negative response to treatment types utilized to control invasive and exotic species. The use of approved chemicals, mechanical or prescribed fire may result in some areas being closed to the public for a period of time during treatment.

Objective 1.8: Manage open water habitat to facilitate water management on 77 miles of flowing water and 387 acres of water bodies. Ditches play a critical role in maintaining desired hydrological conditions in management units throughout the refuge. The maintenance and improvement of these ditches are critical to waterfowl habitat management.

The maintenance of ditches throughout the refuge will require that some roads be closed to the general public during clean-out activities. This may hinder movement around the refuge by members of the public and result in closures of specific areas for designated periods of time.

Anglers may view clean-out activities as a negative impact to fisheries from the loss of vegetation or structure. Anglers will also be impacted by temporary closures of some ditches during maintenance activities.

Objective 1.9: Replace and change the elevation of the current spillway. The ability to efficiently and adequately move water off of the refuge will improve the hydrological conditions for all water dependent habitat classes.

The replacement of the spillway may require the road to be closed to the general public during construction activities. This may hinder movement around the refuge by members of the public and result in closures of specific areas for designated periods of time.

Objective 2.1: Provide habitat to support the recovery of the endangered Indiana bat, through habitat protection and enhancement and through population monitoring.

Some areas of the refuge may have public access restraints applied for roost tree protection.

Objective 3.1**:** Through management, restoration and protection of up to a 21,592 acre block of refuge lands, provide sufficient habitat to support migratory landbirds (Table 4) specifically the species of management concern.

The refuge is no longer in acquisition phase and forest blocks may be too small to meet recovery criteria set for some species. Much of the refuge is currently in mature BLH stands. Some species that require scrub, grassland, or edge habitats may be limited due to a lack of those habitats being available on the refuge.

Objective 3.2: Manage, restore and maintain 1,315 acres of upland forests to provide quality habitat for migratory birds.

The upland forest habitats on the refuge are typically on steep, rocky ground and will be difficult to manipulate. The areas are adjacent to private lands and may inhibit some treatment types such as controlled burn. The refuge has a relatively small amount of upland habitat available for landbird species.

Objective 3.3**:** Establish and expand existing stands of giant cane throughout bottomland hardwood areas of the refuge.

Adequate, quality sources for giant cane for propagation and planting are limited to sites near the refuge. These sights are often on private land and may be difficult to utilize in a high enough quantity.

Propagation of giant cane is time consuming and somewhat costly. Adequate staff time and funding may limit the number of cane propogules that are available each year.

Objective 3.4**:** Manage and maintain 765 acres of pole stand and early successional forested areas through mechanical, chemical and fire treatments.

Early successional forest stands areas are limited on the refuge and may not be sufficient in area for large numbers of nesting pairs requiring that habitat type. As these stands age, they will transition into BLH or upland forest and will have limited usage by those guilds. Natural disturbances, fire, chemical, and mechanical treatments will be needed to maintain or enhance early successional forest stands.

Objective 3.5: Monitor RNAs for vegetative, noxious or invasive weeds, habitat, nuisance species and/or any additional important ecological and scientific values.

If adequate monitoring is not carried forth on the RNAs, the areas may become

infested with noxious or invasive organisms.

Objective 4.1**:** Time drawdowns of impounded wetlands to provide a minimum of 500 acres of shallowly flooded mudflat habitats with < 25% vegetative cover and varying water levels (< 8 inches in depth) to support shorebirds during spring migration (March to May).

Springtime flooding could limit the refuge's ability to provide quality shorebird habitat in the complex during this time frame.

Objective 4.2: Provide a minimum of 500 acres of shallowly flooded mudflat habitats with < 25% vegetative cover and varying water levels (< 8 inches in depth) during fall migration (late June to October).

The limited number of reliable water sources and irrigation options could confine the refuge's ability to provide 500 acres of mudflat habitat during dry years across different locations in the complex each year.

Objective 4.3: Identify a minimum of 1000 acres of impounded wetlands to provide shallow water feeding areas for wading birds and marshbirds during summer (May-July).

In drawdown years that are abnormally dry, water levels in the marshes may be lower than optimal depths during the later part of the summer.

Objective 4.4: Provide a minimum of 200 acres of emergent marsh habitat through water management and by mechanical, chemical or fire disturbances. This habitat will consist of a 50:50 ratio of open water interspersed with vegetation (i.e. "hemi-marsh") to produce desirable conditions for marshbirds. Provide open water conditions throughout the year from 6 inches to 3 ft in depth.

If additional wells and pumps, irrigation materials, levees, and water control structures are not installed, then 200 acres of emergent marsh habitat may not be difficult to obtain each year considering the size of current units in relation to the limited amount of current floodable acreage.

Objective 4.5: Monitor shorebird and wading bird populations on the refuge.

If monitoring is not carried forth on the refuge, staff will not be able to determine habitat and resource needs of shorebirds and waterbirds. By monitoring utilization, refuge staff will have the ability to improve habitat and increase shorebird and waterbird numbers on the refuge.

Objective 4.6: Monitor, treat and evaluate invasive and exotic species on Mingo NWR to minimize or remove the impacts to shorebird and wading bird habitat.

The general public may have a negative response to treatment types utilized to control invasive and exotic species. The use of approved chemicals, mechanical or prescribed fire may result in some areas being closed to the public for a period of time during treatment.

Objective 5.1: Conserve, restore, and manage 77 miles of flowing water and 220 acres of open water (e.g., ponds sloughs, ditches, etc.) and 15, 169 acres of seasonally flooded bottomland hardwood forest to provide resting, foraging, and breeding habitats for resident and migratory wetland dependent wildlife species, including native fish and invertebrates; and provide opportunities for recreational harvest of selected fish species on the refuge.

Constraints associated with this strategy include obtaining permits related to Section 404 of the Clean Water Act, and unwilling and/or uncooperative adjacent landowners which could reduce the ability to restore and maintain natural hydrological functions.

Objective 5.2: Continue the reintroduction effort of alligator gar and promote favorable habitat conditions for the species.

The ability to obtain stock may limit the efforts to reestablish alligator gar on the refuge. The current system of ditches and structures may limit alligator gar in their ability to freely move across the refuge and utilize specific habitat such as spawning or brood rearing habitats.

Objective 5.3: Monitor mercury and other heavy metals throughout the refuge to determine contaminant levels and potential "hotspots" or species that are at elevated risk for detrimental impacts.

Additional monitoring equipment will be needed to obtain contaminant levels. If elevated levels are detected, mitigation will require additional testing, monitoring and removal if possible.

Objective 5.4: Water Resources Continue in the development of a water resources plan to monitor flows onto, within, and flowing off of the refuge.

Regional office personnel are often occupied with multiple projects and areas of responsibilities. These may limitations could cause a delay in the completion of a Water Resources Plan for Mingo NWR.

Objective 6.1: Conserve, restore, and manage up to 21,592 acres of refuge lands to support resident wildlife species and population levels.

Hunter participation and/or harvest rates may not be high enough to reduce resident wildlife populations from exceeding carrying capacity or reaching levels where they affect other species or communities. Anti-hunting groups can also create a constraint to managing resident wildlife populations.

C. Impacts to the resources of concern

Objective 1.1**:** Maintain the current core waterfowl management area (4000 acres) as an inviolate sanctuary for waterfowl and other migratory birds where little to no disturbance factors are allowed during the critical winter period (November to March). This area includes Monopoly

and Rockhouse Marshes, and all of the moist soil units.

> Waterfowl and many of the other resources of concern require areas free from disturbances. The inviolate sanctuary provides an area where waterfowl and shorebirds can stopover to rest and feed, which is vital in meeting the requirements of migrating and wintering waterfowl and shorebirds. This area provides opportunities for molting, preening, pair bonding, and fat storage, which in turn helps build healthier and larger waterfowl populations. The closed area also helps maintain regional populations of waterfowl in and around the refuge, providing hunting opportunity on nearby private and public lands. The sanctuary meets the many requirements of migrating and wintering waterfowl and shorebirds to help ensure the preservation of these two groups of birds for the future. Other resources of concern find an area of safe haven in the sanctuary and many negative impacts from human disturbances are minimized in this area to restore and promote natural processes that are required by the resources of concern. There are no negative impacts of the inviolate sanctuary to the resources of concern.

Objective 1.2**:** Manage 800 acres of moist soil units (Figure 2) through water manipulation, planting, mechanical, and chemical treatments to provide quality moist soil habitat and high energy food resources for waterfowl. Provide a minimum of 800 acres of managed moist soils that produce an annual average of 3 million DEDs in support of the average of 11 million DED objective at Mingo NWR.

> These habitats provide the critical food, water, and cover resources for waterfowl, shorebirds, and waterbirds. Flooded moist soil and agricultural habitats also provide food resources such as fish and waterfowl for bald eagles. Moist soil and agricultural habitats are utilized by an assortment of migratory landbird species that forage, nest, and/or escape in these habitat types. Additionally, they provide important vegetative and food resources for many aquatic resources such as early successional associated reptiles and amphibians (Fredrickson and Taylor 1982). An assortment of resident wildlife species either forage, nest, and/or escape in these habitats.
>
> Early successional management may negatively impact forest-dwelling migratory landbirds that utilize mature forest by not providing appropriate habitat conditions and by increasing fragmentation. Intensive moist soil management may impact some aquatic resources and or temporarily remove available habitats. The intensive management of water levels and soil conditions may impact aquatic resources by impacting breeding habitat (Semlitsch 2000). The use of chemicals to manage vegetation may impact aquatic resources by impacting habitat and causing reduced fecundity or production. This will be minimized by only using approved chemicals.

Objective 1.3: Over the long-term (100-200 years), on 70% of the refuge BLH, including GTR, achieve a mosaic of bottomland hardwood stands of different age and structural classes

distributed across a narrow elevation gradient ranging from 335.5-339.5' MSL with lowest elevations dominated by bald cypress and water tupelo; low elevations dominated by overcup oak, red maple, green ash and water hickory; intermediate elevations dominated by pin oak, sugarberry, American elm, sweetgum, and willow oak; and high elevations dominated by willow and cherrybark oaks, shagbark and shellbark hickory, sweetgum, sugarberry, post oak, American elm, and green ash (Heitmeyer et al. 2006).

A substantial red oak component in the bottomland hardwood forest will provide mast production necessary to meet the food requirements of waterfowl. Forest management actions will create a variety of habitat types that will benefit many migratory landbird species that need early successional habitats and uneven forest structure. Silvicultural practices will also retain large, mature trees that will meet the needs of other migratory landbird species such as the cerulean warbler as well as listed species such as the Indiana bat. Forest management activities may also create important structural components that meet the needs of a larger host of aquatic resources. A substantial red oak component in the bottomland hardwood forest will provide mast production necessary to meet the food requirements of many resident wildlife species and structural diversity that meets the habitat requirements of many resident species. There are no known positive impacts to shorebirds and waterbirds.

There are minimal negative impacts to waterfowl, shorebirds, waterbirds, or resident wildlife. Intensive silvicultural treatments will provide negative implications for forest-interior migratory landbirds by increasing fragmentation. Some forest management activities may exterminate some aquatic resources or temporarily remove required habitats. Treatment activities may impact listed species such as the Indiana bat by creating noise and impacting roost trees. Efforts will be made to reduce all impacts to listed species.

Objective 1.4**:** Manage four GTR (Pools 4, 5, 7, and 8), totaling 6,308 acres, for no more than 130 consecutive days annually between November and March avoiding the flooding of units prior to tree dormancy. Drain water prior to growing season to encourage regeneration and avoid killing trees. Under dry conditions water may be held in GTR into spring to provide wood duck and hooded merganser breeding habitat. Flooding into spring during dry conditions would not occur more than two consecutive seasons in the same GTR.

Managing water levels in the GTRs will result in improved growing conditions for desired tree species. This will result in improved habitat and food availability for waterfowl and forest-interior landbirds. The Indiana bat may have additional roost trees and snags available and an increased area for foraging.

Aquatic resources may have a reduction in available breeding and foraging habitats resulting from a reduced time period of flooded areas within the pools (Semlitsch 2000).

Impacts to resident wildlife may include temporary displacement, noise, and habitat fragmentation. There are no known negative impacts to shorebirds.

Objective 1.5: Over the next 15 years, maintain 2,008 acres of open marsh habitat within Monopoly Marsh comprised of a mixture of desirable submergent, floating and emergent vegetation to produce between 1 and 6 million DEDs per year with higher production coming in drawdown years. Convert approximately 225 acres of Monopoly Marsh from open marsh habitat to wet forest dominated by bald cypress and water tupelo. Ensure that summer pool (April-October) is maintained at or below 335' MSL whenever possible.

Managing water levels in Monopoly Marsh will result in improved growing conditions for desired forage species. This will result in improved habitat and food availability for waterfowl and shorebirds. The Indiana bat may have additional forage areas provided by marsh edge and an increase in emergent insects.

Aquatic resources may have a reduction in available breeding and foraging habitats resulting from a reduced time period of flooded areas within the pools (Semlitsch 2000). During drawdown periods, fish may be forced out of Monopoly Marsh or into small pools where die-offs could occur due to water temperature and oxygen level extremes.

Resident wildlife will have a larger forage area due to more open dry land with increased level of forage species. Some species of resident wildlife will benefit from the concentration of aquatic resources used as prey.

Invasive and exotic species may move into recently exposed areas after drawdown. Monitoring will be needed to identify and treat areas where this occurs.

Objective 1.6: Over the next 15 years, maintain 903 acres of open marsh habitat within Rockhouse Marsh comprised of a mixture of desirable submergent, floating and emergent vegetation to produce between 0.5 and 3.5 million DEDs per year with higher production coming in drawdown years. Ensure that summer pool (April-October) is maintained at or below 335.5' MSL whenever possible.

Managing water levels in Rockhouse Marsh will result in improved growing conditions for desired forage species. This will result in improved habitat and food availability for waterfowl and shorebirds. The Indiana bat will may have additional forage areas provided by marsh edge and an increase in emergent insects.

Aquatic resources may have a reduction in available breeding and foraging habitats resulting from a reduced time period of flooded areas within the pools (Semlitsch 2000). During drawdown periods, fish could be forced out of Rockhouse Marsh or into small pools where die-offs may occur due to water temperature and oxygen level extremes.

Resident wildlife will have a larger forage area due to more open dry land with increased level of forage species. Some species of resident wildlife will benefit from the concentration of aquatic resources used as prey.

Invasive and exotic species may move into recently exposed areas after drawdown. Monitoring will be needed to identify and treat areas where this occurs.

Objective 1.7: Monitor, treat and evaluate invasive and exotic species on Mingo NWR to minimize or remove the impact to waterfowl habitat.

Management of invasive and exotic species will benefit all resources of concern. By limiting the amount of invasive and exotic species on the refuge, native habitats will have reduced competition and will provide appropriate habitats for all resources of concern.

The use of chemical, mechanical, or fire treatments may temporarily negatively impact all resources of concern other than invasive/exotic species management. Fire and mechanical treatments may temporarily displace resident wildlife, shorebirds, migratory landbirds, waterfowl, and threatened and endangered species. Migratory landbirds that may have used invasive or exotic species for nesting would be forced to find other suitable habitat. Chemical treatments may impact aquatic resources by potentially hindering development or water quality.

Objective 1.8: Manage open water habitat to facilitate water management on 77 miles of flowing water and 387 acres of water bodies. Ditches play a critical role in maintaining desired hydrological conditions in management units throughout the refuge. The maintenance and improvement of these ditches are critical to waterfowl habitat management.

By maintaining flows within the hydrologic system on the refuge, habitat for waterfowl, shorebirds, migratory landbirds, resident wildlife, aquatic resources, and management of invasive and exotic species will be improved over the long-term. Waterfowl habitat will be improved by reducing forest die-off due to flooding during the growing period, increased regeneration of desirable tree species, and the ability to generate desirable forage species in the moist soil units. Shorebirds will have larger areas of improved open mudflat habitat during migration due to the maintained ability to remove water thus exposing desirable habitat. Resident wildlife will have less area inundated throughout the spring and summer months allowing for a larger forage area. Aquatic resources will have greater areas of habitat within the open water areas with improved oxygen levels and reduced temperatures during the summer months. Management of invasive or exotic species through water control and regulation will prevent spread of some species around the refuge by allowing for timely removal or addition of water onto areas.

Temporary impacts to aquatic resources and threatened and endangered species may occur due to maintenance of open water areas and ditches on the refuge. Aquatic resources may be impacted when debris or silt is removed from the ditches by impacting habitat, cover, and forage areas. The Indiana bat may be impacted by the removal of potential roost trees during ditch maintenance. These trees will be removed outside of the roost period or after Section 7 consultation is completed to reduce or eliminate these impacts.

Objective 1.9: Replace and change the elevation of the current spillway. The ability to efficiently and adequately move water off of the refuge will improve the hydrological conditions for all water dependent habitat classes.

By improving the ability to remove water within the hydrologic system on the refuge, habitat for waterfowl, shorebirds, migratory landbirds, resident wildlife, aquatic resources, and management of invasive and exotic species will be improved over the long-term. Waterfowl habitat will be improved by reducing forest die-off due to flooding during the growing period, increased regeneration of desirable tree species, and the ability to generate desirable forage species in the moist soil units. Shorebirds will have larger areas of improved open mudflat habitat during migration due to the maintained ability to remove water thus exposing desirable habitat. Resident wildlife will have less area inundated throughout the spring and summer months allowing for a larger forage area.

Temporary impacts to aquatic resources may occur due to the replacement of the spillway. Aquatic resources may be impacted when debris or silt is deposited into the ditch during construction activities. Resident wildlife may be temporarily displaced during construction activities.

Objective 2.1: Provide habitat to support the recovery of the endangered Indiana bat, through habitat protection and enhancement and through population monitoring.

Indiana bat habitat management may result in reduced flexibility in project design and implementation across the refuge. Projects involving impacts to potential roost trees will have a longer timeline for completion due to consultation requirements. Some forest management techniques will only be feasible during the fall and winter months. These constraints may hinder the chances of completing forest management projects when coupled with constraints due to flooding in the fall and winter in the GTRs and bottomland hardwood areas.

The ability to manage the refuge's waterways may be hindered due to timing and tree removal constraints. Removal of trees along ditches may be delayed during the spring and summer due to timing restrictions.

Objective 3.1**:** Through management, restoration and protection of up to 21,592 acre block of refuge lands, provide sufficient habitat to support migratory landbirds specifically the species of management concern.

Impacts from active or passive management needed to improve landbird habitats may have a negative impact to threatened and endangered species, aquatic resources, and resident wildlife. Listed species may be impacted due to removal of roost trees during the inactive fall and winter months when active forest management activities are occurring. Aquatic resources may be impacted due to increased sediment and run-off during timber cutting activities. Some species of resident wildlife may be displaced due to changes in forest structure during active management techniques or due to long term changes in passive management activities such as forest maturation.

Objective 3.2: Manage, restore and maintain 1,315 acres of upland forests to provide quality habitat for migratory birds.

Forest management actions will create a variety of habitat types that will benefit many migratory landbird species that need early successional habitats and uneven forest structure. Silvicultural practices will also retain large, mature trees that will meet the needs of other migratory landbird species such as the cerulean warbler as well as listed species such as the Indiana bat. Mast production in upland forest will help meet the food requirements of many resident wildlife species and structural diversity that meets the habitat requirements of many resident species. There are no known positive impacts to shorebirds and waterbirds.

There are minimal negative impacts to waterfowl, waterbirds or resident wildlife. Intensive silvicultural treatments will provide negative implications for forest-interior migratory landbirds by increasing fragmentation. Some forest management activities may impact aquatic resources by temporarily increasing sedimentation and run-off. Treatment activities may impact listed species such as the Indiana bat by creating noise and impacting roost trees. Efforts will be made to reduce all impacts to listed species.

Objective 3.3: Establish and expand existing stands of giant cane throughout bottomland hardwood areas of the refuge.

Cane restoration will benefit many species of migratory landbirds by providing critical nesting and brood rearing habitat. Cane breaks will provide cover for resident wildlife. Cane breaks established adjacent to water will provide cover and foraging habitats for aquatic resources, waterfowl and waterbirds and shorebirds. There are no known benefits to threatened and endangered species.

Negative impacts may occur to some species of landbirds when trees are thinned in existing cane breaks on the refuge.

Objective 3.4: Manage and maintain 765 acres of pole stand and early successional forested areas through mechanical, chemical and fire treatments.

Early successional forests provide cover, nesting and brood rearing habitat for some species of migratory landbirds. This habitat benefits resident wildlife by providing forest edge habitat that is utilized for food and cover. There are no known benefits to waterbirds, aquatic resources or threatened and endangered species.

Removal of mature stands or the conversion of grassland habitats to early successional forest may impact grassland landbirds, some resident wildlife, and threatened and endangered species. Conversion from grasslands to early successional forest may reduce usable habitat for grassland bird species. Resident wildlife may have a reduction in available forage areas that were previously grasslands. The conversion of mature forest to early successional forest may result in reduced roost tree availability for threatened and endangered species.

Objective 3.5: Monitor RNAs for vegetative, noxious or invasive weeds, habitat, nuisance species and/or any additional important ecological and scientific values.

Management of the RNAs will benefit all resources of concern on the refuge. By removing or controlling noxious and invasive weeds, other native resources will benefit.

Objective 4.1**:** Time drawdowns of impounded wetlands to provide a minimum of 500 acres of shallowly flooded mudflat habitats with < 25% vegetative cover and varying water levels (< 8 inches in depth) to support shorebirds during spring migration (March to early June).

Spring shorebird habitats will provide excellent habitat conditions for late migrating teal, resident wood ducks, and waterbirds. Management practices should also enhance productivity in moist soil wetlands by stimulating desirable annual plants. Retention of spring water will extend availability of food resources for Indiana bat. Retention of spring water will extend availability of habitats for many associated migratory landbirds, aquatic resources, and resident wildlife species.

Late season drawdowns could stimulate the growth of undesirable plants that will require management actions to correct. The temporary removal and disturbance of vegetation may decrease habitat value for rails.

Objective 4.2**:** Provide a minimum of 500 acres of shallowly flooded mudflat habitats with < 25% vegetative cover and varying water levels (< 8 inches in depth) to support shorebirds during fall migration (July to October).

Fall shorebird habitats will provide excellent habitat conditions for early migrating teal and resident wood ducks. Management practices should also enhance productivity in moist soil wetlands by stimulating invertebrate “blooms”. Fall water should provide food resources for least terns during late summer and

early arriving bald eagles. Management for shorebirds should also provide excellent habitat conditions for waterbirds, associated migratory landbirds and resident wildlife. Early fall water should provide important habitat components for many aquatic resources.

Management practices could destroy desirable plant communities for waterfowl. Vegetation removal and structural disturbance will remove early successional habitat for associated migratory landbird species. The temporary removal and disturbance of vegetation may decrease habitat value or displace rails, some aquatic resources and associated resident wildlife species.

Objective 4.3: Identify a minimum of 1000 acres of impounded wetlands to provide shallow water feeding areas for wading birds and marshbirds during summer (May-July).

Managed summer habitat will provide quality habitat conditions for resident wood ducks. Summer water management should mesh with providing food and water resources for interior least terns. Additionally, this habitat type should provide excellent benefits to associated migratory landbirds, waterbirds, aquatic resources, and many resident wildlife species. Management practices will limit moist soil management options for wintering waterfowl.

Objective 4.4: Provide a minimum of 200 acres of emergent marsh habitat through water management and by mechanical, chemical or fire disturbances. This habitat will consist of a 50:50 ratio of open water interspersed with vegetation (i.e. "hemi-marsh") to produce desirable conditions for marshbirds. Provide open water conditions throughout the year from 6 inches to 3 ft in depth.

Emergent marsh will provide food and cover resources, along with roosting habitat for wintering, migrating, and resident waterfowl. Emergent marsh management will meet the food resource needs of Indiana bat. This habitat type will also provide excellent food resources in the form of insects and plant matter for many migratory landbirds such as wrens and swallows. Emergent marsh habitats will provide excellent nesting, foraging, and other use conditions for waterbirds, along with providing good habitat conditions for a variety of shorebirds and aquatic resources. Many resident wildlife species will also utilize these habitats to fulfill their life history requirements.

Deeper water depths may result in limiting duck use to primarily divers. Seed production and availability will also be limited. Deep water areas may not be useful to many shorebird species.

Objective 4.5: Monitor shorebird and wading bird populations on the refuge.

There are no negative impacts to resources of concern by monitoring populations of shorebirds and wading birds. By monitoring shorebirds and wading birds, the refuge will be able to better monitor habitats being utilized and provide addition

resources to those species.

Objective 4.6: Monitor, treat and evaluate invasive and exotic species on Mingo NWR to minimize or remove the impact to shorebird and wading bird habitat.

Management of invasive and exotic species will benefit all resources of concern. By limiting the amount of invasive and exotic species on the refuge, native habitats will have reduced competition and will provide appropriate habitats for all resources of concern.

The use of chemical, mechanical, or fire treatments may temporarily negatively impact all resources of concern other than invasive/exotic species management. Fire and mechanical treatments may temporarily displace resident wildlife, shorebirds, migratory landbirds, waterfowl, and threatened and endangered species. Migratory landbirds that may have used invasive or exotic species for nesting would be forced to find other suitable habitat. Chemical treatments may impact aquatic resources by potentially hindering development or water quality.

Objective 5.1**:** Conserve, restore, and manage 77 miles of flowing water and 220 acres of open water (e.g., ponds sloughs, ditches, etc.) and 15,169 acres of seasonally flooded bottomland hardwood forest to provide resting, foraging, and breeding habitats for resident and migratory wetland dependent wildlife species, including native fish and invertebrates; and provide opportunities for recreational harvest of selected fish species on the refuge.

All restoration and protection efforts will benefit the resources of concern and their habitats. Scattered open water areas will provide important roosting, loafing, and foraging habitats in close proximity for waterfowl utilization. These open water areas will provide important feeding areas for Indiana bats. They will also provide important habitat for many migratory landbirds, especially along habitat edges, and important food and water resources for groups such as warblers, waterthrush, and swallows. Shorebirds and waterbirds will utilize open water areas for roosting, loafing, and foraging. There are no negative impacts to the resources of concern.

Objective 5.2: Improve water quality by restoring floodplain hydrology and vegetation management.

Open water areas will provide critical habitat components within close proximity for many fish, invertebrate and resident wildlife species. Additionally, working with partners should benefit these resources through awareness, protection, management, and conservation. There are no negative impacts to the resources of concern.

Objective 5.3: Continue the reintroduction effort of alligator gar and promote favorable habitat conditions for the species.

All resources of concern may benefit by re-establishing this species into the Mingo Basin. This will help balance the ecosystem by bringing back a keystone

aquatic species and should benefit the overall functioning of the system.

Objective 5.4: Monitor mercury and other heavy metals throughout the refuge to determine contaminant levels and potential "hotspots" or species that are at elevated risk for detrimental impacts.

There are no known negative impacts to resources of concern from this objective. By identifying any known "hotspots" or areas that have higher than acceptable levels of contaminants, mitigation may be carried out that would benefit all resources of concern by removing contaminants of limiting exposure to contaminants by species utilizing Mingo NWR.

Objective 5.5: Water Resources Continue in the development of a water resource plan to monitor flows onto, within, and flowing off of the refuge.

There are no known negative impacts to resources of concern from this objective. By improving management ability to regulate and monitor water across the refuge, the staff will be able to improve capabilities and improve habitat for aquatic resources, resident wildlife, waterfowl and shorebirds and wading birds.

Objective 6.1: Conserve, restore, and manage up to 21,592 acres of refuge lands to support resident wildlife species and population levels.

Maintaining resident wildlife populations will protect critical waterfowl habitats and resources from being exploited by means such as over browsing. Competition for food resources and depredation will also be minimized. Maintaining resident wildlife populations will protect critical habitats and resources utilized by all of the resources of concern from being exploited. Depredation of nesting birds and other animals should also be minimized. Resident wildlife populations will be healthier and less susceptible to disease outbreaks, habitat destruction, and increased competition through control measures.

Individual animals will be removed from the population. There are no negative impacts to the other resources of concern or resident wildlife populations as a whole.

D. Management strategy documents

1. Necessary Resources

The refuge staff consists of a refuge manager, assistant refuge manager, wildlife biologist, supervisory refuge ranger, refuge law enforcement officer, administrative assistant, and two maintenance mechanics. Seasonal student temporary experiences program (STEP) students and

volunteers are often times available to provide assistance. A Bunkhouse and four concrete pads support RV/campers with electricity and water hookups as temporary quarters for volunteers and student researchers.

Future staffing needs for habitat management are included in the Refuge Operations Needs database (RONS). To fully implement the habitat management program, the following positions should be established and filled over the next 15 years: Refuge Forester, Maintenance Worker and a Refuge Operations Specialist.

2. Documentation of Special Uses

a. Policy and Administration of Timber Sales

Guidelines for making timber sales are found in the Refuge Manual, sections 5 RM 17 and 6 RM 3, and they will be observed in all timber sales.

The preferred method of timber sales is a formal competitive sealed bid process with lump-sum payments prior to cutting. Small sales (estimated receipts less than $2,500) will be negotiated as authorized by Service policy, and the receipts from negotiated sales shall not exceed $2,500. The Refuge Forester shall make a reasonable effort to obtain at least 3 verbal bids to ensure the sale is competitive. For large sales, marked areas will be divided into payment units and payment will be received when these areas are entered. Another alternative is to receive payments as sawtimber is scaled at the mill, which will require the sawmill to mail a copy of scale tickets to the refuge. Formal bid invitations will be mailed to all prospective buyers or all standard timber sales.

3. Cooperative Farming Agreement

Contracts with cooperative farmers are renegotiated annually prior to the planting season. At that time, the acreage amount and location of the cooperative farmer's share and refuge's share are negotiated and all provisions of the agreement are discussed and agreed upon by both parties. The agreement is then signed by the cooperative farmer and the Service representative (refuge manager). Shares are acreage based on 66% cooperators share and 33% refuge share. The cooperator assumes responsibility for all associated costs for crop production. Refuge staff may complete some farming as refuge budgets allow. When this occurs, the cooperative farming agreements will be altered accordingly. Modifications to the original contract may occur throughout the farming season with amendments agreed upon and signed by all parties involved. The Service's share of crops is usually left in the field for wildlife. In cases were monetary remittances are submitted, the procedures are the

same as timber sales. In some cases cooperators are allowed to provide needed habitat services.

c. Documentation of Compliance

Some habitat management activities and development may require additional permits. This plan will go through a Section 7 review for activities associated with endangered or threatened species.

Activities associated with wetlands (e.g. levee construction) may require a Section 404 permit from the Corps of Engineers.

Appendix A

Mingo NWR Species Lists

Mammal Species List, Mingo NWR

Opossum	*Didelphis virginiana*
Golden Mouse	*Ochrotomys nuttalli*
Shorttail Shrew	*Blarina brevicauda*
Hispid Cotton Rat	*Sigmodon hispidus*
Least Shrew	*Cryptotis parva*
Eastern Woodrat	*Neotoma floridana*
Eastern Mole	*Scalopus aquaticus*
Southern Bog Lemming	*Synaptomys cooperi*
Little Brown Bat	*Myotis lucifugus*
Prairie Vole	*Microtus ochrogaster*
Eastern Red Bat	*Lasiurus borealis*
Pine Vole	*Microtus pinetorum*
Eastern Cottontail	*Sylvilagus floridanus*
Muskrat	*Ondatra zibethicus*
Swamp Rabbit	*Sylvilagus aquaticus*
Norway Rat	*Rattus norvegicus*
Woodchuck	*Marmota monax*
House Mouse	*Mus musculus*
Eastern Chipmunk	*Tamias striatus*
Coyote	*Canis latrans*
Eastern Gray Squirrel	*Sciurus carolinensis*
Red Fox	*Vulpes vulpes*
Eastern Fox Squirrel	*Sciurus niger*
Gray Fox	*Urocyon cinereoargenteus*
Southern Flying Squirrel	*Glaucomys volans*
Raccoon	*Procyon lotor*
Beaver	*Castar canadensis*
Longtail Weasel	*Mustela frenata*
Nutria	*Myocastar coypus*
Mink	*Mustela vison*
Rice Rat	*Mys palustris*
Striped Skunk	*Mephitis mephitis*
Western Harvest Mouse	*Reithrodontomys megalotis*
River Otter	*Lontra canadensis*
Deer Mouse	*Peromyscus maniculatus*
Bobcat	*Lynx rufus*
White-footed Mouse	*Peromyscus leucopus*
White-tailed Deer	*Odocoileus virginianus*
Cotton Mouse	*Peromyscus gossypinus*

Amphibian Species List, Mingo NWR

Smallmouth Salamander	*Ambystoma texanum*
Mole Salamander	*Ambystoma talpoideum*
Marbled Salamander	*Ambystoma opacum*
Spotted Salamander	*Ambystoma maculatum*
Tiger Salamander	*Ambystoma tigrinum*
Red-backed Salamander	*Plethodon serratus*
Slimy Salamander	*Plethodon albagula*
Central Newt	*Notophthalmus viridescens louisianensis*
Lesser Siren	*Siren intermedia*
Amphiuma	*Amphiuma tridactylum*
Blanchard's Cricket Frog	*Acris crepitans blanchardi*
Northern Spring Peeper	*Pseudacris crucifer crucifer*
Green Treefrog	*Hyla cinerea*
Western Chorus Frog	*Pseudacris triseriata*
Illinois Chorus Frog	*Pseudacris streckeri illinoensis*
Gray Treefrog	*Hyla chrysoscelis/versicolor*
Bullfrog	*Rana catesbeiana*
Southern Leopard Frog	*Rana sphenocephala*
Pickerel Frog	*Rana palustris*
Bronze Frog	*Rana clamitans clamitans*
Green Frog	*Rana clamitans*
American Toad	*Bufo americanus*
Fowler's Toad	*Bufo fowleri*
Eastern Spadefoot	*Scaphiopus holbrookii*
Eastern Narrow-mouthed Toad	*Gastrophryne carolinensis*

Reptile Species List, Mingo NWR

Common Snapping Turtle	*Chelydra serpentina*
Alligator Snapping Turtle	*Macroclemys temminckii*
Mississippi Mud Turtle	*Kinosternon subrubrum hippocrepis*
Three-toed Box Turtle	*Terrapene carolina triunguis*
Southern Painted Turtle	*Chrysemys picta belli*
Red-eared Slider	*Trachemys scripta*
Cooter	*Pseudemys concinna/Chrysemys floridana*
Western Chicken Turtle	*Deirochelys reticularia miaria*
Spiney Softshell	*Apalone spiniferus spiniferus*
Midland Smooth Softshell	*Apalone muticus muticus*
Map Turtle	*Graptemys geographica*
Mississippi Map Turtle	*Graptemys pseudogeographica kohnii*
Ouachita Map Turtle	*Graptemys ouachitensis ouachitensis*
Stinkpot	*Sternotherus odoratus*
Green Water Snake	*Nerodia cyclopion*
Diamondback Water Snake	*Nerodia rhombifer*

Yellow-bellied Water Snake	*Nerodia erythrogaster flavigaster*
Broad-banded Water Snake	*Nerodia fasciata confluens*
Graham's Water Snake	*Regina grahamii*
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*
Western Ribbon Snake	*Thamnophis proximus proximus*
Eastern Hognose Snake	*Heterodon platirhinos*
Mississippi Ringneck Snake	*Diadophis punctatus stictogenys*
Western Worm Snake	*Carphophis vermis*
Western Mud Snake	*Farancia abacura reinwardtii*
Southern Black Racer	*Coluber constrictor priapus*
Black Rat Snake	*Elaphe obsoleta*
Speckled King Snake	*Lampropeltis getula holbrooki*
Red Milk Snake	*Lampropeltis triangulum syspila*
Prairie King Snake	*Lampropeltis calligaster calligaster*
Midland Brown Snake	*Storeria dekayi wrightorum*
Northern Red-belly Snake	*Storeria occipitomaculata occipitomaculata*
Rough Green Snake	*Opheodrys aestivus aestivus*
Southern Copperhead	*Agkistrodon contortrix contortrix*
Western Cottonmouth	*Agkistrodon piscivorus leucostoma*
Timber Rattlesnake	*Crotalus horridus*
Broad-headed skink	*Eumeces laticeps*
Five-lined Skink	*Eumeces fasciatus*
Race Runner	*Cnemidophorus sexlineatus*
Ground Skink	*Scincella lateralis*
Fence Lizard	*Sceloporus undulatus hyacinthinus*

Fish Species List, Mingo NWR

Flier Sunfish	*Centrarchus macropterus*
Banded Pygmy Sunfish	*Elassoma zonatum*
Green Sunfish	*Lepomis cyanellus*
Warmouth Sunfish	*Lepomis gulosus*
Orange-spotted Sunfish	*Lepomis humilis*
Bluegill	*Lepomis macropterus*
Dollar Sunfish	*Lepomis marginatus*
Longear Sunfish	*Lepomis megalotis*
Redear Sunfish	*Lepomis microlophus*
Red-spotted Sunfish	*Lepomis miniatus*
Bantam Sunfish	*Lepomis symmatricus*
Spotted Bass	*Micropterus punctulatus*
Largemouth Bass	*Micropterus salmoides*
White Crappie	*Pomoxis annularis*
Black Crappie	*Pomoxis nigromaculatus*
Bluntnose Darter	*Etheostoma chlorosomum*

Slough Darter	*Etheostoma gracile*
Johnny Darter	*Etheostoma nigrum*
Cypress Darter	*Etheostoma proeliare*
Speckled Darter	*Etheostoma stigmaeum*
Blackside Darter	*Percina maculata*
Swamp Darter	*Etheostoma fusiforme*
Pirate Perch	*Aphredoderus sayanus*
Black Bullhead	*Ictalurus melas*
Yellow Bullhead	*Ictalurus natalis*
Brown Bullhead	*Ameiurus nebulosus*
Channel Catfish	*Ictalurus punctuatus*
Tadpole Madtom	*Noturus gyrinus*
Lake Chubsucker	*Erimyzon sucetta*
Smallmouth Buffalo	*Ictiobus bubalus*
Bigmouth Buffalo	*Ictiobus cyrinellus*
Black Buffalo	*Ictiobus niger*
Spotted Sucker	*Minytrema melanops*
Black Redhorse	*Moxostoma duquesnei*
Golden Redhorse	*Moxostoma erythrurm*
Largescale Stoneroller	*Campostoma oligolepis*
Cental Stoneroller	*Campostoma pullum*
Blacktail Shiner	*Cyprinella venusta*
Carp	*Cyprinus carpio*
Ozark Minnow	*Notropis nubilus*
Striped Shiner	*Luxilus chrysocephalus*
Redfin Shiner	*Lythrurus umbratilis*
Golden Shiner	*Notemigonus crysoleucas*
Taillight Shiner	*Notropis maculatus*
Weed Shiner	*Notropis texanus*
Mimic Shiner	*Notropis volucellus*
Pallid Shiner	*Notropis amnis*
Pugnose Minnow	*Opsopoedus emilae*
Bluntnose Minnow	*Pimephales notatus*
Bullhead Minnow	*Pimephales vigilax*
Creek Chub	*Semotilus atromaculatus*
Bowfin	*Amia calva*
Spotted Gar	*Lepisosteus oculatus*
Longnose Gar	*Lepisosteus osseus*
Shortnose Gar	*Lepisosteus platostomus*
Alligator Gar	*Lepisosteus spatula*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Grass Pickerel	*Esox americanus vermiculatus*
Chain Pickerel	*Esox niger*

Northern Studfish	*Fundulus catenatus*
Black-stripe Topminnow	*Fundulus notatus*
Starhead Topminnow	*Fundulus dispar*
Black-spotted Topminnow	*Fundulus olivaceus*
Western Mosquitofish	*Gambusia affinis*
Brook Silverside	*Labidesthes sicculus*

Bird List, Mingo NWR

Name	Breeding Status	Seasonal Abundance			
		Spring	Summer	Fall	Winter
Pied-billed Grebe *Podilymbus podiceps*	Documented Breeder	common	rare	common	common
Horned Grebe *Podiceps auritus*		rare	-	rare	-
Eared Grebe *Podiceps nigricollis*		rare	-	rare	-
American White Pelican *Pelecanus erythrorhynchos*		rare	-	uncommon	-
Double-crested Cormorant *Phalacrocorax auritus*		rare	-	rare	-
American Bittern *Botaurus lentiginosus*		common	rare	rare	-
Least Bittern *Ixobrychus exilis*		rare	rare	rare	-
Great Blue Heron *Ardea herodias*	Documented Breeder	common	common	common	uncommon
Great Egret *Ardea alba*		uncommon	uncommon	uncommon	-
Snowy Egret *Egretta thula*		rare	rare	-	-
Little Blue Heron *Egretta caerulea*	Documented Breeder	common	common	common	-
Cattle Egret *Bubulcus ibis*	Documented Breeder	common	uncommon	common	-
Green Heron *Butorides virescens*	Documented Breeder	common	abundant	common	rare
Black-crowned Night-Heron *Nycticorax nycticorax*	Documented Breeder	rare	rare	uncommon	-
Yellow-crowned Night-Heron *Nyctanassa violacea*	Documented Breeder	common	common	uncommon	-
White Ibis *Eudocimus albus*		uncommon	rare	uncommon	-
Tundra Swan *Cygnus columbianus*		-	-	-	rare

Trumpeter Swan *Cygnus buccinator*		-	-	-	rare
Greater White-fronted Goose *Anser albifrons*		rare	-	uncommon	rare
Snow Goose *Anser caerulescens*		uncommon	-	uncommon	uncommon
Canada Goose *Branta canadensis*	Documented Breeder	abundant	uncommon	abundant	abundant
Wood Duck *Aix sponsa*	Documented Breeder	common	common	abundant	common
Green-winged Teal *Anas crecca*		common	-	common	uncommon
American Black Duck *Anas rubripes*		uncommon	-	uncommon	uncommon
Mallard *Anas platyrhynchos*		abundant	rare	abundant	abundant
Northern Pintail *Anas acuta*		common	-	common	common
Blue-winged Teal *Anas discors*		abundant	-	common	uncommon
Northern Shoveler *Anas clypeata*		common	-	common	uncommon
Gadwall *Anas strepera*		common	-	abundant	uncommon
American Wigeon *Anas americana*		common	-	common	uncommon
Canvasback *Aythya valisineria*		rare	-	rare	rare
Redhead *Aythya americana*		rare	-	rare	rare
Ring-necked Duck *Aythya collaris*		common	-	common	common
Lesser Scaup *Aythya affinis*		uncommon	-	uncommon	uncommon
Common Goldeneye *Bucephala clangula*		rare	-	rare	rare
Bufflehead *Bucephala albeola*		rare	-	rare	rare
Hooded Merganser *Lophodytes cucullatus*	Documented Breeder	uncommon	uncommon	uncommon	common
Common Merganser *Mergus merganser*		rare	-	rare	rare
Red-breasted Merganser *Mergus serrator*		rare	-	rare	-
Ruddy Duck *Oxyura jamaicensis*		-	-	rare	rare
Black Vulture C*oragyps atratus*	Documented Breeder	uncommon	uncommon	uncommon	rare
Turkey Vulture* *Cathartes aura*	Documented Breeder	common	common	common	uncommon

Osprey *Pandion haliaetus*		rare	-	rare	-
Mississippi Kite *Ictinia mississippiensis*	Documented Breeder	rare	uncommon	-	-
Bald Eagle *Haliaeetus leucocephalus*	Documented Breeder	uncommon	rare	common	common
Northern Harrier *Circus cyaneus*		uncommon	-	common	common
Sharp-shinned Hawk *Accipiter striatus*	Documented Breeder	rare	rare	rare	rare
Cooper's Hawk *Accipiter cooperii*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Northern Goshawk *Accipiter gentilis*		-	-	rare	rare
Red-shouldered Hawk *Buteo lineatus*	Documented Breeder	common	common	common	common
Broad-winged Hawk B*uteo platypterus*		rare	rare	rare	rare
Red-tailed Hawk *Buteo jamaicensis*	Documented Breeder	common	common	common	common
Rough-legged Hawk *Buteo lagopus*		rare	-	rare	uncommon
Golden Eagle *Aquila chrysaetos*		rare	-	rare	rare
American Kestrel *Falco sparverius*	Documented Breeder	uncommon	uncommon	uncommon	common
Merlin *Falco columbarius*		rare			rare
Peregrine Falcon F*alco peregrinus*		rare	-	rare	rare
Ring-necked Pheasant P*hasianus colchicus*		rare	rare	rare	rare
Wild Turkey *Meleagris gallopavo*	Documented Breeder	common	common	common	common
Northern Bobwhite *Colinus virginianus*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Yellow Rail C*oturnicops noveboracensis*		rare	rare	-	-
King Rail *Rallus elegans*		rare	rare	-	-
Virginia Rail *Rallus limicola*		uncommon	-	uncommon	-
Sora *Porzana carolina*		common	-	common	-

Purple Gallinule *Porphyrio martinicus*		-	rare	-	-
Common Moorhen *Gallinula chloropus*		rare	rare	-	-
American Coot *Fulica americana*		common	rare	abundant	common
Sandhill Crane *Grus canadensis*		rare			rare
American Golden-Plover *Pluvialis dominica*		rare	-	-	-
Semipalmated Plover *Charadrius semipalmatus*		rare	rare	rare	-
Killdeer *Charadrius vociferus*	Documented Breeder	common	common	common	uncommon
American Avocet *Recurvirostra americana*		rare	rare	rare	
Greater Yellowlegs *Tringa melanoleuca*	Does not breed	uncommon	uncommon	uncommon	-
Lesser Yellowlegs *Tringa flavipes*	Does not breed	common	common	common	-
Solitary Sandpiper *Tringa solitaria*	Does not breed	common	common	rare	-
Willet *Catoptrophorus semipalmatus*		rare	rare	rare	
Spotted Sandpiper *Tringa macularia*	Documented Breeder	uncommon	common	rare	-
Upland Sandpiper *Bartramia longicauda*	Does not breed	rare	-	rare	-
Sanderling *Calidris alba*	Does not breed	rare	-	rare	-
Semipalmated Sandpiper *Calidris pusilla*	Does not breed	uncommon	uncommon	rare	-
Least Sandpiper *Calidris minutilla*	Does not breed	uncommon	uncommon	uncommon	-
White-rumped Sandpiper *Calidris fuscicollis*	Does not breed	rare	-	-	-
Western Sandpiper *Calidris mauri*	Does not breed	rare	-	rare	-
Baird's Sandpiper *Calidris bairdii*		-	-	rare	-
Pectoral Sandpiper *Calidris melanotos*	Does not breed	common	common	common	-

Dunlin *Calidris alpina*	Does not breed	uncommon	-	uncommon	-
Stilt Sandpiper *Micropalama himantopus*	Does not breed	uncommon	rare	uncommon	-
Dowitcher Spp.		uncommon	rare	uncommon	-
Common Snipe *Gallinago gallinago*	Does not breed	common	rare	common	rare
American Woodcock *Scolopax minor*		common	rare	common	rare
Wilson's Phalarope *Steganopus tricolor*		uncommon	-	uncommon	-
Franklin's Gull *Larus pipixcan*				rare	
Ring-billed Gull *Larus delawarensis*		uncommon	-	uncommon	uncommon
Herring Gull *Larus argentatus*		uncommon	-	uncommon	uncommon
Caspian Tern *Sterna caspia*		rare		rare	
Common Tern *Sterna hirundo*		uncommon	-	-	-
Forster's Tern *Sterna forsteri*		uncommon	-	-	-
Least Tern *Sterna antillarum*		rare	rare		
Black Tern *Chlidonias niger*		uncommon	rare	rare	-
Rock Dove *Columba livia*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Mourning Dove *Zenaida macroura*	Documented Breeder	abundant	abundant	abundant	common
Black-billed Cuckoo *Coccyzus erythropthalmus*	Documented Breeder	uncommon	uncommon	-	-
Yellow-billed Cuckoo *Coccyzus americanus*	Documented Breeder	abundant	abundant	uncommon	-
Barn Owl *Tyto alba*	Documented Breeder	rare	rare	rare	rare
Eastern Screech-Owl *Otus asio*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Great Horned Owl *Bubo virginianus*	Documented Breeder	uncommon	uncommon	uncommon	uncommon

Barred Owl *Strix varia*	Documented Breeder	common	common	common	common
Short-eared Owl *Asio flammeus*		rare	-	rare	rare
Long-eared Owl *Asio otus*		rare	-	-	rare
Northern Saw-whet Owl *Aegolius acadicus*		-	-	-	rare
Common Nighthawk *Chordeiles minor*	Documented Breeder	uncommon	uncommon	-	-
Chuck-will's-widow *Caprimulgus carolinensis*	Documented Breeder	common	common	-	-
Whip-poor-will *Caprimulgus vociferus*	Documented Breeder	common	common	-	-
Chimney Swift *Chaetura pelagica*	Documented Breeder	common	common	uncommon	-
Ruby-throated Hummingbird *Archilochus colubris*	Documented Breeder	common	common	uncommon	-
Belted Kingfisher *Ceryle alcyon*	Documented Breeder	common	common	uncommon	uncommon
Red-headed Woodpecker *Melanerpes erythrocephalus*	Documented Breeder	common	common	abundant	abundant
Red-bellied Woodpecker *Melanerpes carolinus*	Documented Breeder	common	common	common	common
Yellow-bellied Sapsucker *Sphyrapicus varius*		uncommon	-	uncommon	uncommon
Downy Woodpecker P*icoides pubescens*	Documented Breeder	common	common	common	common
Hairy Woodpecker *Picoides villosus*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Pileated Woodpecker *Dryocopus pileatus*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Northern Flicker *Colaptes auratus*	Documented Breeder	common	common	common	abundant
Olive-sided Flycatcher *Contopus cooperi*		uncommon	uncommon	-	-
Eastern Wood-Pewee *Contopus virens*	Documented Breeder	common	common	-	-
Yellow-bellied Flycatcher *Empidonax flaviventris*		rare	rare		-
Acadian Flycatcher *Empidonax virescens*	Documented Breeder	common	common	-	-
Alder Flycatcher	Does not	uncommon	uncommon	-	-

Empidonax alnorum	breed				
Willow Flycatcher *Empidonax traillii*	Does not breed	uncommon	uncommon	-	-
Least Flycatcher E*mpidonax minimu*s	Does not breed	uncommon	uncommon	-	-
Eastern Phoebe S*ayornis phoebe*	Documented Breeder	common	common	rare	rare
Great Crested Flycatcher *Myiarchus crinitus*	Documented Breeder	common	common	-	-
Eastern Kingbird *Tyrannus tyrannus*	Documented Breeder	common	common	-	-
Scissor-tailed Flycatcher *Tyrannus forficatus*		rare	rare	rare	
Horned Lark *Eremophila alpestris*	Documented Breeder	common	uncommon	uncommon	common
Purple Martin *Progne subis*	Documented Breeder	uncommon	uncommon	-	-
Tree Swallow *Tachycineta bicolor*	Documented Breeder	abundant	abundant	uncommon	-
Northern Rough-winged Swallow *Stelgidopteryx serripennis*	Documented Breeder	uncommon	uncommon	-	-
Bank Swallow *Riparia riparia*	Documented Breeder	uncommon	uncommon	-	-
Cliff Swallow *Petrochelidon pyrrhonota*	Documented Breeder	rare	rare	-	-
Barn Swallow *Hirundo rustica*	Documented Breeder	common	common	-	-
Blue Jay *Cyanocitta cristata*	Documented Breeder	common	common	common	common
American Crow *Corvus brachyrhynchos*	Documented Breeder	common	common	common	abundant
Fish Crow *Corvus ossifragus*	Documented Breeder	uncommon	uncommon	uncommon	rare
Black-capped Chickadee *Poecile atricapillus*		-	-	-	uncommon
Carolina Chickadee *Poecile carolinensis*	Documented Breeder	common	common	common	common
Tufted Titmouse *Baeolophus bicolor*	Documented Breeder	common	common	common	common
Red-breasted Nuthatch *Sitta canadensis*		-	-	-	rare
White-breasted Nuthatch *Sitta carolinensis*	Documented Breeder	uncommon	uncommon	common	common
Brown Creeper *Certhia americana*		uncommon	-	uncommon	uncommon

Carolina Wren *Thryothorus ludovicianus*	Documented Breeder	common	common	common	common
Bewick's Wren *Thryomanes bewickii*	Documented Breeder	rare	rare	rare	rare
House Wren *Troglodytes aedon*	Documented Breeder	common	common	common	-
Winter Wren *Troglodytes troglodytes*		common	-	common	common
Sedge Wren *Cistothorus platensis*	Documented Breeder	rare	rare	rare	rare
Marsh Wren *Cistothorus palustri*s		uncommon	-	rare	rare
Golden-crowned Kinglet *Regulus satrap*a		uncommon	-	common	common
Ruby-crowned Kinglet *Regulus calendula*		uncommon	-	uncommon	rare
Blue-gray Gnatcatcher *Polioptila caerulea*	Documented Breeder	abundant	abundant	uncommon	-
Eastern Bluebird *Sialia sialis*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
Veery *Catharus fuscescens*		rare	-	rare	-
Gray-cheeked Thrush *Catharus minimus*		uncommon	-	uncommon	-
Swainson's Thrush *Catharus ustulatus*		uncommon	-	uncommon	-
Hermit Thrush *Catharus guttatus*		common	-	common	uncommon
Wood Thrush *Catharus mustelinus*	Documented Breeder	common	common	common	-
American Robin *Turdus migratorius*	Documented Breeder	common	common	common	common
Gray Catbird *Dumetella carolinensis*	Documented Breeder	common	common	common	rare
Northern Mockingbird *Mimus polyglottos*	Documented Breeder	common	common	common	common
Brown Thrasher *Toxostoma rufum*	Documented Breeder	common	common	common	uncommon
Cedar Waxwing *Bombycilla cedrorum*		uncommon	-	uncommon	uncommon
Loggerhead Shrike *Lanius ludovicianus*	Documented Breeder	uncommon	uncommon	uncommon	uncommon
European Starling *Sturnus vulgaris*	Documented Breeder	abundant	common	abundant	abundant
White-eyed Vireo *Vireo griseus*	Documented Breeder	common	common	-	-
Bell's Vireo *Vireo bellii*	Documented Breeder	uncommon	uncommon	-	-
Blue-headed Vireo *Vireo solitarius*		uncommon	-	uncommon	rare

Yellow-throated Vireo *Vireo flavifrons*	Documented Breeder	common	common	uncommon	-
Warbling Vireo *Vireo gilvus*	Documented Breeder	common	common	uncommon	-
Philadelphia Vireo *Vireo philadelphicus*		rare	-	rare	-
Red-eyed Vireo *Vireo olivaceus*	Documented Breeder	common	common	uncommon	-
Blue-winged Warbler *Vermivora pinus*		uncommon	-	rare	-
Golden-winged Warbler *Vermivora chrysoptera*		rare	-	rare	-
Tennessee Warbler *Vermivora peregrina*		uncommon	-	uncommon	-
Orange-crowned Warbler *Vermivora celata*		uncommon	-	uncommon	rare
Nashville Warbler *Vermivora ruficapilla*		common	-	uncommon	-
Northern Parula *Parula americana*	Documented Breeder	common	common	uncommon	-
Yellow Warbler *Dendroica petechia*	Documented Breeder	uncommon	uncommon	uncommon	-
Chestnut-sided Warbler *Dendroica pensylvani*ca		uncommon	-	uncommon	-
Magnolia Warbler *Dendroica magnolia*		uncommon	-	uncommon	-
Cape May Warbler *Dendroica tigrina*		rare	-	-	-
Black-throated Blue Warbler D*endroica caerulescens*		uncommon	-	uncommon	-
Yellow-rumped Warbler *Dendroica coronata*		common	-	common	uncommon
Black-throated Green Warbler *Dendroica virens*		common	-	uncommon	-
Blackburnian Warbler *Dendroica fusca*	Does not breed	uncommon	rare	uncommon	-
Yellow-throated Warbler *Dendroica dominica*		common	uncommon	-	-
Pine Warbler Dendroica pinus		uncommon	rare	rare	-
Prairie Warbler *Dendroica discolor*		uncommon	uncommon	-	-
Palm Warbler *Dendroica palmarum*		uncommon	-	uncommon	-
Bay-breasted Warbler		uncommon	-	-	-

Dendroica castanea					
Blackpoll Warbler *Dendroica striata*		uncommon	-	uncommon	-
Cerulean Warbler *Dendroica cerulea*		uncommon	uncommon	-	-
Black-and-white Warbler *Mniotilta varia*	Documented Breeder	uncommon	uncommon	uncommon	-
American Redstart *Setophaga ruticilla*	Documented Breeder	uncommon	uncommon	uncommon	-
Prothonotary Warbler *Protonotaria citrea*	Documented Breeder	common	common	uncommon	-
Worm-eating Warbler *Helmitheros vermivorus*		uncommon	uncommon	-	-
Swainson's Warbler *Limnothlypis swainsonii*		rare	rare	-	-
Ovenbird *Seiurus aurocapillus*		common	uncommon	uncommon	-
Northern Waterthrush *Seiurus noveboracensis*	Does not breed	common	uncommon	-	-
Louisiana Waterthrush *Seiurus motacilla*	Documented Breeder	common	uncommon	uncommon	-
Kentucky Warbler *Oporornis formosus*	Documented Breeder	common	common	uncommon	-
Mourning Warbler *Oporornis philadelphia*		uncommon	-	uncommon	-
Common Yellowthroat *Geothlypis trichas*	Documented Breeder	common	common	common	rare
Hooded Warbler *Wilsonia citrina*	Documented Breeder	uncommon	uncommon	-	-
Wilson's Warbler *Wilsonia pusilla*		uncommon	-	uncommon	-
Canada Warbler *Wilsonia canadensis*		uncommon	-	uncommon	-
Yellow-breasted Chat *Icteria virens*	Documented Breeder	common	common	uncommon	-
Summer Tanager *Piranga rubra*	Documented Breeder	common	common	uncommon	-
Scarlet Tanager *Piranga olivacea*	Documented Breeder	uncommon	uncommon	uncommon	-
Northern Cardinal *Cardinalis cardinalis*	Documented Breeder	abundant	abundant	abundant	abundant
Rose-breasted Grosbeak *Pheucticus ludovicianus*	Documented Breeder	common	rare	uncommon	-
Blue Grosbeak *Guiraca caerulea*		uncommon	rare	-	-
Indigo Bunting *Passerina cyanea*	Documented Breeder	abundant	abundant	common	-
Dickcissel	Documented	common	common	-	-

Spiza americana	Breeder				
Eastern Towhee *Pipilo erythrophthalmus*	Documented Breeder	common	common	common	uncommon
American Tree Sparrow *Spizella arborea*		rare	-	rare	common
Chipping Sparrow *Spizella passerina*	Documented Breeder	common	common	uncommon	rare
Field Sparrow *Spizella pusilla*	Documented Breeder	common	common	uncommon	uncommon
Vesper Sparrow *Pooecetes gramineus*		uncommon	-	uncommon	rare
Lark Sparrow *Chondestes grammacus*		uncommon	rare	rare	-
Savannah Sparrow *Passerculus sandwichensis*		common	-	common	rare
Grasshopper Sparrow *Ammodramus savannarum*		uncommon	uncommon	uncommon	-
Henslow's Sparrow *Ammodramus henslowii*		rare	rare		
Le Conte's Sparrow *Ammodramus leconteii*		rare	-	-	rare
Fox Sparrow *Passerella iliaca*		uncommon	-	uncommon	uncommon
Song Sparrow *Melospiza melodia*	Documented Breeder	common	common	common	common
Lincoln's Sparrow *Melospiza lincolnii*		rare	-	rare	rare
Swamp Sparrow *Melospiza georgiana*		common	-	common	common
White-throated Sparrow *Zonotrichia albicollis*		common	-	common	abundant
White-crowned Sparrow *Zonotrichia leucophrys*		common	-	common	common
Harris's Sparrow *Zonotrichia querula*		-	-	-	rare
Dark-eyed Junco *Junco hyemalis*		uncommon	-	uncommon	abundant
Lapland Longspur *Calcarius lapponicus*		-	-	-	rare
Bobolink *Dolichonyx oryzivorus*		rare	-	rare	-
Red-winged Blackbird *Agelaius phoeniceus*	Documented Breeder	abundant	abundant	abundant	abundant
Eastern Meadowlark *Sturnella magna*	Documented Breeder	common	common	common	common
Western Meadowlark *Sturnella neglecta*		rare		rare	rare

Yellow-headed Blackbird *Xanthocephalus xanthocephalus*				rare	rare
Rusty Blackbird *Euphagus carolinus*		uncommon	-	uncommon	common
Brewer's Blackbird *Euphagus cyanocephalus*		rare	-	rare	uncommon
Common Grackle *Quiscalus quiscula*	Documented Breeder	common	common	common	abundant
Brown-headed Cowbird *Molothrus ater*	Documented Breeder	common	common	common	uncommon
Orchard Oriole *Icterus spurius*	Documented Breeder	common	common	-	-
Baltimore Oriole *Icterus galbula*	Documented Breeder	uncommon	uncommon	-	-
Purple Finch *Carpodacus purpureus*		uncommon	-	uncommon	uncommon
Red Crossbill *Loxia curvirostra*		rare		rare	rare
Pine Siskin *Carduelis pinus*		rare	-	rare	rare
American Goldfinch *Carduelis tristis*	Documented Breeder	common	common	common	common
Evening Grosbeak *Coccothraustes vespertinus*		-	-	-	rare
House Sparrow *Passer domesticus*	Documented Breeder	common	common	common	common
Western Grebe *Aechmophorus occidentalis*	Casual				
Anhinga *Anhinga anhinga*	Casual				
Tricolored Heron *Egretta tricolor*	Casual				
Glossy Ibis *Plegadis falcinellus*	Casual				
Roseate Spoonbill *Ajaia ajaja*	Casual				
Wood Stork *Mycteria americana*	Casual				
Fulvous Whistling-Duck *Dendrocygna bicolor*	Casual				
Mute Swan *Cygnus olor*	Casual				
Ross's Goose *Chen rossii*	Casual				
Brant *Branta bernicla*	Casual				

Cinnamon Teal *Anas cyanoptera*	Casual				
Greater Scaup *Aythya marila*	Casual				
Long-tailed Duck *Clangula hyemalis*	Casual				
White-winged Scoter *Melanitta fusca*	Casual				
Black Scoter *Melanitta nigra*	Casual				
Swainson's Hawk *Buteo swainsoni*	Casual				
Prairie Falcon *Falco mexicanus*	Casual				
Gyrfalcon *Falco rusticolus*	Casual				
Whooping Crane *Grus americana*	Casual				
Snowy Owl *Nyctea scandiaca*	Casual				
Nelson's Sharp-tailed *Sparrow Ammodramus nelsoni*	Casual				
White-winged Crossbill *Loxia leucoptera*	Casual				

Appendix B
Bibliography

Bibliography

Allen, J.A., B.D. Keeland, J.A. Stanturf, A.F. Clewell, and H.E. Kennedy, Jr. 2001. A guide to bottomland hardwood restoration: U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD/ITR-2000-0011, U.S. Department of Agriculture, Forest Service, Southern Research Station, Gen. Tech. Rep. SRS-40. 132 pp.

Batema, D.L., G.S. Henderson, and L.H. Fredrickson. 1985. Wetland invertebrate distribution in bottomland hardwoods as influenced by forest type and flooding regime. Pages 196-202 in Proc. Fifth Annu. Hardwood Conf., Univ. Ill., Urbana.

Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. The U.S. Shorebird Conservation Plan, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.

Carter, M.F., W.C. Hunter, D.N. Pashley, and K.V. Rosenberg. 2000. Setting conservation priorities for landbirds in the United States: the Partners in Flight approach. Auk 117:541-548.

Christisen, D.M., and L.J. Korschgen. 1955. Acorn yields and wildlife useage in Missouri. Trans. N. Am. Wildl. Conf. 20:337-356.

Clatterbuck, W. K. and J. S. Meadows. 1993. Regenerating oaks in the bottomlands. In. Loftis, D. and C. E. McGee (editors), Oak Regeneration: Serious Problems, Practical Recommendations, Symposium Proceedings. USDA For. Serv. Gen. Tech. Rep. SE-84, pp. 184-195.

Coblentz, B.E., 1990. Exotic organisms: a dilemma for conservation biology. Conserv. Biol. 4, pp. 261–265.

Dugger, K. M., B. D. Dugger, And L. H. Fredrickson.1999. Annual survival rates of female Hooded Mergansers and Wood Ducks in southeastern Missouri. Wilson Bull. 111:1–6.

Eddleman, W.R., K.E. Evans, and W.H. Elder. 1980. Habitat characteristics and management of Swainson's warbler in Southern Illinois. Wildlife Society Bulletin 8:228-233.

Eldridge, J. 1990. Aquatic invertebrates important for waterfowl production. U.S. Fish Wildl. Leafl. 13.3.3. 7 p.

Eldridge, J. L. 1992. Management of habitat for breeding and migrating shorebirds in the Mid-west. U.S. Fish and Wildl. Serv. Leafl. 13.2.14. U.S. Fish and Wildl. Serv., Twin Cities, Minn. 5pp.

Elliott, L. and K. McKnight, editors. 2000. U.S. Shorebird Conservation Plan: Lower Mississippi Valley/Western Gulf Coastal Plain. Prepared by Mississippi Alluvial Valley/ West Gulf Coastal Plain Working Group.

Fitzgerald, J. A. and D. N. Pashley. 2000a. Partners in Flight Bird Conservation Plan for The Ozark/Ouachitas (Physiographic Area 19), Version 1.0. American Bird Conservancy.

Fredrickson, L.H., and T.S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U.S. Fish Wildl. Serv., Resour. Publ. 148. 29 pp.

Fredrickson, L.H., and F.A. Reid. 1986. Wetland and riparian habitats: a nongame management overview. Pages 59-96 in J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the Midwest: a developing art. Northcentral Section, The Wildlife Society, Madison, Wis.

Fredrickson, L.H., and F.A. Reid. 1988. Waterfowl use of wetland complexes. U.S. Fish Wildl. Leafl. 13.2.1.6 pp.

Fredrickson, L.H. .1991. Strategies for water level manipulations in moist-soil systems. *Waterfowl Management Handbook* (ed. D.H. Cross). Fish & Wildlife Leaflet 13.4.6. US Dept of the Interior, Washington, DC

Fredrickson, L.H. 1996. Moist soil management, 30 years of field experimentation. Proceedings of the International Waterfowl Symposium. 7:168-177.

Hamel, Paul B. 2000. Cerulean warbler: *Status Assessment*, U. S. Fish and Wildlife Service. 141pp.

Hamel, Paul B., and John B. Dunning, Jr. 2000. An approach to quantifying long-term habitat change on managed forest lands. Studies in Avian Biology No. 21: 122-129

Hamel, P. B., D. K. Dawson, and P. D. Keyser. 2004. How we can learn more about the Cerulean Warbler (*Dendroica cerulea*). Auk 121:7–14.

Harris, L. D. 1984. The fragmented forest. University of Chicago Press, Chicago, IL. 211 pp.

Heitmeyer, M. E. 1985. Wintering strategies of female mallards related to dynamics of lowland hardwood wetlands in the Upper Mississippi Delta. Ph.D. Dissertation, Univ. Missouri, Columbia. 378 pp.

Heitmeyer, M. E., F.A. Nelson, and L.H. Fredrickson. 2006. An Evaluation of Ecosystem Restoration and Management Options for the Duck Creek/Mingo Basin Area of Southeast Missouri. Gaylord memorial Lab Spec. publication No. 12, Univ. of Missouri- Columbia. 106pp.

Helmers, D. L. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network. Manomet, MA. 58 pp.

Hunter, W.C., M. F. Carter, D. N. Pashley, and K. Barker. 1993. Partners in Flight Species Prioritization Scheme. Pages 109-119 *in* Finch, D. M., and P. W. Stangel (eds.), Status and

management of Neotropical migratory birds. Gen. Tech. Rep. RM-229. USDA Forest Service.

Hunter, W. C, W. Golder, S. L. Melvin, and J. A. Wheeler. 2006. Southeast United States regional waterbird conservation plan. U.S. Fish and Wildlife Service, Atlanta, Georgia, USA. <http://www.fws.gov/ birds/waterbirds/SoutheastUS>. Accessed 01 Jun 2011.

Kahl, R.B., T.S. Baskett, J.A. Ellis, and J.N. Burroughs. 1985. Characteristics of summer habitats of selected nongame birds in Missouri. Univ. Missouri-Columbia Agric. Exp. Sta. Res. Bull. 1056.

Kaminski, R. M., J. B. Davis, H. W. Essig, P. D. Gerard and K. J. Reinecke. 2003. True metabolizable energy for wood ducks from acorns compared to other waterfowl foods. J. Wildl. Manage., 67:542–550.

Korte, P. A., and L. H. Fredrickson. 1977. Loss of Missouri's lowland hardwood ecosystem. Trans. North Am. Wildl. and Nat. Resour. Conf. 42:31-41.

Laubhan, M. K., AND L. H. Fredrickson. 1992. Estimatig seed production of common plants in seasonally flooded wetlands. J. Wildl. Manage. 56: 329-337.

Lee, G., Macdonald, I.A.W. 1997. Foreword. In: Proceedings of the World Conservation Congress Workshop on Alien Invasive Species, Montreal, Canada, October 13–23, 1996

LMVJV Forest Resource Conservation Working Group. 2007. Restoration, Management and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat. Edited by R. Wilson, K. Ribbeck, S. King, and D. Twedt.

MacDonald, P.O., W.E. Frayer, & J.K. Clauser. 1979. Documentation, chronology, and future projections of bottomland hardwood habitat losses in the lower Mississippi Alluvial Plain. Vols. 1 and 2. U.S. Fish and Wildlife Service, Washington, D.C. 34 pp.

Meadows, J.S. and J.A. Stanturf. 1997. Silvicultural Systems for Southern Bottomland Hardwood Forests. Forest Ecology and Management. vol. 90 pp. 127-140.

Meanley, B. 1966. Some observation on habitats of Swainson's warbler. Living Bird 5:151-165.

Meanley, B. 1971. Natural history of the Swainson’s warbler. U.S. Fish and Wildlife Service, North American Fauna Series, No. 69.

McQuilkin, R.A., and R. A. Musbach. 1977. Pin oak acorn production on green tree reservoirs in southeastern Missouri. J. Wildl. Manage. 41(2):218-225.

Meadows, James S. and John A. Stanturf. 1997. Silvicultural systems for southern bottomland hardwood forests. Forest Ecology and Management 90 (1997) 127-140.

Missouri's Comprehensive Wildlife Conservation Strategy. 2005. Missouri Department of Conservation, 2901 W. Truman Blvd., Jefferson City, MO, 65102. http://www.fws.gov/midwest/FederalAid/documents/03MOWAP06Dmjs.pdf. Accessed 2010 May 13

Mueller, A. J., D. J. Twedt, and C. R. Loesch. 1999. Development of Management Objectives for Breeding Birds in the Mississippi Alluvial Valley. In Bonney, Rick, David N. Pashley, Robert Cooper, and Larry Niles, eds. Strategies for Bird Conservation: The Partners in Flight Planning Process. Cornell Lab of Ornithology. http://birds.cornell.edu/pifcapemay/mueller.htm

Natural Resources Conservation Service, Mississippi Fish and Wildlife Foundation, U.S. Fish and Wildlife Service, Ducks Unlimited, and Delta Wildlife. 2001. Wetland Management for Waterfowl Handbook. 119 pp.

Potter, B. A., R. J. Gates, G. J. Soulliere, R. P. Russell, D. A. Granfors, and D. N. Ewert. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Shorebird Habitat Conservation Strategy. U. S. Fish and Wildlife Service, Fort Snelling, MN. 101 pp.

Reid, F.R., J. R. Kelley, Jr., T.S. Taylor and L. H. Fredrickson. 1989. Upper Mississippi Valley Wetlands-refuges and moist soil impoundments. Pgs. 181-202 in R. Kaminski, R. Pederson and L. Smith, Editors. Habitat management for migrating and wintering waterfowl in North America. Texas Technical University Press, Lubbock.

Reinecke, K. J., R. M. Kaminski, K. J.Moorehead, J. D. Hodges and J. R. Nassar. 1989. Mississippi Alluvial Valley, p. 203–247. In: L.M. Smith, R. L. Pederson and R. M. Kaminski (eds.). Habitat management for migrating and wintering waterfowl in North America. Texas Tech University Press, Lubbock, Texas.

Richardson, D.M., P. Pysek, M. Rejmane, M.G. Barbour, F.D. Panetta, and C.J.West. 2000. Naturalization and invasion of alien plants: concepts and definitions. Divers. Distrib. 6, pp. 93–107

Sallabanks, R., J. R. Walters, and J. A. Collazo. 2000. Breeding bird abundance in bottomland hardwood forests: habitat, edge, and patch size effects. Condor 102:748–758.

Semlitsch, R.D. 2000. Principles for management of aquatic-breeding amphibians. J. Wildl. Manage. 64(3): 615-631.

Stanturf, J.A., Schweitzer, C.J. and E.S. Gardiner. 1998. Afforestation of marginal agricultural land in the Lower Mississippi River Alluvial Valley, U.S.A. Silva Fennica 32(3): 281–297.

Stanturf, J. A., E. S. Gardiner, P. B. Hamel, M. S. Devall, T. D. Leininger, and M. E. Warren, Jr. 2000. Restoring bottomland hardwood ecosystems in the Lower Mississippi Alluvial Valley. Journal of Forestry, Vol. 98, No. 8, August 2000. pp. 10-16.

Taylor, T.S. 1977. Avian use of moist soil impoundments in southeastern Missouri. M.S. Thesis. University of Missouri, Columbia. 98 pp.

Taylor, T.S. 1978. Spring foods of migrating blue-winged teal on seasonally flooded impoundments. J. Wildl. Manage. 42(4): 900-903.

Thompson, R. L. 1980. Woody vegetation and floristic affinities of Mingo Wilderness Area, a northern terminus of southern floodplain forest, Missouri. Castanea 45(3) 194-212

Tirpack, J.M. (Spetemeber 17, 2010). Email Interview.

Tirpak, J. M., D.T. Jones-Faarrand, F.R. Thompson, D.J. Twedt, and W. B. Uilein III. 2009. Multiscale Habitat Suitabilty Index Model for Priority Landbird in the Central hardwoods and West gulf Coast Plain/Ouachitas Bird Conservation Regions. Gen Tech. Rep NRS-49. Newton Square, PA: U.S. Dept. of Agriculture, Forest Service Northern Research Station. 195 pp.

Twedt, D.J., D. Pashley, C. Hunter, A. Mueller, C. Brown, and B. Ford. 1999. Partners in Flight Bird Conservation Plan for the Mississippi Alluvial Valley. 71 pp.

Twedt, D. J., C.O. Nelms, V.E. Rettig and S. R. Aycock. 1998. Shorebird use of managed wetlands in the Mississippi Alluvial Valley. Am. Midl. Nat. 140:14-152.

Twedt, D. J., and C. R. Loesch. 1999. Forest area anddistribution in the Mississippi alluvial valley: Implications for breeding bird conservation. Journal of Biogeography 26: 1215–1224.

U.S. Fish and Wildlife Service (USFWS), 1986. Forest Management Plan, Mingo National Wildlife Refuge, Puxico, MO. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. Agency draft Indiana bat (*Myotis sodalis*) revised recovery plan. Region 3, US Fish and Wildlife Service, Fort Snelling, MN. 53 pp.

U.S. Fish and Wildlife Service (USFWS). 2003. Increasing Wood Duck Productivity - Guidelines for Management and Banding, Southeast Region. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2005. The migratory bird program's focal species strategy. U. S. Fish and Wildlife Service, Arlington, VA.

U.S. Fish and Wildlife Service (USFWS). 2007. Mingo, Pilot Knob, Ozark Cavefish National Wildlife Refuge Comprehensive Conservation Plan, Region 3. 182 pp.

U.S. Fish and Wildlife Service (USFWS). 2007a. Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 45 pp.

U.S. Fish and Wildlife Service (USFWS). 2009. Indian Bat (*Myotis sodalis*) 5-year Review: Summary and Evaluation. Region 3. 45 pp.

U.S. Fish and Wildlife Service (USFWS). 2006 Chickasaw National Wildlife Refuge Habitat Mangament Plan. Region 4. 61pp.

Wenny, D.G., R.L. Clawson, J. Faaborg and Sheriff, S.L. 1993. Population density, habitat selection and minimum area requirements of 3 forest-interior warblers in central Missouri. Condor 95, 968–979 pp.

Wilcove, D.S., C.H. McLellan, and A.P Dobson. 1986. Habitat fragmentation in the temperate zone. In: Soule, M.E. (Ed.), Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, MA.

Wilson, R. R. and D. J. Twedt. 2002. Spring bird migration in Mississippi Alluvial Valley forests. American Midland Naturalist 149:163-175.

Yates, J.M., D.F. Levia, and C.L.Williams. 2004. Recruitment of three non-native invasive plants into a fragmented forest in southern Illinois. Forest Ecol. Manage. 190, 119–130.