Chapter 3: Refuge Environments and Management

Introduction

Established in 1944 under authority of the Migratory Bird Treaty Act, the 21,592-acre Mingo National Wildlife Refuge covers portions of Stoddard and Wayne counties in southeast Missouri, approximately 150 miles south of St. Louis. It contains 15,000 acres of bottomland hardwood forest, the largest remnant of the 2.5 million acres that once enveloped southeastern Missouri, and serves as a resting, breeding, and wintering area for migratory birds. The Refuge also includes 3,500 acres of marsh and water, 411 acres of cropland, 704 acres of moist soil units, and 474 acres of grassy openings.

Clearing of the region's bottomland hardwood forests for lumber and railroad ties began in the 1880s and continued into the 1930s, feeding the demand of a growing nation. Conservation and sustainable yield – notions still in their infancy – lost out to short-term economic gain, and the once expansive bottomland forests disappeared. Timber companies looking to reap additional revenue from the cleared landscape funded projects aimed at dewatering the swamp. Ultimately, legislation passed allowing the formation of drainage districts financed by long-term bonds. In 1914 more than 20 such districts existed in Stoddard County, including the Mingo Drainage District near Puxico.

The Mingo Drainage District struggled. Overflow from the St. Francis River thwarted permanent drainage, and soils proved less productive than those in other areas of the Missouri Bootheel. When land values plummeted during the Great Depression many drainage district land owners defaulted on tax payments rather than maintain unprofitable investments. The financially strapped Mingo Drainage District defaulted on bond payments and went bankrupt. Unregulated land uses followed until the U.S. Fish and Wildlife Service acquired the property in 1945. By that time the lands had been deforested, drained with an extensive system of ditches, burned by wildfires, and grazed indiscriminately by livestock.

Stanley Creek on Mingo NWR. USFWS

Through time and careful stewardship the land recovered, and along with it the flora and fauna once common to the swamp. Today the ditches and levees intended to drain Mingo Swamp allow Refuge staff to control and manage water levels, mimicking once natural water fluctuations. Drainage districts throughout the remainder of the Missouri Bootheel survive to this day, rendering it suitable for agriculture and human habitation. This widespread conversion of the bottomland forest with its intermingled streams, lakes, swamps, bayous, and sloughs to an agricultural landscape with roads, dikes, and levees

permanently altered drainage patterns and seasonal flooding regimes.

Mingo Wilderness Area

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.

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 MIST (Minimum Impact Suppression Tactics) analysis. Ditches and levees, specifically excluded from Wilderness designation, help approximate water level fluctuations that once happened naturally.

Special Management Areas

There are seven research natural areas on the Refuge; six are within the Mingo Wilderness Area (Table 1). 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 1: 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

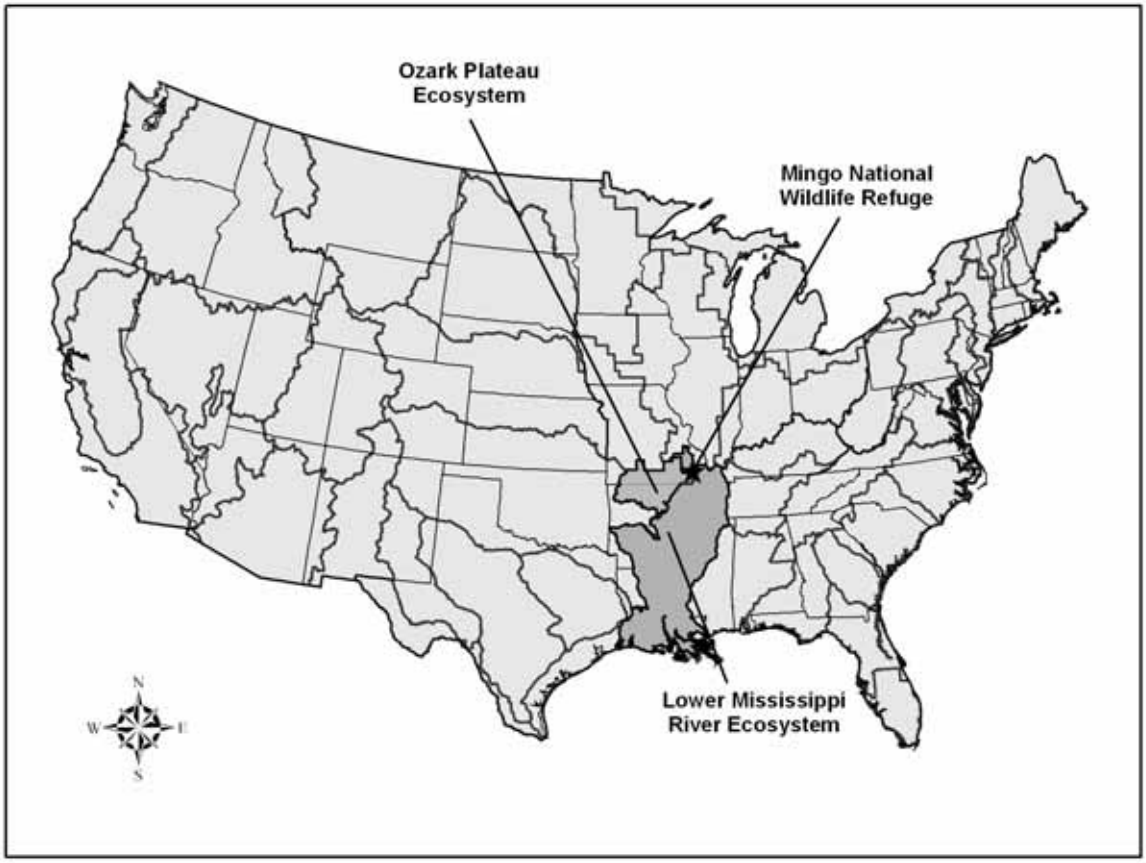
Geographic/Ecosystem Setting

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. The Refuge is bordered to the west by the Missouri Ozarks and to the east by Crowley's Ridge, a prominent landform in the otherwise level Mississippi floodplain. Waters from the Refuge flow south to the St. Francis River via Mingo Creek and a series of drainage ditches.

U.S. Fish and Wildlife Service Ecosystems

In 1994 the Service adopted an ecosystem approach as a framework and extension of its ongoing conservation efforts. An ecosystem approach demands looking beyond administrative boundaries to develop strategies that address threats and challenges to the conservation of natural resources. The Service recognizes 53 ecosystems across the United States, Puerto Rico, and the Virgin Islands (see Figure 2). Each of these ecosystems is a grouping of watersheds as defined by the U.S. Geological Survey's Hydrologic Unit Map. Teams of Service employees work with cooperating partners throughout each ecosystem to identify and address conservation issues that consider biological resources as well as the economic health of communities within each watershed.

Figure 2: U.S. Fish & Wildlife Service Ecosystems of Contiguous States



Mingo National Wildlife Refuge lies at the northern tip of the Lower Mississippi River Ecosystem where it meets the Ozark Plateau Ecosystem. The forested wetlands found across the Mingo basin are characteristic of the Lower Mississippi River Ecosystem, while the upland forests found along the bluffs are characteristic of the Ozark Plateau Ecosystem.

The Lower Mississippi River Ecosystem was a 25-million-acre complex of forested wetlands that extended along both sides of the Mississippi River from Illinois to Louisiana. The extent and duration of seasonal flooding from the Mississippi River fluctuated annually, recharging aquatic systems and creating a diversity of dynamic habitats that supported a vast array of fish and wildlife. Today less than 20 percent of the bottomland hardwood forest remains and most is fragmented or in scattered patches throughout the region. Conservation and restoration of these forests is a top priority for the Service.

The Ozark Plateau is a dome-shaped uplift approximately 50,000 square miles in size, spread across portions of Arkansas, Oklahoma and Missouri. It is characterized by limestone-based karst geology that includes horizontal bedrock, caves, sink holes, and natural springs. The main vegetation communities are upland oak-hickory forest and bottomland hardwood forest in the floodplains of large rivers. The Ozark Plateau Ecosystem is home to numerous rare and declining species, unique endemics, neotropical migrant birds, and other species that are of concern to the Service.

Migratory Bird Conservation Initiatives

Over the last decade, bird conservation planning has evolved from a largely local, site-based focus to a more regional, landscape-oriented perspective. Significant challenges include locating areas of high-quality habitat for the conservation of particular guilds and priority bird species, making sure no species are inadvertently left out of the regional plan-

ning process, avoiding unnecessary duplication of effort, and identifying unique landscape and habitat elements of particular tracts targeted for protection, management and restoration. Several migratory bird conservation initiatives have emerged to help guide the planning and implementation process. Collectively, they comprise a tremendous resource as Mingo NWR engages in comprehensive conservation planning and its translation into effective on-the-ground management.

The North American Waterfowl Management Plan

Signed in 1986, the North American Waterfowl Management Plan (NAWMP) outlines a broad framework for waterfowl management strategies and conservation efforts in the United States, Canada, and Mexico. The goal of the NAWMP is to restore waterfowl populations to historic levels. The NAWMP is designed to reach its objectives through joint ventures of private, state, and federal entities focusing effort within defined geographic areas, or on particular species.

The Refuge is in the Lower Mississippi Valley Joint Venture, one of 12 habitat-based joint ventures. Its focus has expanded beyond the Mississippi Alluvial Valley to include the West Gulf Coastal Plain, encompassing portions of Missouri, Arkansas, Oklahoma, Texas, Louisiana, Mississippi, Tennessee, and Kentucky. The goal of this Joint Venture is to increase populations of waterfowl and other wetland wildlife by protecting, restoring and enhancing wetland and associated upland habitats within the Joint Venture region.

The Lower Mississippi Valley Joint Venture strives to provide habitat for over-wintering waterfowl in the Mississippi Alluvial Valley and West Gulf Coastal Plain Bird Conservation Regions. As such, the Joint Venture assumes that the availability of foraging habitat is the most important factor affecting the number of dabbling ducks that can be accommodated during winter. Based on a "step-down" process, the LMVJV established habitat objectives that link continental waterfowl populations to on-the-ground habitat objectives. Habitat objectives are apportioned among three categories: public managed, private managed, and natural flooding within each state (in the LMVJV administrative boundaries). By doing so, each national wildlife refuge (e.g., Mingo NWR) is responsible for contributing to some portion of the habitat objectives.

Partners In Flight

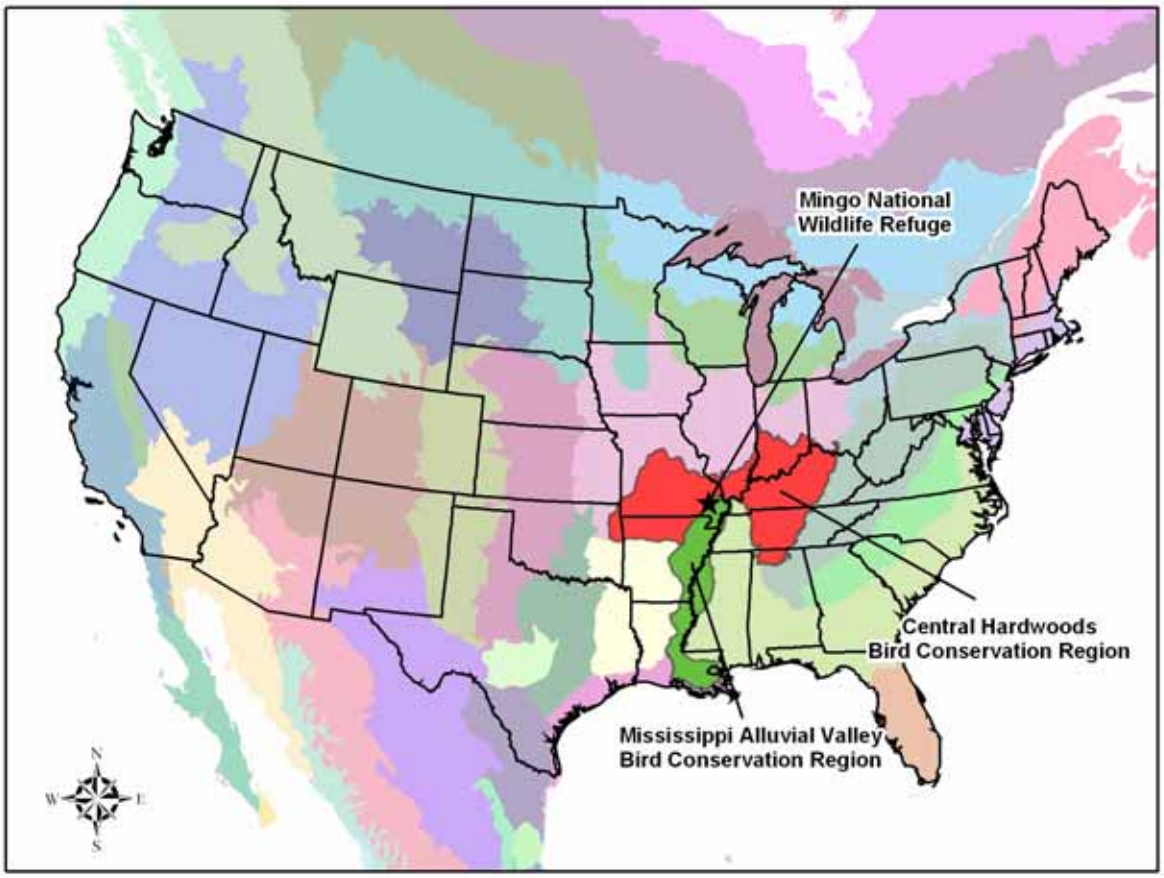
Formed in 1990, Partners In Flight (PIF) is concerned primarily with landbirds and has developed Bird Conservation Plans for numerous *Physiographic Areas* across the U. S. (see http://www.partnersinflight.org). These plans include priority species lists, associated habitats, and management strategies. Mingo NWR lies within PIF Physiographic Area (PA) 05, the Mississippi Alluvial Valley Physiographic Area.

The U. S. Shorebird Conservation Plan and the North American Waterbird Conservation Plan are plans that address the concerns for shorebird and waterbirds. These larger scale plans identify priority species and conservation strategies.

In a continental effort, PIF, NAWMP, U. S. Shorebird Conservation, and the North American Waterbird Conservation plans are being integrated under the umbrella of the North American Bird Conservation Initiative (NABCI). The goal of NABCI is to facilitate the delivery of the full spectrum of bird conservation through regionally-based, biologically-driven, landscape-oriented partnerships. The NABCI strives to integrate the conservation objectives for all birds in order to optimize the effectiveness of management strategies. NABCI uses Bird Conservation Regions (BCRs) as its planning units. BCRs are becoming increasingly common as the unit of choice for regional bird conservation efforts; Mingo NWR lies at the interface of two regions: BCR 24 Central Hardwoods, and BCR 26 Mississippi Alluvial Valley (see Figure 3).

Each of the four bird conservation initiatives has a process for designating conservation priority species, modeled to a large extent on the PIF method of calculating scores based on independent assessments of global relative abundance, breeding and wintering distribution, vulnerability to threats, area importance (at a particular scale, e.g. PA or BCR), and population trend. These scores are often used by agencies in developing lists of bird species of concern; e.g., the U. S. Fish and Wildlife Service based its assessments for its 2001 list of nongame Birds of Conservation Concern primarily on the PIF, shorebird, and waterbird status assessment scores.

Figure 3: Bird Conservation Regions



Region 3 Fish and Wildlife Resource Conservation Priorities

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

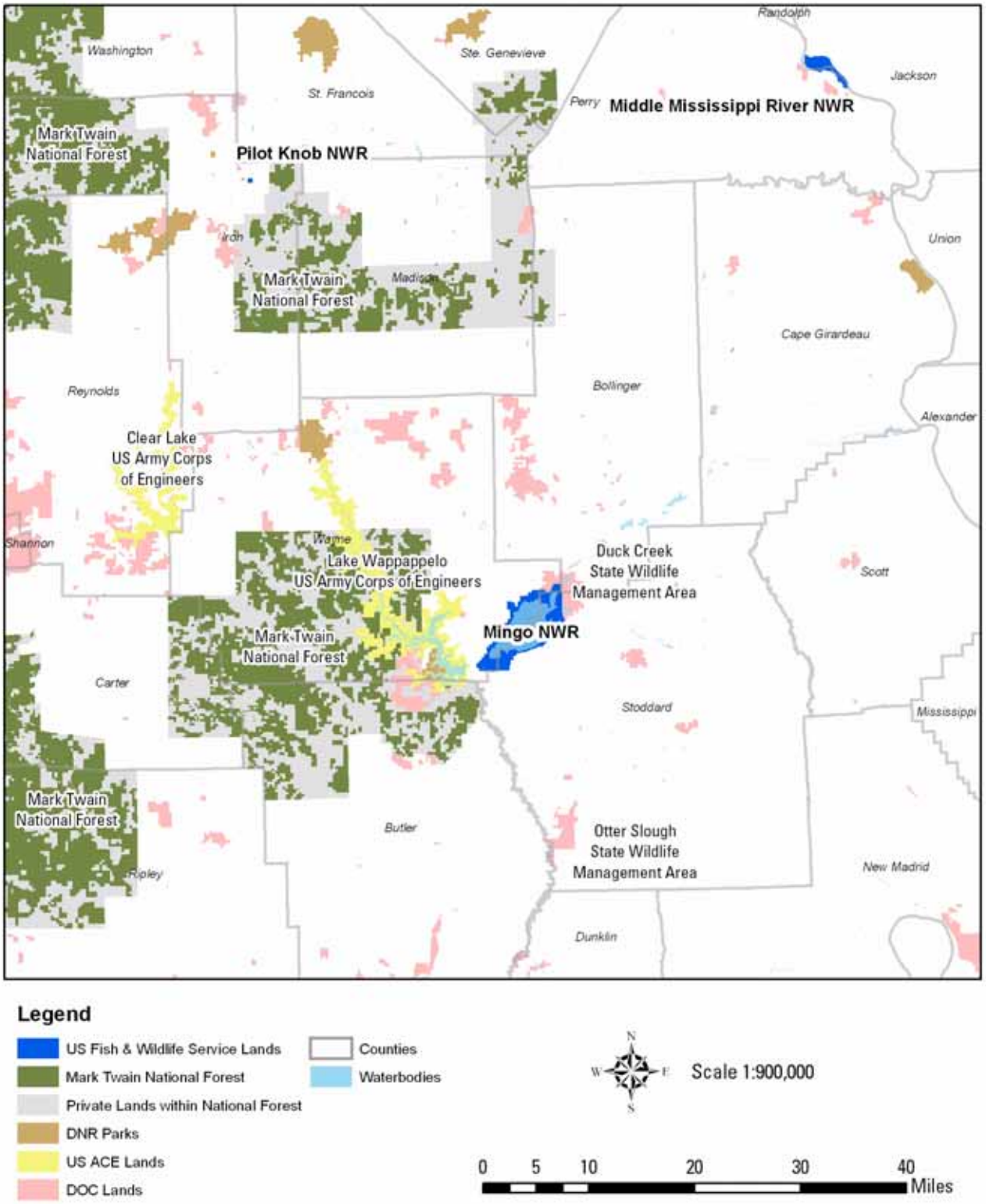
all federally listed threatened and endangered species and proposed and candidate species that occur in the Region
migratory bird species derived from Service wide and international conservation planning efforts
rare and declining terrestrial and aquatic plants and animals that represent an abbreviation of the Endangered Species program's preliminary draft "Species of Concern" list for the Region.

Appendix J lists 52 Resource Conservation Priority species relevant to the Refuge.

Other Recreation and Conservation Lands in the Area

Figure 4 displays other ownerships surrounding the Refuge. The 6,190-acre Duck Creek Conservation Area managed by the Missouri Department of Conservation adjoins the Refuge to the northeast. The Poplar Bluff Ranger District of the 1.5-million-acre Mark Twain National Forest lies several miles southwest of the Refuge. Wappapello Lake, a 44,000-acre reservoir along the St. Francis River, and much of the surrounding land is managed by the U.S. Army Corps of Engineers. Wappapello State Park, which is administered by the Missouri Department of Natural Resources, borders a portion of the reservoir.

Figure 4: Other Conservation Lands in the Vicinity of Missouri National Wildlife Refuges



Socioeconomic Setting

Mingo National Wildlife Refuge is located in Wayne and Stoddard counties, and is adjacent to Bollinger and Butler counties. Compared to the State of Missouri, this four-county area has a smaller population growth rate and is less racially and ethnically diverse. The area's population has a lower average income, and less high school and college education than the state's population as a whole.

Population and Demographics

The total population of the four counties was 95,861 in the 2000 Census. The population increased 6.9 percent during the 1990s while the State's population increased 9.3 percent. Wayne County grew the most at 14.9 percent, and Stoddard County grew the least at 2.8 percent. The four-county population was 95.2 percent white in 2000; the State population was 84.9 percent white. In Missouri, 5.1 percent of the people 5 years and older speak a language other than English at home; in the four-county area it is 2.5 percent.

Employment

In 2000 there were a total of 47,522 full- and part-time jobs in the four-county area. Farm employment accounted for 8.0 percent of the jobs across the area. Bollinger County had the highest proportion of farm employment, 19.9 percent. Other sectors with sizable proportions of jobs are the services, retail, and manufacturing sectors.

Income and Education

Average per-capita income in the four-county area was $14,814 in 1999; in Missouri it was $19,936. The median household income in the four-county area was $27,114 in 1999; in the state it was $37,934.

In the four-county area, 9.9 percent of persons over 25 years of age hold a bachelor's degree or higher. The comparable figure in the state is 21.6 percent.

Potential Refuge Visitors

In order to estimate the potential market for visitors to the Refuge, we looked at 1998 consumer behavior data for an area within an approximate 60-mile radius. The data were organized by zip code areas. We used a 60-mile radius because we thought this was an approximation of a reasonable drive to the Refuge for an outing.

The consumer behavior data used in the analysis is derived from Mediamark Research Inc. data. The company collects and analyzes data on consumer demographics, product and brand usage, and exposure to all forms of advertising media. The consumer behavior data were projected by Tetrad Computer Applications Inc. to new populations using Mosaic data. Mosaic is a methodology that classifies neighborhoods into segments based on their demographic and socioeconomic composition. The basic assumption in the analysis is that people in demographically similar neighborhoods will tend to have similar consumption, ownership, and lifestyle preferences. Because of the assumptions made in the analysis, the data should be considered as relative indicators of potential, not actual participation.

We looked at potential participants in birdwatching, photography, freshwater fishing, hunting, and hiking. In order to estimate the general environmental orientation of the population we also looked at the number of people who potentially might hold a membership in an environmental organization.

The consumer behavior data apply to persons more than 18 years old. For the area that we included in our analysis, out of a total population of 673,773 people, the number of persons more than 18 years old was 504,913. The estimated maximum participants in the 60-mile radius for each activity are: birdwatching (37,280), photography (50,452), hunting (48,602), freshwater fishing (83,537), and hiking (43,791). The number of persons who might hold a membership in an environmental organization is estimated at about 9,300. The projections represent the core audience for repeated trips to the Refuge. On days with special events or major attractions

Monopoly Marsh from Ditch 6 Road on Mingo NWR. USFWS

such as when large numbers of birds are at the Refuge, visitors can be expected to travel longer distances.

Climate

This discussion is modified from the climate section of the Stoddard County Soil Survey. Long, hot summers and rather cool winters characterize the climate of the Refuge and surrounding area. An occasional cold wave brings near freezing or subfreezing temperatures but seldom much snow. Precipitation is fairly heavy throughout the year, and prolonged droughts are rare. Summer precipitation falls mainly in the form of afternoon thunderstorms.

In winter the average temperature is 37 degrees Fahrenheit, and the average daily minimum temperature is 28 degrees. In summer the average daily temperature is 78 degrees, and the average daily maximum temperature is 90 degrees. Total annual precipitation is 48 inches. Of this, about 25 inches, or 50 percent, usually falls between April and September. In 2 years out of 10, the rainfall between April and September is less than 20 inches. Thunderstorms occur on about 55 days each year, mostly in summer. The average annual snowfall is 11 inches. On average, 9 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in mid afternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south. The average wind speed is at its highest, 12 miles per hour, in March. Severe local storms, including tornadoes, may strike occasionally. These are usually of short duration, and damage is variable and spotty.

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 further 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.

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.

Water and Hydrology

Accumulation, movement, and drainage of water 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 run-off 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 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.

Figure 5 shows the ditch system that dominates the surface hydrology of Mingo NWR.

Refuge Resources

Plant Communities

Refuge vegetation may be broadly divided into wetlands, comprised mainly of bottomland mixed hardwood forests, and upland forest. Figure 6 displays the principal plant communities at Mingo NWR.

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 (see Figure 5 and Figure 6). Vegetation varies along a narrow elevational gradient that corresponds to duration of flooding. Four community types are delineated within the Refuge based on dominant species, elevation, and inundation.

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, Bitternut Hickory (*Carya cordiformis*)
Sweetgum (*Liquidambar styraciflua*)
American Elm (*Ulmus americana*)
Hackberry (*Celtis occidentalis*)
Box Elder (*Acer negundo*)
Chinkapin Oak, Blackgum (*Nyssa sylvatica*)
Black Walnut, Butternut (*Juglans cinerea*)
Black Cherry (*Prunus serotina*)
Bur Oak (*Quercus macrocarpa*)
Swamp Red Oak (*Quercus falcata*).

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*)

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.

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:

Figure 5: Hydrologic Features of Mingo National Wildlife Refuge

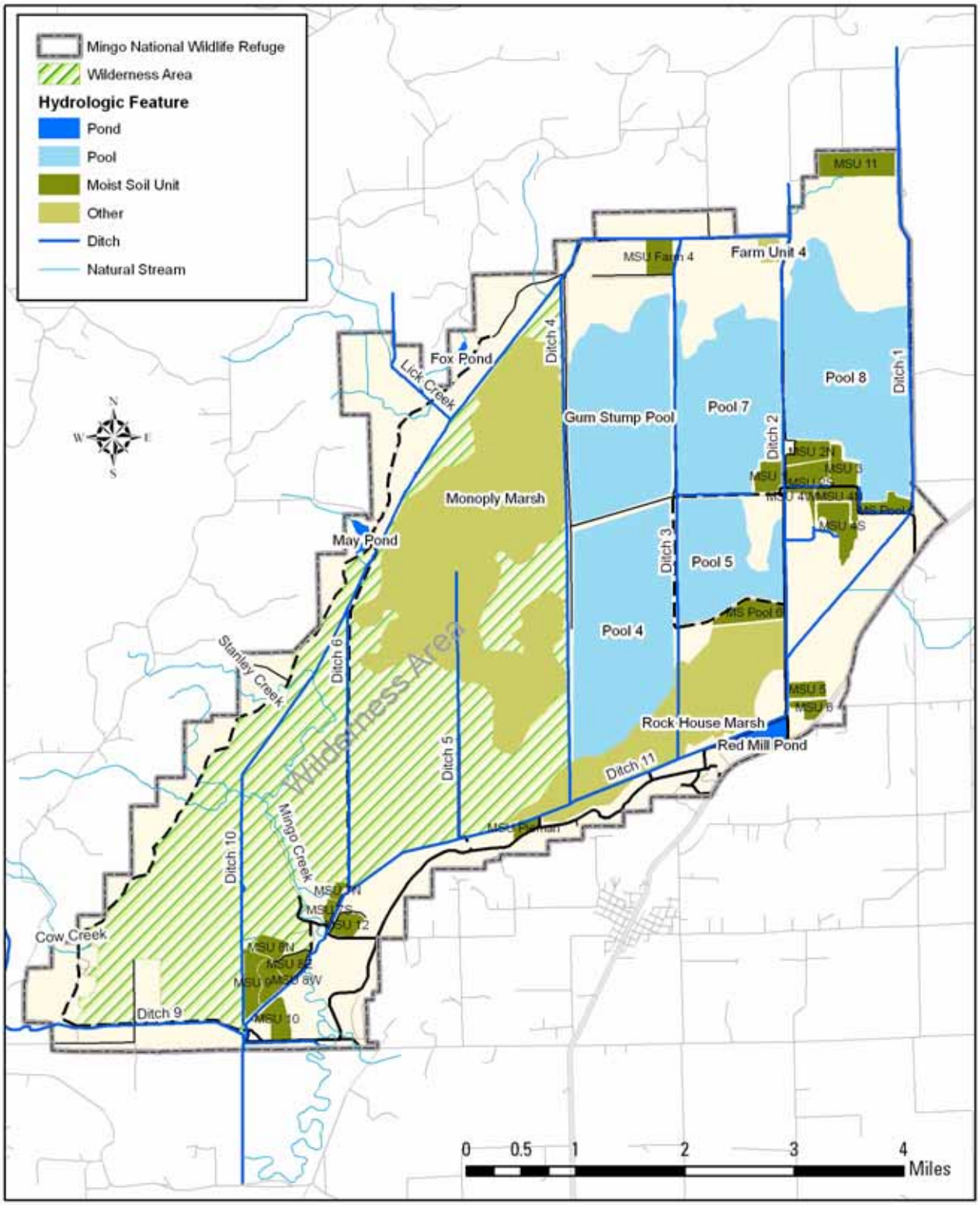
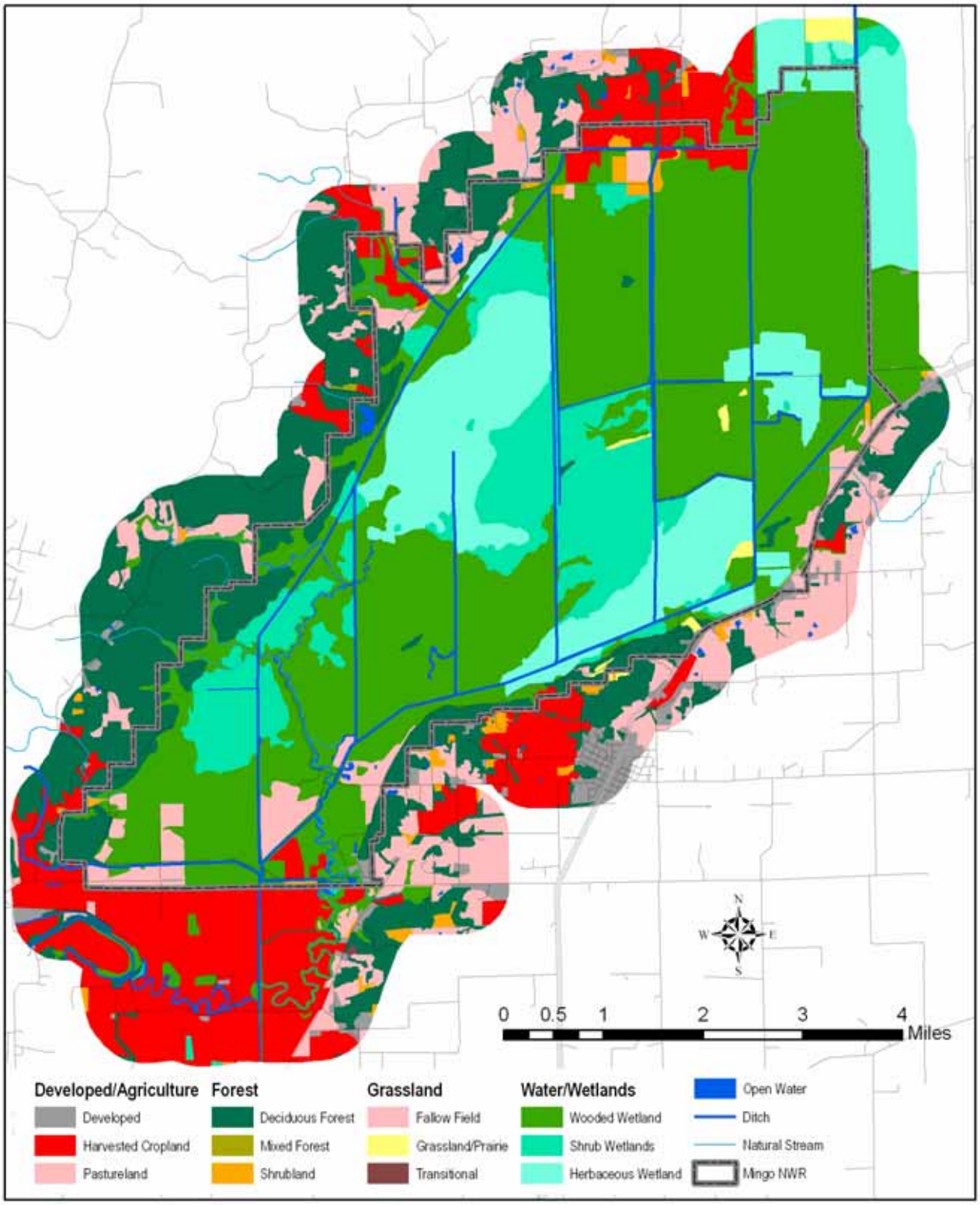


Figure 6: Landcover, Mingo NWR



Bald Cypress (*Taxodium distichum*)
Blackgum (*Nyssa 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.

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 (*Diospyros virginiana*)
Honey Locust (*Gleditsia triacanthos*)
Sumac (*Rhus spp.*)
Elm (*Ulmus spp.*)
Black Walnut (*Juglans nigra*)
Red Cedar (*Juniperus virginiana*)
Blackberry (*Rubus allegheniensis*)
Dewberry (*Rubus spp.*)
Coralberry (*Symphoricarpos orbiculatus*)

Great Blue Heron on the shore of May Pond, Mingo NWR. USFWS

Multiflora Rose (*Rosa spp.*).

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 (*Rhus spp.*)
Blueberry (*Vaccinium spp.*)
St. Andrew's Cross (*Ascyrum hypericoides*).

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 (*Carya ovata*)
Chinkapin Oak (*Quercus muehlenbergii*)
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*).

Fish and Wildlife Communities

Birds

A total of 279 resident and migratory bird species use Refuge habitats throughout each year. Tens of thousands of Mallards, Canada Geese, and other migrating waterfowl use Refuge wetlands as stopover or wintering habitat. Hooded Mergansers and Wood Ducks are resident breeders on the Refuge. Monopoly Marsh draws Wood Ducks from a five-

state area during molting season. Bald Eagles, Least Bitterns, and Mourning Doves are among the 108 bird species that regularly breed on the Refuge. Appendix F contains a complete list of birds known to occur on the Refuge.

Mammals

Thirty-eight mammal species are found within the Refuge. White-tailed deer, a species popular for hunting and viewing, are abundant at a population density of up to 35 per square mile. There is a wide diversity of small mammals including three species of squirrels, two species of bats, and various mice, rats, and voles. The Refuge is one of the few places in Missouri where the swamp rabbit, a larger relative of the eastern cottontail rabbit, is known to occur. Unlike other rabbits, the swamp rabbit regularly takes to the water to move about and avoid predators. Appendix F contains a complete list of mammals found at Mingo NWR.

Amphibians and Reptiles

Amphibians and reptiles are abundant on the Refuge with more than 30 species of frogs, toads, salamanders, and snakes including the venomous western cottonmouth, southern copperhead, and timber rattlesnake. Many of these species hibernate within the cracks and crevices of the bluffs along the perimeter of the Refuge.

Fish

A complete list of fish species is not available. At least 46 species, including channel catfish, white crappie, spotted bass, and green sunfish, are known to occur in the ponds and ditches of the Refuge.

Threatened and Endangered Species

The Bald Eagle (*Haliaeetus leucocephalus*) occurs as a winter migrant and a summer breeder on Mingo NWR. The wintering Bald Eagle population can reach as high as 50 birds. Three active nesting territories existed in 2004 including one that has fledged 43 young over 19 years. The Bald Eagle is currently listed as a threatened species but is proposed to be delisted.

Threats to Resources

Invasive Species

At least eight invasive species – non-native species of plants and animals that adversely affect native species – are found on the Refuge. (See Table 2)

Contaminants

In 2001, the Missouri Department of Health issued its first fish consumption advisory for mercury. The state-wide advisory includes Mingo NWR. Presently, Refuge waters are not monitored for mercury concentrations. The mercury pathway into the food chain is complex and affected by many factors. But anaerobic conditions found in many wetland soils help convert mercury to its more biologically reactive form that accumulates up the food chain.

In 2002 the Missouri Department of Natural Resources began operation of a mercury monitoring station on the Refuge that serves as one site in the national Mercury Deposition Network (MDN). The station monitors atmospheric mercury deposition. The objective of the MDN is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. The data will be used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors.

Administrative Facilities

The administrative facilities for the Refuge are located 1 mile north of Puxico, Missouri. The Refuge Office includes a visitor center. The maintenance shop, carpentry shop, vacant former Refuge office, eight-stall maintenance building, and four-bayed pole barn are located slightly north of the Visitor Center entrance along the west side of State Highway 51. A storage building containing flammable liquids and other materials is located in the area as well. Two residences housing employees and volunteers are located near the maintenance facilities. No administrative facilities are located at Pilot Knob NWR or Ozark Cavefish NWR. These refuges are administered and managed by Mingo NWR staff and facilities.

Archeological and Cultural Values

As of September 2003, Stoddard and Wayne counties listed seven properties on the National Register of Historic Places, probably not indicative of the kinds of historic places that exist in the two counties. The Refuge contains one of the National Register properties, the Mingo National Wildlife Refuge Archeology District.

Completed archeological surveys of the Refuge, including the Mingo Job Corps campus, have covered almost 7,200 acres. These surveys and other sources have identified more than 140 cultural

Table 2: Invasive Plants and Animals at Mingo National Wildlife Refuge

Species Name	Summary
Nutria	Nutria, a large, dark-colored, semi-aquatic rodent native to southern South America, was introduced into North America as early as 1899. It was first discovered on the Refuge in 2000. The nutria's prolific burrowing weakens dikes, levees, and other structures. The rodent also feeds on native vegetation and crops, and can cause damage when it occurs in higher numbers.
Sericia lespedeza	*Sericea lespedeza* is a native of eastern Asia. It was first introduced in southern United States, and has now become naturalized from Maryland, Virginia, Tennessee, Missouri, and Texas, north to Pennsylvania, Ohio, Michigan, Illinois and Oklahoma. It has been introduced into various areas as a soil cover for erosion control, for soil improvement, as food and cover for bob-white, wild turkey, and other wildlife, and to a lesser extent, for forage and hay. In open areas such as roadsides and levees, it out-competes other species, creating a monoculture and decreasing diversity.
Johnson Grass	Originally native to the Mediterranean, this grass now occurs in all warm-temperate regions of the world. It is found in all the major river bottoms of Missouri, with more than 300,000 acres infested in the Missouri Bootheel alone. It invades riverbanks and disturbed sites crowding out native species and slowing succession.
Bull Thistle	Native to Europe, bull thistle was introduced to North America during colonial times, and is now found in all 50 states. It thrives in fields and disturbed areas, degrading habitat quality.
Reed Canary Grass	This grass is native to lowland areas of northwestern Missouri and has escaped from cultivation in other regions. It is a major threat to marshes and natural wetlands because its hardiness, aggressive nature, and rapid growth allow it to displace native wetland plant species.
Multiflora Rose	Originally introduced to the East Coast from Japan in 1886 as rootstock for cultivated roses. It was widely used to control soil erosion. It is a thorny, bushy shrub that forms impenetrable thickets and out-competes native vegetation.
Feral Hogs	Since the days of open range, a few Missouri counties have had populations of domestic wild hogs. In recent years those hogs have been crossed with the European boar strain to produce animals that reproduce prolifically and have strong survival instincts that make them especially wary. Feral hogs cause damage to livestock, wetlands and wildlife.
Autumn Olive	Autumn olive was introduced into U.S. cultivation in 1830 from its native range in China, Japan, and Korea. Autumn olive crowds out native plant species.

resources sites on the Refuge. These sites represent all Midwest United States cultural periods from the earliest Paleo-Indian through 20th century Western, a period of about 12,000 years. Nevertheless, evidence shows no human presence in the Refuge and vicinity at the time Europeans first entered the region. One standing structure on the Refuge, the Patrol or Sweet's Cabin from the early 20th century, is representative of Depression era homesteads in the region, it is historically significant and may be eligible for the National Register.

The North American Consultation Database run by the Park Service to assist Federal agencies responding to the requirements of the Native American Graves and Protection and Repatriation Act lists no tribes with identified interests in Stoddard and Wayne counties. The database, however, is not a comprehensive list, being based on a limited number of legal sources. Cherokee, Choctaw, Creek, Delaware, Miami, Mingo (Iroquois), Osage, Quapaw, Seneca, and Shawnee may have had limited historic period interest in the Refuge area, the Chickasaw and Tunica may have had protohistoric period interest, and the antecedent Pawnee and Wichita may have had prehistoric interest. Other interest groups that might have a cultural resources concern about the Refuge have not yet been identified.

Cultural resources are important parts of the nation's heritage. The Service preserves valuable evidence of human interactions with each other and the landscape. Protection is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

Visitation

In fiscal year 2004, Mingo NWR received 119,439 total visits, including 7,446 visits to the Visitor Center. A total of 71,491 visitors participated in interpretation and nature observation. A total of 2,298 students participated in environmental education programs. In 2004, 3,760 visits to the Refuge were for hunting and 2,324 visits were for fishing. There were 7,446 visits to the Wilderness Area. The Ref-

uge staff reached more than 9,053 people in off-site outreach activities during the year.

Current Management

Habitat Management

Management emphasizes the natural productivity of the swamp. Acorns from oak trees provide an important source of food for dabbling ducks as well as for turkey, deer, and squirrel. Open marsh areas produce seed-bearing moist soil plants such as wild millet as well as large numbers of invertebrates, both of which are important to waterfowl and other waterbirds. Water levels are manipulated through use of water control structures, ditches and dikes, helping produce an annual crop of natural food.

Food for wildlife is also produced by farming about 600 acres. Most of this land is tilled by neighboring farmers on a sharecrop basis. The Refuge's share of the crop is left standing in the field for wildlife.

Wetland Management

Excluding the bluffs along the periphery of the Refuge, elevation across the basin varies less than 10 feet, rising from 335 to 344 feet above mean sea level. Minor changes in water levels result in vast differences in area flooded. Four green tree reservoirs totaling 3,721 acres and two open marsh impoundments totaling 3,305 acres are managed for waterfowl and other wetland associated wildlife. Current management of these areas is described in the following paragraphs.

Green Tree Reservoirs – The presence of live trees and the ability to manipulate water levels define green tree reservoirs (GTR). Flooded annually for no more than 130 consecutive days between November and March, water is drained during the growing season to encourage regeneration and avoid killing trees. Seasonally flooding these lowland forests makes mast available to wintering waterfowl, and mimics flooding that occurred before ditches, levees, and roads altered drainage within the Refuge and surrounding basin.

Open Marsh – Monopoly Marsh is drawn down once every 5 years, shrinking the flooded area from 2,400 acres to 30 acres. Drawdowns aerate the soil, enhance invertebrate populations, decrease rough fish populations, and allow bald cypress and oak regeneration. Upon completion of each drawdown the pool is held at a slightly lower level to avoid killing bald cypress seedlings along the perimeter. This

Mingo National Wildlife Refuge

process is slowly restoring the marsh to a bald cypress swamp. When not drawn down, the marsh is maintained at a constant level and is a nursery for young fish. The steady water level reduces abundance of American lotus, an aquatic plant that out competes other vegetation under fluctuating water levels. American lotus provides habitat for waterfowl, and is of greatest benefit when it covers no more than half of the surface area of the marsh.

Rockhouse Marsh is drawn down completely by May 15 every other year to maintain it as an open marsh. During the drawdown, woody vegetation such as willow that competes with bald cypress trees are removed or mowed. Reflooding the marsh begins on October 1.

Open Water – Stanley Creek impoundment takes its name from Stanley Creek, a small tributary that enters the Refuge from the west and intersects Ditch 10 before entering Mingo Creek. Ditches, constructed when the area was a drainage district, divert much of the flow from Mingo Creek. An earthen plug constructed along Ditch 10 and a water control structure at Flat Banks impound water within the former stream channel, helping sustain a fishery. Stanley Creek impoundment floods when runoff overwhelms the water control structure at Flat Banks, sending overflow into adjacent lowland forests. The aim is to keep the flood duration short, maintain the creek within its banks, and sustain the fishery.

Nearly 60 miles of ditches form a drainage network that moves water onto, around, and off the Refuge. These ditches hold water year round and often provide refuge for fish species during low water periods. Years of sediment accumulation decreased the depth of the ditches, reducing their effectiveness for moving water. This hampered the already poor drainage within the Refuge. Lowland

Table 3: Main Habitat Management Units at Mingo NWR

Unit Name	Acres	Description
Pool 4	29	Green Tree Reservoir
Pool 5	501	Green Tree Reservoir
Pool 7	876	Green Tree Reservoir
Pool 8	1191	Green Tree Reservoir
Monopoly Marsh (Pool 1)	2405	Open Marsh
Rockhouse Marsh (Pool 2)	900	Open Marsh
Stanley Creek Impoundment		Flood Control/Fisheries
Pool 3 (Gum Stump)	1021	50% Oaks 40% Scrub/Shrub 10% Cypress/Tupelo
Pool 6	80	40% Moist Soil Unit 60% wood duck brood habitat
MS-1, MS-2S, MS-2N, MS-3, MS-4N, MS-4W, MS-4S, MS-5, MS-6, MS-7N, MS-7S, MS-8E, MS-8W, MS-9N, MS-9S, MS-10, MS-11, MS-12	704	Moist Soil Units
Farm Units	587	Cropland/Food Plots
Haying Units	421	Grassy Openings

forests adapted to short duration flooding held water for most or all of the year, killing large patches of trees. Sediment removal initiated in 1999 improved drainage and water level management across the Refuge.

Red Mill Pond is drawn down once every 5 years from May to October to relieve stress on flooded shrubs, and encourage growth of woody vegetation. This scrub/shrub pond, managed for Wood Duck nesting and brood cover, also contains sunfish that are locally abundant but rare within the State.

May Pond and Fox Pond were built to catch sediment eroded from the bluffs on the west side of the Refuge. Managed for fishing, stocked blue gill and bass populations are now self-sustaining, while more easily caught catfish are restocked every 2-3 years.

Pool 3, also known as Gum Stump, is a natural backwater closely linked to Monopoly Marsh. The pool stores overflow carried by Ditch 3 during high water levels. When not used for storage, water levels rise and fall in conjunction with management of Monopoly Marsh. Oak forest covers half of the pool, a mixture of bald cypress and tupelo about 10 percent, and scrub/shrub the remainder.

Pool 6 is formed by a levee placed along the northern portion of Rockhouse Marsh. About 40 percent of the pool is managed for moist soil habitat. The remainder is managed to provide overhead cover and food for Wood Duck broods. Periodically, taller shrubs are removed to encourage growth of understory shrubs. Removing the taller shrubs increases sunlight to the understory, and eliminates potential perches for avian predators.

Table 3 lists each of the water bodies and other habitat units on the Refuge.

Moist Soil Units

Sixteen moist soil units totaling 704 acres are managed to produce food for migrating waterfowl and shorebirds. Moist soil units (MSUs) are former farm fields developed to impound water through construction of dikes and water control structures. Moist soil management entails manipulating water levels to encourage growth of plants occurring naturally in the seed bank. The plants produce seeds that are high energy food for migrating waterfowl.

Flooding of moist soil units begins in October or November and proceeds in stages. Initially, one-third of each MSU is flooded. Once waterfowl

deplete the food supply an additional one-third is flooded, and finally the units are entirely flooded. Progressive flooding concentrates feeding waterfowl more fully utilizing moist soil foods. February through April waterfowl feed on invertebrates found in the MSUs. Draining begins in March and by April exposes mud flats attracting migrating shorebirds which also feed on invertebrates. The MSUs remain dry throughout the growing season to produce food for the following year.

Grassy Openings

There are a number of grassy openings mostly located along the perimeter of the Refuge that total 474 acres. These areas provide habitat diversity within the largely forested Refuge.

Forests

Other than water level manipulations described under the wetland management section, the forested areas of the Refuge are not actively managed. The majority of the upland oak/hickory forest lies in or adjacent to the wilderness area, where policy prohibits active management. Until recently, lowland forests were too wet to allow timber harvest operations, but ditch cleaning has improved drainage and water level control throughout the Refuge.

Cropland and Food Plots

Annually, food crops such as corn, milo, and soybeans are planted on 411 acres of cropland maintained through cooperative agreements with local farmers, and on an additional 95 acres of food plots maintained by Refuge staff and volunteers. Tilling prevents trees from reclaiming the ground, maintaining open habitat that adds diversity to mostly forested Refuge. All or a portion of each crop is left as food for wildlife, and is especially important for resident species during severe winters.

Fire Management

Mingo NWR has a Fire Management Plan (FMP), adopted in 2003, which provides a detailed course of action to implement fire management policies for the Refuge (USFWS, 2003a; USFWS, 2003b). The FMP describes the responsibilities of each member of the fire management team, including training, experience, physical fitness requirements, and fire duty assignments.

The general fire management goals for the Refuge FMP are:

Firefighter and public safety is the priority of the program. All Fire Management activities will reflect this commitment.
Protect life, property, and other resources from unplanned fire.
Use prescribed fire where appropriate to accomplish resource management objectives.
Restore fire into the ecological process.
Develop and implement a process to ensure the collection, analysis, and application of fire management information needed to make management decisions.

Mingo NWR's fire management objectives are the following:

Protect from fire all important scientific, cultural, historic, prehistoric, visitor facilities, administrative sites, and Refuge 17 housing.
Restore and perpetuate habitat important to migratory and native wildlife species by maintaining a diversity of plant communities in various successional stages.
Use prescribed fire to the fullest extent possible to restore natural ecological processes, fire regimes, and vegetative communities on the Refuge, including native warm season grasses.
Prevent human-caused wildland fires.
Educate the public regarding the role of prescribed fire within the Refuge.
Maintain and enhance moist soil units by retarding the invasion of woody species and noxious weeds.
Use prescribed fire when it is the most effective and efficient means for achieving management objectives.
Manage the risks associated with hazard fuels. Use prescribed fire near the urban wildland interface, sensitive resources and sensitive boundary areas to reduce risk from wildland fire damage.

All of Mingo NWR is considered as a single Fire Management Unit (FMU) for the purpose of wildland fire suppression. All wildland fires at Mingo NWR are suppressed. In the Refuge's Wilderness Area, wildland fires will be suppressed utilizing Minimum Impact Suppression Techniques (MIST). Prescribed fires on the Refuge are located in one of four prescribed FMUs.

Prescribed fire is currently not used in the Wilderness Area.

Fish and Wildlife Monitoring

A number of surveys, censuses, studies, and investigations are conducted at Mingo NWR that

help monitor the status of its fish and wildlife populations (USFWS, 2002).

Surveys

Waterfowl – Geese, ducks, swans, and Great Blue Herons are surveyed from vehicles along roads and levees weekly from October through March. Aerial counts are conducted biweekly by the Missouri Department of Conservation.

Bald Eagle – Annual roadside surveys are conducted to determine peak populations (about 30) and locations of wintering Bald Eagles. Three active nest sites are monitored during the breeding season to determine activity and success.

Mourning Dove – Two 25-mile off-Refuge routes assigned by the Service's Office of Migratory Bird Management are conducted annually. The Refuge Biologist runs the routes in late May to early June. Survey consists of driving 1 mile, stop, listen and count birds and coos for 3 minutes, then repeat for each mile on the route.

Mid-winter Waterfowl Survey – This is an annual survey conducted throughout the nation by the Service in cooperation with state conservation agencies. During the specified week, all waterfowl on the Refuge are counted and reported on a supplied datasheet to the Missouri Department of Conservation. Simultaneous surveys occur across the nation during this same time period. The objective of the survey is to estimate the distribution and habitat utilization of waterfowl throughout the country.

Christmas Bird Count – The East Ozark Audubon Chapter from Farmington, Missouri sponsors this annual survey, which has about 30 participants. The survey includes the entire Refuge.

Breeding Bird Count – This survey is based on observations within 25 meters from each of 60 points spaced 150 meters apart in a grid pattern. Observers record visual and audible observations to determine presence or absence of species. It takes about 4 days to complete the count, which averages 41 species.

Deer – Three counts are conducted in December and three in January (Pre- and post-hunting season). Counts are made along a 25-mile transect at night using held lights from an auto; the driver does not assist the observer. Counts are made during the dark of moon to assure maximum deer activity. The driver maintains 10 mph in wooded areas and 15 mph in open habitat. The observer counts all deer seen within 30 yards in wooded areas and 300 yards in open areas. Data have been used to modify hunts

Mingo NWR Refuge Biologist Charley Shaiffer assessing habitat conditions on Mingo NWR. USFWS

and habitat management at least seven times in recent years. Deer density is about 40 per square mile, down from an overpopulated density of 63 per square mile in the 1970s.

Deer Habitat Exclosures – Three exclosures, fenced areas that exclude deer, are monitored annually to assess browse rates. There has been no significant difference in habitat quality inside and out of the exclosures. Evaluations are made once a year.

Bottomland Hardwood Regeneration – This is an annual cooperative study with MDC Forestry to determine senesce dates of mast tree seedlings in order to avoid flood-kills of seedlings during fall flooding of moist soil and green tree reservoir units.

Scent Post Surveys – This is an annual survey involving 15 stations with a 3-foot sand base circle. There have been no surprise visitors.

Moth Survey – This is an annual survey done by a private individual.

Mushroom Survey Assessment – The Mycological Society of St. Louis conducts a survey annually to inventory mushroom species.

Vegetation Transects on Moist Soil Units – This an annual survey is conducted three times in the spring on moist soil units immediately after germination. Random plots are used to determine species, density, germination dates to determine management needs for the moist soil units for the year.

Studies and Investigations

Least Bittern Nesting Ecology – Mingo NWR is one of three study areas established by the University of Missouri Gaylord Lab to study the nesting

ecology of the Least Bittern. The giant cutgrass patches in Monopoly Marsh are continually searched by Lab students for nests between June through August. This study should result in a better definition of the breeding ecology of this species.

Tree Frog Surveys – A University of Missouri graduate student visits the Refuge once a year to listen for calls of the green and grey tree frogs. Call counts are used for population density estimations. This survey is to be done for 2 years.

Woodcock/Radio Tagged Birds – This is a Migratory Bird Office (MBO) study to track migrating Woodcocks. Non-Refuge personnel visit the Refuge in the fall to see if any tagged birds are using the Refuge. This is an ongoing study likely to continue to 2006.

Wood Duck and Hooded Merganser – Annually, 100 nest boxes are checked to determine estimated day of hatching and young are banded on the day of hatching. Plasticine bands are stainless steel with a clay-base liner that deteriorates as a ducking grows, leaving only the steel portion by the time the bird is full grown. The banded birds are often recaptured during Wood Duck banding, giving a reference for estimating the ratio of box nesters versus natural cavity nesters. The nest box checks are completed in conjunction with student helpers from Gaylord Lab.

Swamp Rabbits – This is a search for droppings to identify location of existing populations. MDC did this survey one year.

Mussel Survey – This was a monitoring survey to compare long-term species composition and location. Larvae movements and recruitment are inhibited by the outlet structure at end of Ditch 11. This was a repeat of an earlier survey and will not likely be repeated unless there is an identified need.

Bottomland Hardwood Bird Community Study – A Southeast Missouri State graduate student conducts forest bird surveys in Pools 3 and 7 to determine changes in the forest bird community relative to a hydrologic gradient, determine changes in forest bird activity relative to a hydrologic gradient, identify habitat characteristics related to high bird species richness, and determine if modifications in management would create a more desirable habitat for bird species. This study was initiated in 2005.

Region 3/5 Impoundment/Shorebird Study – This study involves numerous Refuges in Regions 3 and 5 and is focused on the timing of impoundment drawdowns and impact on waterbird, invertebrate, and vegetation communities within managed wetlands. Refuge biological personnel conduct waterbird/shorebird surveys, vegetation survey, and invertebrate surveys to contribute to the larger database collected from all participating refuges. Two moist-soil impoundments were selected for this study and will be manipulated according to study protocol for the duration of the study. This study was initiated in 2005 and will continue at least two years.

Spotted Skunk Survey – A University of Missouri graduate student conducted surveys on the Refuge to determine presence of spotted skunks. Scent stations were set up in Pools 8 and 7, with both track detection and photo devices to document presence of spotted skunks. No spotted skunks were detected in 2005.

Fisheries Assessment – The Refuge, in coordination with the Missouri Department of Conservation, is assessing fisheries populations on the Refuge with a focus on the Mingo Wilderness Area.

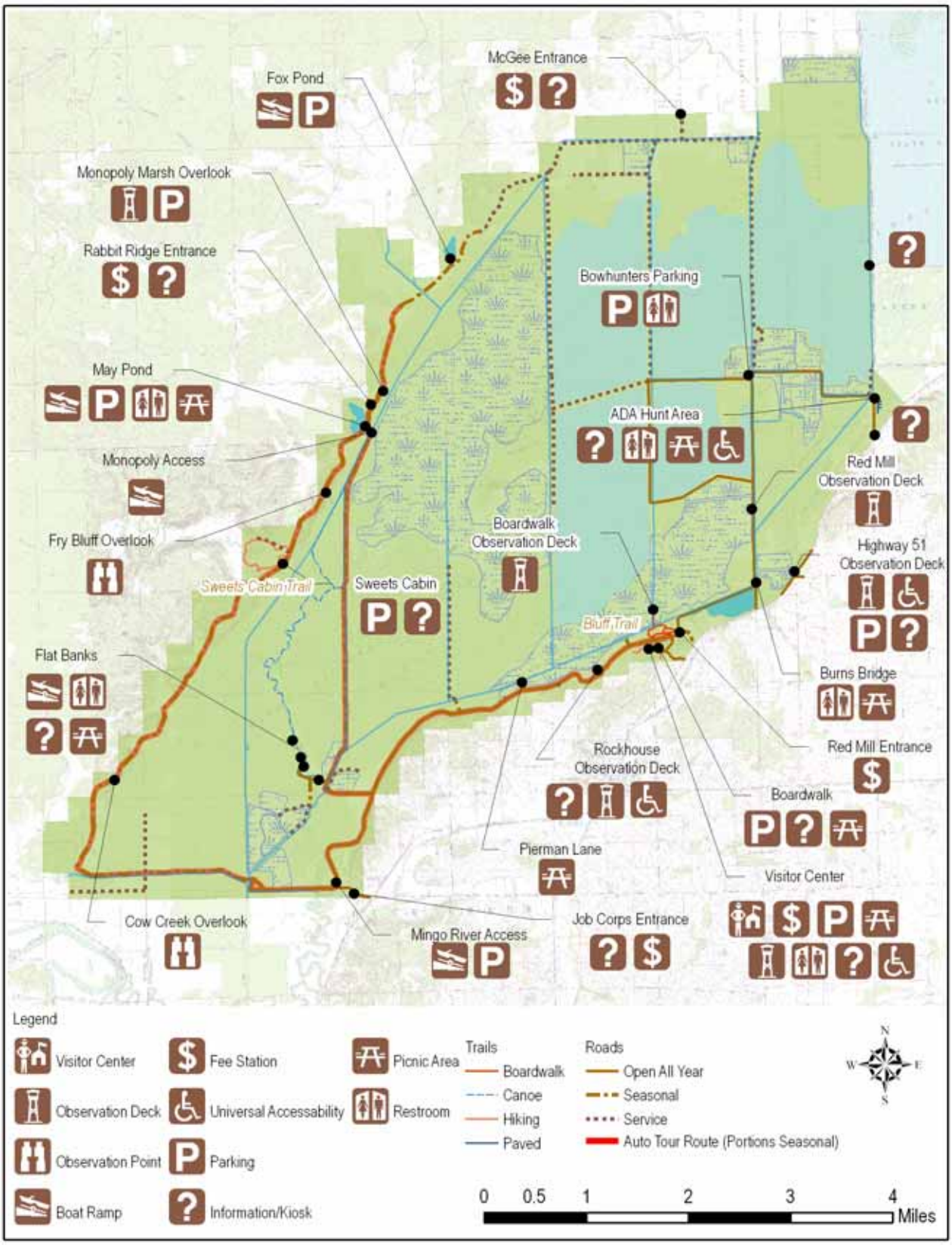
Visitor Services

Each year thousands of people visit Mingo NWR (119,439 visits in 2004) to enjoy the resources found there. The Refuge provides opportunities for six wildlife dependent public uses: hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation. Additionally, the Refuge provides opportunities for canoeing, kayaking, horseback riding, biking, hiking, jogging, berry and mushroom gathering, and picnicking. At present, nearly all of the Refuge is open to some type of use throughout the year. A variety of facilities are available to enhance visitor experiences (see Figure 7).

Open Areas and Closed Periods

The Wilderness Area, Red Mill Drive, a portion of the Auto Tour Route, and the Boardwalk Nature Trail are open year-round to visitors. The hunting area is closed to general visitation from October 1 to March 1 and open the rest of the year. The canoe route is open year-round. Boating use is permitted throughout the Refuge except on Ditches 3, 4, 5 and Monopoly Marsh, which are closed from October 1 to March 1. The use of gasoline powered boat motors is prohibited. Electric motors are permitted outside the Wilderness Area but not within it. The moist soil units, Monopoly Marsh, and Rockhouse Marsh are closed to all entry from October 1 to March 1 during the period of peak waterfowl.

Figure 7: Current Facilities, Mingo NWR



Monitoring

The number of people visiting the Refuge is estimated using car counters, counting visitors entering the Visitor Center, hunter registration stations, and counting participants at special events.

Fees

From March 15 through November 30, all visitors are required to purchase a user fee permit or hold a Federal Duck Stamp, Golden Age or Access Passport. The Refuge began the entrance fee program in 1988. The entrance fee is $3 per vehicle per day or $12 for an annual pass.

Hunting

A public hunting area is designated within the Refuge (Figure 8). Within this area archery deer and turkey hunting, spring firearm turkey hunting, and squirrel hunting are allowed concurrent with the State seasons. All hunters must register at the Hunters Sign-in Station and record the number of hours hunted and any animals harvested upon leaving the Refuge. The Refuge is open for hunters from 1 and a half hours before sunrise to 1 and a half hours after sunset.

Squirrel – Squirrel hunting is permitted from the Saturday preceding Memorial Day through September 30. Squirrel hunters may use a .22 rifle or a shotgun.

Deer and Turkey (Archery) – The archery turkey season opens October 1 and runs through January 15. The archery deer season opens September 15 and runs through January 15. Bow hunters can harvest two deer during the archery season. During the firearms deer season in November hunters with a valid firearms deer permit can archery deer hunt on the Refuge. Tree stands are permitted from 2 weeks before the season until 2 weeks after the season. All stands must be clearly marked with owner name, address, and phone number.

Managed Deer Hunt – A muzzleloading firearms deer hunt is conducted in coordination with the Missouri Department of Conservation on a western portion of the Refuge (Figure 8). Hunters are selected through a lottery system. In 2004, 1,293 people applied for the 135 available permits. A hunter was permitted to take one deer of either sex. During the hunt, the firearms hunt area is closed to other visitors, including anglers, Auto Tour Route users, and canoe trail users.

Turkey (Spring) – A spring turkey hunt is allowed that runs approximately the last week of April through the first 2 weeks of May in the General Hunt Area. The Refuge also participates in the state-wide spring youth turkey hunt that occurs 1 to 2 weeks prior to the regular turkey season.

Waterfowl – Waterfowl hunting is permitted in Pool 8 (Figure 8), a 1,191-acre Green Tree Reservoir, concurrent with the state season. The unit is managed through a cooperative agreement with the Missouri Department of Conservation as a wade-in hunting area. Duck Creek Conservation Area conducts the duck hunt on a draw operation where hunters may choose a blind in the state area or the wade-in hunting area. Many hunters prefer to hunt the flooded timber in the wade-in area. Dogs are permitted for waterfowl hunting only and must be leashed or under voice command.

Universally Accessible Hunts – The Refuge manages an area with five blinds that can be reached by an asphalt trail. These blinds are used to hunt squirrels and spring turkeys with firearms and turkey and deer with bows. If hunters have the necessary permit from the State of Missouri, they can also hunt from a parked vehicle on pulloffs along Red Mill Drive. The Refuge has set aside a designated area for an accessible hunt during the Managed Deer Hunt (Figure 8). Five temporary blinds are used during this hunt.

Fishing

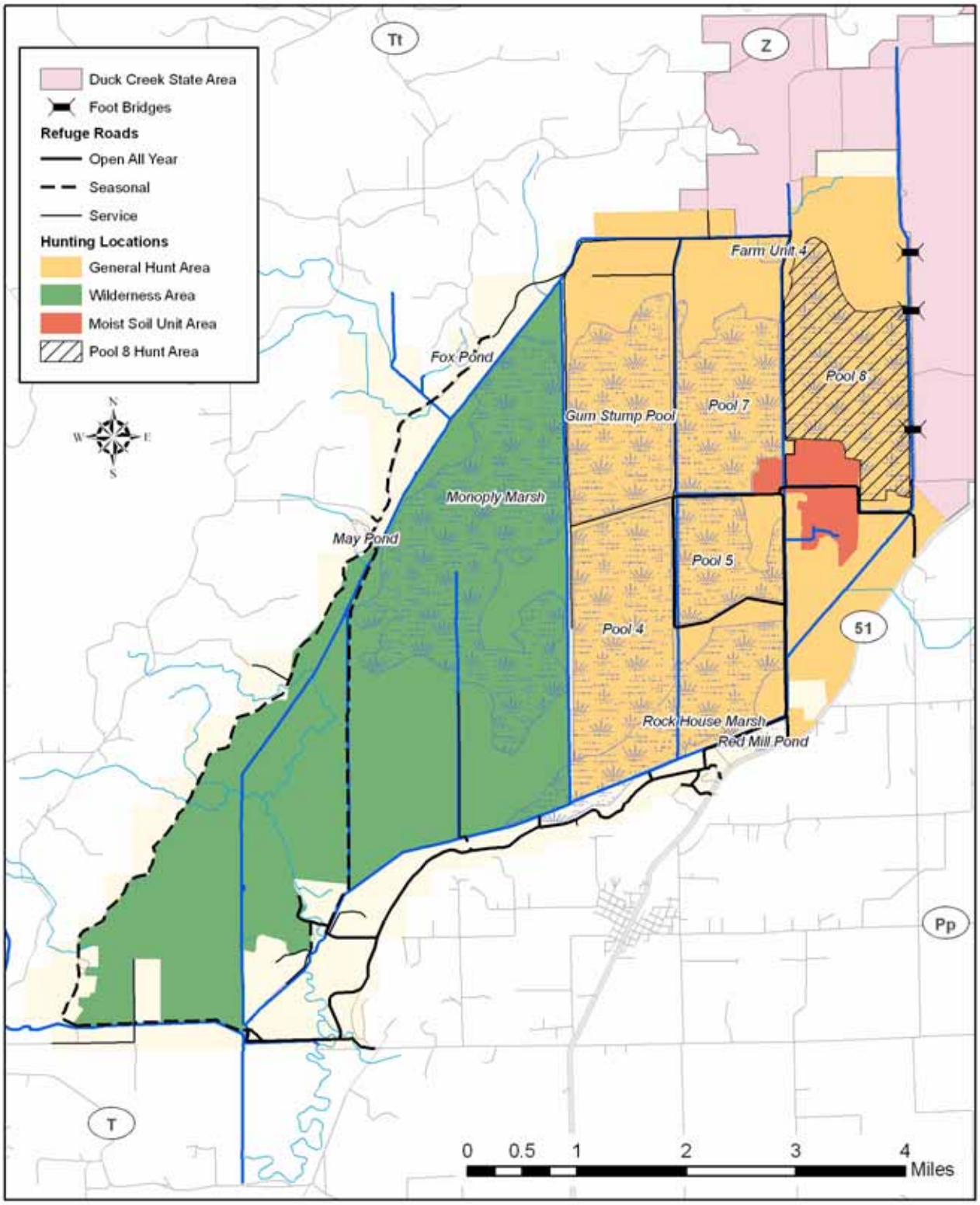
Fishing is allowed on the Refuge concurrent with state seasons and regulations. All of the Refuge is open year-round except Ditches 3, 4, 5, the moist soil units, and Monopoly Marsh, which are closed from October 1 to March 1. The road between May Pond and Fox Pond and the road between Ditches 2 and 3 are open to vehicular traffic access from May 15 to September 30. Fishing in the Managed Deer Hunt Area is closed during the weekend of the hunt.

Weather changes and water management objectives cause the fishing conditions to fluctuate greatly throughout the season and from year to year. The species most commonly sought are crappie, bass, bluegill, and catfish. It is permissible to take non-game fish for personal use, but not for commercial purposes, with nets and seines from March 1 to September 30.

Observation, and Photography

Although observation and photography occur throughout the Refuge, facilities that support these activities by bringing the visitor closer to wildlife include the Auto Tour Route, eight overlooks and observation platforms, and five trails. The 19-mile

Figure 8: Hunting Areas at Mingo National Wildlife Refuge



Park Ranger Vergial Harp addressing Ecology Day students at Mingo NWR. USFWS

Auto Tour Route is open during April, May, October, and November. The trails are open year-round. The primary attraction during the spring on the Auto Tour Route is spring wildflowers. The attractions in the fall are the changing colors of foliage and migrating birds.

Visitors use Bluff Road along the east side of the Refuge to view white-tailed deer and Wild Turkeys, which are commonly seen year-round. Wildlife observation appears to be weather related – the cooler the summer and milder the fall the more visitors. In the fall and winter, visitors come to see concentrations of ducks, geese, swans, and Bald Eagles. Peak months for wildlife observation are May and October.

Interpretation

Interpretation facilities on the Refuge include the Visitor Center, exhibits along the Auto Tour Route, and five trails. The Visitor Center contains an audio-visual program, exhibits, dioramas, and displays on wildlife management, swamp ecology, archaeology, geology, and history. An Auto Tour Route flier interprets points of interest, Refuge management techniques, and wildlife habitat.

Interpretive Foot Trails

The Boardwalk Nature Trail, Hartz Pond Trail, and the Trail to Sweet's Cabin offer visitors to the Refuge an opportunity to view wildlife in three distinct ecological settings.

The Boardwalk Nature Trail attracts the most visits. The trail is constructed of a raised boardwalk traversing bottomland hardwoods and Rockhouse Marsh. It is 0.8-mile long with a 0.2-mile spur leading to an overlook of Rockhouse Marsh. A spotting scope enhances wildlife viewing. The Boardwalk Trail is a highlight of the Refuge for visitors. Many local residents routinely walk the trail for exercise. Monthly tours by school group activities and other environmental education programs were conducted on the Boardwalk Nature Trail this year while taking advantage of easy access into the hardwood swamp and the opportunity to view many different species of flora and fauna.

The Hartz Pond Trail is a 0.2-mile loop around a small pond ecosystem near the Visitor Center. Due to its easy access and proximity to the Visitor Center, the trail remained popular with school groups for aquatic biology studies and other interpretive classes.

The 1.5-mile Trail to Sweet's Cabin offers wilderness hiking and photography opportunities for the public during the Auto Tour Route months of April, May, October, and November. Winding along a riparian forested environment on the edge of the Ozark Uplands, this trail provides access to Sweet's historic cabin and the serene environment near Stanley Creek. Recent improvements to the trail have also reopened some of the areas that had once been blocked by downed trees from tornado damage in past years.

Interpretive Auto Tour Route

Open the months of April, May, October, and November, the Auto Tour Route provides access for mobility-impaired and other visitors of all ages and outdoor interest. With the assistance of a self-guided interpretive pamphlet available at the entrance kiosks, visitors enjoy a view of the Refuge that denotes key points of interest, Refuge management techniques, and wildlife habitat of many different varieties for the 19-mile drive. The autumn foliage attracted an estimated 4,263 visitors in 2004. Spring visitors number as many as 1,761 visitors who came to view the abundance of blooming wildflowers set on a backdrop of hardwood-forested-swamp and riparian environments, Ozark foothills and meadows. The Auto Tour Route is also open

during the week of the Puxico Homecoming in early August. In 2004 174 visitors utilized the Auto Tour Route during this period.

Special Events

The Refuge staff participate in two special events each year that bring the Refuge message to large numbers of people. In one event the Refuge cooperates with the Missouri Department of Conservation to provide an exhibit at the Southeast Missouri District Fair. Approximately 25,000 people are contacted each year in this cooperative effort. In the second event the Refuge participates in the Puxico's Community Homecoming Parade and visitors to the community include a visit to the Refuge in their return to the community. In 2004 approximately 2,675 visitors to the Refuge were from the Puxico Homecoming celebration.

Environmental Education

The Refuge hosts Ecology Days for Stoddard and Butler Counties. Fifth grade students from seven schools in Stoddard County and fourth grade students in Butler County participate. Ecology Days reinforces what students learn about Missouri's natural resources in the classroom. The objective of the program is to prepare students for the Missouri Mastery Achievement Test, a statewide test administered in public schools.

In addition, staff conduct environmental education programming throughout the year. In 2004, a total of 2,298 students participated in Refuge environmental education activities.

Non-wildlife Dependent Recreation

Horseback riding is allowed on the Refuge roads that are open to vehicular traffic sometime during the year. The route of the Auto Tour Route, for instance, is open year-round to horseback riding, hiking, and biking.

The canoe trail is open year round. Canoeists are primarily using the trail for bird watching and, to a lesser extent, for fishing.

Berry, mushroom, pokeweed, and nut gathering occurs near the Rockhouse Overlook and along Bluff Drive. These activities are permitted outside the Wilderness Area as long as the ground is not disturbed.

Law Enforcement

Presently, two Refuge staff members have law enforcement authority and perform this function as a collateral duty, that is, they are not full-time law enforcement officers. They work in close cooperation with Missouri Department of Conservation agents and Stoddard County deputies. The number of public contacts far exceeds the citations and warnings issued during a year. Past violations have included trespass, poaching, traffic, and parking. Problems of vandalism and littering exist, but violators are not often caught.

Partnerships

The Mingo Swamp Friends Incorporated was organized as a Refuge Friends group in 2001. The Friends offer support to the Refuge through a number of activities including outreach activities, operation of the cooperative sales unit, and improvement of facilities such as the boardwalk.

The volunteer program supports all aspects of Refuge operations. In 2004, volunteers donated a total of 2,682 hours. Volunteers helped with studies, habitat management, wildlife management, visitor services, infrastructure maintenance and improvements, and outreach.

The 84-acre Mingo Job Corps Center is adjacent to the southeast corner of the Refuge. Built in 1965, it was administered by the Fish and Wildlife Service until it was transferred to the U.S. Forest Service in January 2005. Mingo Job Corps is one of more than 120 Job Corps campuses nation-wide that deliver education and vocational training to help young people ages 16 through 24 find a career. In addition to on-site instruction, students receive on-the-job training by conducting work activities in the local community. The Refuge continues to partner with Mingo Job Corps Center on a variety of projects.

In addition to these groups, the Refuge cooperates on projects of mutual benefit with a number of partners, including:

- Duck Creek Management Area
- U.S. Army Corp of Engineers (Lake Wapappello Project Area; Regulatory Branch, Memphis)
- Ducks Unlimited
- U.S. Navy SeaBees
- Mark Twain National Forest
- Stoddard County Sheriff
- Missouri Department of Conservation (Protection Branch; Fisheries Office; Environmental Education Branch; Private Lands Biologist)
- Missouri Department of Natural Resources

Table 4: Invasive Plant Species and Their Control at Mingo NWR

Species Name	Control Method
Sericia lespedeza	Mowing and herbicide application
Johnson Grass	Spot spraying with herbicide
Bull Thistle	Spot spraying with herbicide
Reed Canary Grass	Herbicide application
Multiflora Rose	Tilling if possible otherwise herbicide application
Autumn Olive	Removing trees and saplings

USFWS Air Quality Office (Denver, Colorado)
Butler and Stoddard County Extension Offices
City of Puxico
Duck Creek Township
USDA Natural Resources Conservation Service
Gaylord Laboratory of the University of Missouri
University of Missouri, Columbia
Audubon (Gape Girardeau and St. Louis chapters)

Pest Management

Animal Species

Refuge staff dispose of nutria whenever they are found. This invasive species, which was first discovered on the Refuge in 2000, causes damage to dikes, levees, and vegetation, especially where it occurs in high numbers. Presently, it does not occur in high numbers on the Refuge.

Beaver are native to the Refuge, but can cause problems by undermining roads, girdling trees, and plugging culverts and water control structures. Beaver problems are addressed on a case-by-case basis by Refuge staff.

Plant Species

Table 4 indicates the various ways pest plant species are controlled on the Refuge. Although invasive species, these plants are usually restricted to disturbed sites such as fields, roadsides, and levees.

Archeological and Cultural Resources

Cultural resources management in the U.S. Fish and Wildlife Service is the responsibility of the Regional Director and is not delegated for the Section 106 process when historic properties could be affected by Service undertakings, for issuing archeological permits, and for Indian tribal involvement. The Regional Historic Preservation Officer (RHPO) advises the Regional Director about procedures, compliance, and implementation of the several cultural resources laws. The Refuge Manager assists the RHPO by early and timely notification of the RHPO about Service undertakings, by protecting archeological sites and historic properties on Service-managed and administered lands, by monitoring archeological investigations by contractors and permittees, and by reporting violations. More than 140 sites are known on the Refuge, and the potential for additional sites is high.

Special Management Areas

No management activities occur within the Research Natural Areas, but they are affected by water level manipulations that occur across the Refuge.

Farm Services Administration Conservation Easements

Mingo NWR manages 17 Farm Services Agency (FSA) conservation easements totaling nearly 448 acres within a 48-county region in the southern third of the state (Table 5). All easement properties are inspected, have management plans, and are posted with signs indicating the properties are under conservation easements.

The Farm Services Agency, formerly known as the Farm Services Administration, is an agency within the U. S. Department of Agriculture. The FSA makes loans to farmers and ranchers temporarily unable to obtain credit from commercial lending institutions. The FSA sometimes obtains title to real property when a borrower defaults on a loan secured by the property and holds such properties in inventory until sale or other disposal.

The Service is involved in the inventory disposal program because some FSA inventory properties contain or support significant fish and wildlife resources or have healthy restorable wetlands or other unique habitats. Some qualifying properties are transferred to the Service and become part of the National Wildlife Refuge System. Others are

Table 5: FSA Conservation Easements Managed by Mingo NWR

Original Landowner	Tract	County	Easement Acres
A. Lenz	BR10c	Barton	42
J. Reaves	BR12c	Barton	33
D. Eaton	BL09c	Butler	14
A. McCombs	BL10c	Butler	17
H. Petty	BL11c	Butler	36
D. Seabaugh	CP10c	Cape Girardeau[1]	16
Probst Hog Farm	CP11c	Cape Girardeau[2]	30
C. Decker	DA11c	Dade	31
D. Eaton	DU10c	Dunklin	35
R. Mattlage	LW10c	Lawrence	4
M. Herman	PR02n	Perry	6
H. Asher	RI10c	Ripley	32
S. Kleffer	SD10c	Stoddard	13
R. Crowell	SD11c	Stoddard	19
S. Lynch	SD12c	Stoddard	29
D. Ast	VE10c	Vernon	66
Goucher		Hickory	25
Total			448

1.These acres are assumed from past reports but could not be verified.
2.These acres are assumed from past reports but could not be verified

sold with restrictions known as conservation easements, which protect wetlands or other habitats. In most cases, the Service is responsible for the management and administration of properties with conservation easements.

Pilot Knob National Wildlife Refuge

Introduction

Pilot Knob National Wildlife Refuge, located on top of Pilot Knob Mountain in Iron County, Missouri, is managed by staff at Mingo NWR (see Figure 9). Acquired by donation from the Pilot Knob Ore Company on July 22, 1987, the 90-acre Refuge contains iron mine shafts dating to the mid-1800s that are critical habitat for the federally-listed endangered Indiana bat. The abandoned shafts, excavated in rhyolite (a light-colored, igneous rock consisting primarily of the mineral silica), are well-ventilated by upper and lower entrances. The mine traps cold air and provides ideal conditions for hibernating bats, which enter the shafts in the fall and exit in the spring. Up to a half of Missouri's known population of Indiana bats is believed to hibernate in the old mine.

The Refuge was created expressly to protect the Indiana bat; there is no other management emphasis. Public use is prohibited at this time.

Special Management Areas

There are no special management areas on the Refuge.

Geographic/Ecosystem Setting

Pilot Knob NWR is located in southeast Missouri in Iron County. It consists of a steep conical hill, ascending more than 560 feet above the Arcadia Valley floor.

U.S. Fish and Wildlife Service Ecosystems

Like Mingo NWR, Pilot Knob NWR is situated near the boundary of the Ozark Plateau Ecosystem and the Lower Mississippi River Ecosystem. See the description of these in Chapter 1 and in Chapter 3 under Mingo NWR, respectively.

Figure 9: Location of Mingo National Wildlife Refuge

Migratory Bird Conservation Initiatives

See the discussion of these initiatives in the discussion of Mingo NWR, "Migratory Bird Conservation Initiatives" on page 20.

Region 3 Fish and Wildlife Resource Conservation Priorities

See the discussion of these priorities under Mingo NWR, "Region 3 Fish and Wildlife Resource Conservation Priorities" on page 22.

Other Recreation and Conservation Lands in the Area

The Fredericktown Ranger District of the 1.5-million-acre Mark Twain National Forest lies approximately 2 miles east of the Refuge.

Socioeconomic Setting

Pilot Knob NWR is located in rural Iron County, Missouri. Iron County lost population between 2000 and 2003, in contrast to the State of Missouri, which grew by about 2 percent; the county is also less racially and ethnically diverse than the state. Its population has a lower average income, and less high school and college education than the state's population as a whole.

When white settlers arrived in what is now Iron County in about 1800, lured mostly by its mining potential, they encountered native Osage Indians as well as displaced eastern tribes, including Delaware, Shawnee, Piankasha, Miami and Peoria (McClure, 2004). Iron County was created in 1857 by a special act of the Missouri Legislature. The St. Louis and Iron Mountain Railroad to Pilot Knob was completed the same year to haul iron ore from the mine there. With the arrival of the railroad, cutting wood and making charcoal for the engines became a big business locally. In the 1860s, Iron County saw its share of Civil War action. Today, Iron County is known for its historical sites like the Civil War-era Fort Davidson and outdoor recreation opportunities in the Mark Twain National Forest and several state parks.

Population and Demographics

The 2003 population estimate for Iron County was 10,306, which was a 3.7 percent decline from the population in 2000 (Census, 2005a). This population decline perpetuated and accelerated a 0.3 percent decline in the county's population from 1990 to 2000. Iron County's rural character is shown by its population density in 2000 of 19 persons per square mile; Missouri's population density was 81 per square mile in the same year. The county's population is less diverse than the state as a whole. Iron County was 97 percent white in 2000, compared with Missouri as a whole which was 85 percent white. In Missouri, 5 percent of the people 5 years and older speak a language other than English at home; in Iron County the corresponding figure is 2 percent. Less than 1 percent of the population was foreign-born.

Employment and Income

Private non-farm employment numbered 2,116 in 2001. Mean travel time to work was slightly higher than the state mean. The unemployment rate of 9-10 percent is almost double the national average of about 5 percent (BLS, 2005). Median household income in 1999 was $26,080, 30 percent lower than the $37,934 median for Missouri as a whole. The 1999 poverty rate of 19 percent for the county was substantially higher than the statewide average of 12 percent, although this higher rate is typical for rural counties.

Education

As with most rural counties, educational attainment in Iron County is lower than the state and nation. In 2000, 65 percent of Iron County residents 25 years old or older had a high school diploma, compared with 81 percent for the state as a whole and 80 percent for the entire United States. With regard to higher education, 8 percent of Iron County residents 25 years old or older had earned a Bachelor's degree or higher, in comparison with 22 percent of state residents 25 years old or older as a whole and 24 percent of all Americans.

Climate

The climate of the Refuge is humid continental with warm summers and cool winters. Mean annual temperature of Iron County is 56 degrees Fahrenheit (F) with a mean January temperature of 32 degrees F and a mean July temperature of 73 degrees F. Mean annual precipitation is 44.3 inches and is rather evenly distributed throughout the year with an average of 3.7 inches per month. Mean length of the growing season in Iron County is 185 days with the average first freeze date occurring October 11 and the average last freeze date occurring April 27.

Geology and Soils

Pilot Knob diverges from the general igneous hills in many aspects. It is cone-shaped and largely separated from the adjoining porphyry hills, con-

nected on the east by a low neck of igneous rock that emerges only about 200 feet above the surrounding Cambrian rocks. It has a basal diameter of three-quarters of a mile and rises about 600 feet above the surrounding valley, attaining an elevation of approximately 1,500 feet above sea level. Buzzard Mountain is located north of Pilot Knob, across a narrow valley. Cedar Hill is located northwest of Pilot Knob, and Shepherd Mountain lies to the southwest. Other mountains can be seen to the east and southeast, all of which are composed of compact, reddish brown porphyry (igneous rock) that does not differ essentially from that constituting the lower portion of Pilot Knob.

The majority of Pilot Knob mountain soils are comprised of Killarney very cobbly silt loam, 14 to 50 percent slopes, and rubbly. This is a well drained soil with a dark grayish brown very cobbly silt loam about 3 inches thick. The subsurface soil is a very brown cobbly silt loam about 4 inches thick. The upper 29 inches of the subsoil is yellowish brown very cobbly silt loam, and very gravelly silty clay loam. The surface runoff is high and erosion is a major hazard. The Killarney soil type covers approximately 50-60 percent of the mountain's base.

The second soil type is Irondale very cobbly silt loam, 15 to 40 percent slopes, and rubbly. Stones and boulders generally cover 15 to 50 percent of the surface. The surface layer is extremely dark grayish brown very cobbly silt loam about 3 inches thick. The subsurface layer is a brown very cobbly silt loam about 5 inches thick. The subsoil is very cobbly silt loam about 32 inches thick. It is yellowish brown in the upper part and reddish brown in the lower part. Rhyolite bedrock is at a depth of about 35 inches. Permeability is moderate, but surface runoff is rapid. The organic content is low, and the surface layer is friable but cannot be easily tilled because it commonly has 50 percent or more rock fragments.

Water and Hydrology

As indicated in a previous section, annual mean precipitation at Pilot Knob NWR is about 44 inches, more or less evenly distributed throughout the year, and falling as rain.

Refuge Resources

Plant Communities

Forests

Upland forest covers the Refuge. Oak-hickory forest types predominate on the cobbly silt loam areas, and are interspersed with shortleaf pine in places. These shallow soils support various forbs and native grasses, such as sumac (*Rhus* spp.), coralberry (*Symphoricarpos orbiculatus*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), and indiangrass (*Sorghastrum nutans*).

Fish and Wildlife Communities

Birds

Appendix C shows the bird species that have been documented at Pilot Knob NWR.

Mammals

See Appendix C for a list of the mammals documented or suspected to occur at Pilot Knob NWR.

Amphibians and Reptiles

See Appendix C for a list of amphibians and reptiles found on the Refuge.

Fish

Due to its location atop a hill or small mountain, there are no water bodies that contain or might contain fish at Pilot Knob NWR.

Invertebrates

At this time, the Refuge does not possess a list of invertebrates whose presence on the Refuge has been documented.

Threatened and Endangered Species

The federally-listed endangered Indiana bat hibernates within the abandoned mine shaft located at the peak of Pilot Knob Mountain. There are differing estimates of Pilot Knob NWR's Indiana bat population, but the number is likely within the range of 50,000 to 100,000. The bats generally arrive in

Indiana bat on Pilot Knob NWR. USFWS

September and leave in April. The bat's historic range includes Missouri, and its summer habitat preference is small to medium river and stream corridors with well developed riparian woods, woodlots within 1 to 3 miles of small to medium rivers and streams, and upland forests.

The Indiana bat was added to the federal endangered species list in 1967. Its dwindling population continues to cause concern and support its protection at the Refuge. Its decline has many different contributing factors, including the commercialization of roosting caves, wanton destruction of habitat by vandals, disturbances caused by increased numbers of spelunkers, bat banding programs, use of bats as laboratory experimental animals, and suspected insecticide poisonings (USFWS, no date-d).

The gray bat also hibernates in the mine, and is federally listed as an endangered species. The bat's fall migration begins in early September and is generally completed by early November.

Since its placement on the endangered species list in 1976, the gray bat has become of particular concern. Its population decline is believed to be due primarily to human disturbances. These disturbances include vandalism, excessive pesticide use, overall insect prey decline due to pollution, and cave commercialization. The decline in gray bat populations can also be attributed to natural catastrophes. Collapsing caves and flooding have been known to render many gray bats homeless.

Since 1976, efforts have been made to assist the recovery of these nearly extinct animals. Some of the major recovery goals include:

Preserving critical winter habitat by securing primary caves and mines and restricting entry.
Initiating informational and educational programs.
Monitoring population levels and habitat to include an evaluation of pesticide effects.

Threats to Resources

Invasive Species

There are no invasive species known to occur on Pilot Knob NWR.

Contaminants

Contaminants have not been studied or documented on the Refuge, but may be expected to occur in at least low concentrations, as they do in virtually all locations. Whether or not these concentrations pose a threat to wildlife and listed species at Pilot Knob NWR is yet to be determined.

Administrative Facilities

No administrative facilities are present on the Refuge. The Refuge is managed entirely by staff from Mingo NWR, 75 miles to the southeast.

Archeological and Cultural Values

No archeological investigations have occurred at Pilot Knob NWR. The iron mine probably is not eligible for the National Register of Historic Places. The summit of Pilot Knob encompassed by the Refuge is thought to have historic significance related to a Civil War battle fought nearby.

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

Visitation

Pilot Knob NWR has never been managed for, nor open to, the public. It has always been managed strictly to protect and enhance Refuge habitat to maintain or increase use by endangered species. Scientific investigations, research, and monitoring are allowed by permit only.

Current Management

Habitat Management

There is no active habitat management program at Pilot Knob NWR.

Fire Management

Fire management at Pilot Knob NWR is guided by a Fire Management Plan (FMP) adopted in 2003 (USFWS, 2003c). The FMP describes the responsibilities of each member of the fire management team, including training, experience, physical fitness requirements, and fire duty assignments.

All wildland fires are suppressed at Pilot Knob and wildland fire use for resource benefit is not be utilized at the present time. Currently prescribed fire is not used either for fuel reduction or habitat management on the Refuge.

Fish and Wildlife Monitoring

Annual bat capture surveys and temperature monitoring in the mine shafts are conducted in conjunction with the Missouri Department of Conser-

vation. Comparison of capture rates helps determine the population trend for Indiana bats.

Visitor Services

The Refuge is not open to the public. No hunting, fishing, wildlife observation or photography take place on Pilot Knob NWR. Refuge staff have recently conducted interpretive hikes as part of the Civil War reinactments at Fort Davidson State Historic Park. In addition, approximately 40 college geology students visit the Refuge annually to study the unique geomorphology. This is done under special use permit and is a Refuge staff member accompanies students.

Non-wildlife dependent recreation is not currently permitted.

Pest Management

No pest management is conducted on the Refuge.

Archeological and Cultural Resources

No management of archeological or cultural resources takes place on the Refuge.

Special Management Areas

The Refuge has no special management areas.

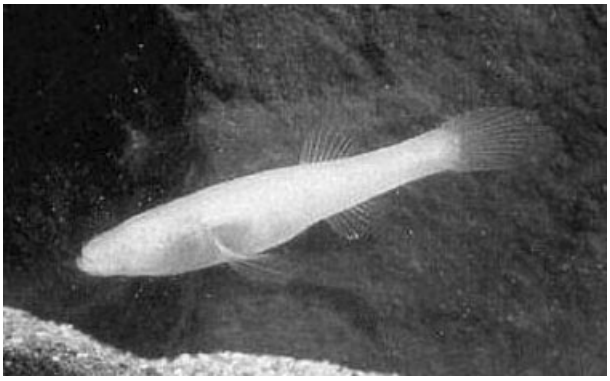
Ozark Cavefish National Wildlife Refuge

Introduction

The 40-acre Ozark Cavefish National Wildlife Refuge, located 20 miles west of Springfield in Lawrence County, Missouri, was acquired in 1991 to protect a federally-listed endangered species, the Ozark cavefish (Figure 10). Turnback Creek Cave Spring is located on this property and is the outlet of an underground stream known to contain a population of the endangered Ozark cavefish. Access to the stream is gained via Turnback Cave, which has openings on adjacent property owned by the Missouri Department of Conservation. There is also a separate 1.3-acre parcel of the Refuge located several miles away along the Hearrell Spring in Neosho, Missouri, that adjoins the Service's Neosho National Fish Hatchery. Ozark cavefish are known to inhabit this site (Figure 11). The Refuge is managed by staff at Mingo NWR in Puxico, Missouri, some 200 miles east of the Refuge.

Special Management Areas

Ozark Cavefish NWR does not contain any special management areas.



Ozark cavefish. USFWS

Geographic/Ecosystem Setting

U.S. Fish and Wildlife Service Ecosystem

Like Mingo NWR, Ozark Cavefish NWR is within the Ozark Plateau Ecosystem. See the description of this ecosystem in Chapter 3 under Mingo NWR.

Migratory Bird Conservation Initiatives

See the discussion of these initiatives under Mingo NWR, "Migratory Bird Conservation Initiatives" on page 20.

Region 3 Fish and Wildlife Resource Conservation Priorities

See the discussion of these priorities under Mingo NWR, "Region 3 Fish and Wildlife Resource Conservation Priorities" on page 22.

Other Recreation and Conservation Lands in the Area

The 208-acre Paris Springs Access managed by the Missouri Department of Conservation adjoins the Refuge to the south.

Socioeconomic Setting

All but 1.3 acres of Ozark Cavefish NWR is located in Lawrence County, Missouri. The county, organized in 1845 out of northern Barry and southern Dade counties, was named for Captain James Lawrence, a hero of the War of 1812. The first settlers of European descent began arriving in what is now Lawrence County in the early 1830s, about 5 years after the Indian Removal of 1825. These migrants came primarily from Virginia, Kentucky, North and South Carolina and Tennessee. Today the county has 14 townships with Mt. Vernon being the county seat (MOGenWeb, 2004).

Figure 10: Turnback Creek Unit, Ozark Cavefish NWR

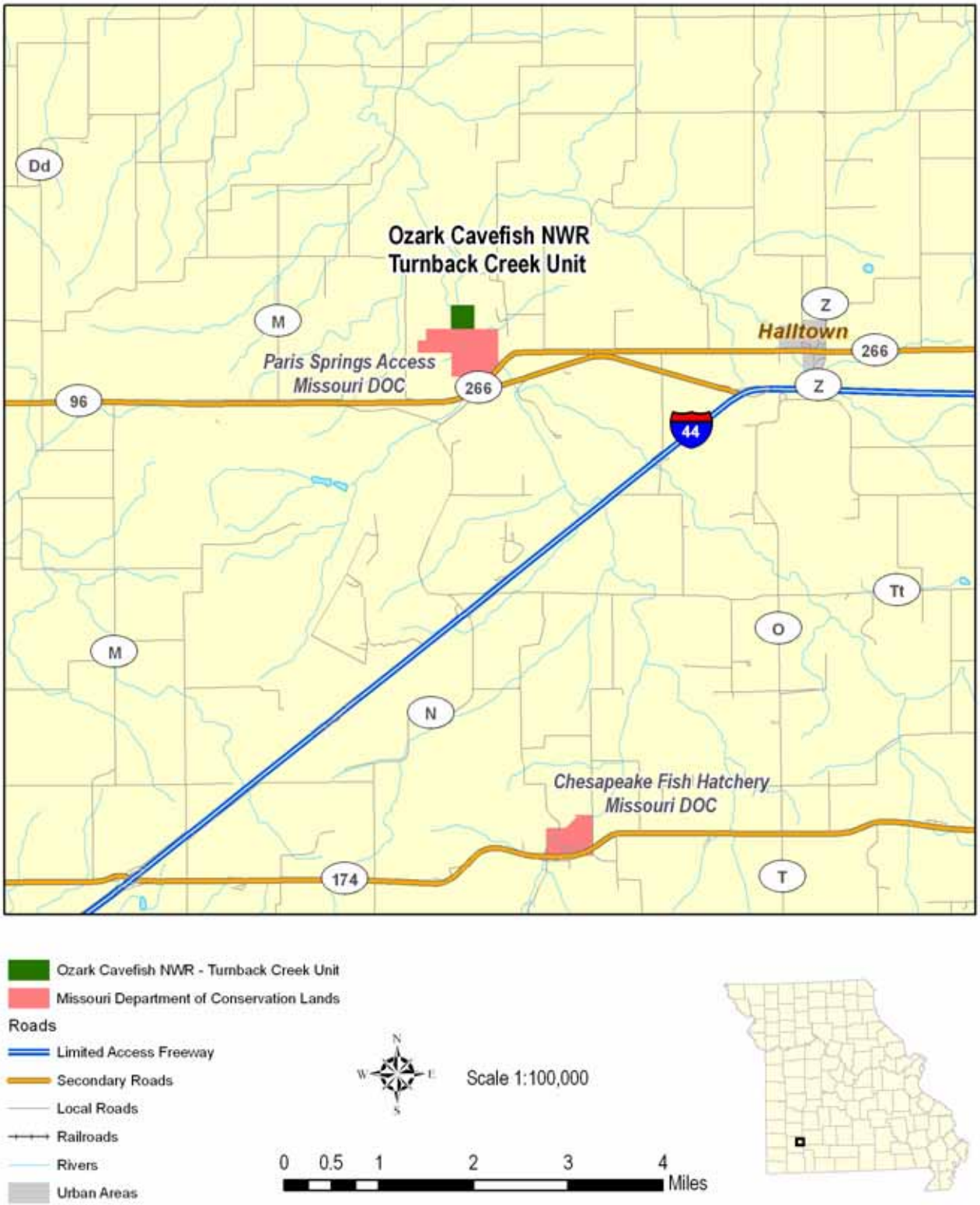


Figure 11: Hearrel Spring Unit, Ozark Cavefish NWR

Lawrence County is primarily agricultural, its principal products including wheat, hay, oats, barley, corn, apples, peaches, and vegetables. Farmers also raise turkeys and cattle and there is a dairy industry. Manufacturing, primarily dairy and grain products, occurs in the towns of Aurora, Mt. Vernon, Pierce City, and Marionville.

Population and Demographics

The 2003 population estimate for Lawrence County was 36,426, which was a 3.5 percent increase from the population in 2000 (Census, 2005b), nearly double the rate of population growth in Missouri as a whole (1.9 percent from 2000 to 2003). This population growth continued a trend from the 1990s during which the county's population grew by 16.4 percent, in comparison to 9.3 percent for the state. Lawrence County's population density in 2000 was 57 persons per square mile, a little less Missouri's density of 81 per square mile in the same year. The county's population is less diverse than Missouri's. Lawrence County was 96 percent white in 2000, compared with Missouri as a whole which was 85 percent white. Blacks comprised 0.3 percent of the county population versus 11 percent in the entire state. The population of people of Asian descent was 0.2 percent, which compares to 1.1 percent in the entire state. However, both American Indians and Hispanics are represented in greater proportions in the county population than in the state's population. Hispanics compose 3.4 percent of the Lawrence County population compared to 2.1 percent of Missouri's population, while American Indians make up 0.8 percent of the county population compared to 0.4 percent of the state as a whole. Approximately 2 percent of the county population was foreign-born, about the same percentage as the state's foreign-born population (Census, 2005b).

Employment and Income

Private non-farm employment in Lawrence County numbered about 7,000 in 2001. Mean travel time to work was almost identical to the state mean, 23.6 compared to 23.8 minutes. The county unemployment rate of 4-5 percent is very close to the national average (BLS, 2005). Median household income in 1999 was $31,239, 18 percent lower than the $37,934 median income for Missouri as a whole. The 1999 poverty rate of 14 percent for the county was slightly higher than the statewide average of 12 percent, although this higher rate is typical for rural counties (Census, 2005b).

Education

Average educational attainment in Lawrence County is slightly lower than averages for the state and nation. In 2000, 77 percent of county residents 25 years old or older had a high school diploma, compared with 81 percent for the state as a whole and 80 percent for the entire United States. With regard to higher education, 12 percent of Lawrence County residents 25 years old or older had earned a Bachelor's degree or higher, compared to 22 percent of state residents 25 years old or older as a whole and 24 percent of all Americans.

Climate

The climate of Lawrence County is humid continental with warm summers and cool winters. Mean annual temperature of Lawrence County is 55.9 Fahrenheit with a mean January temperature of 32.6 F and a mean July temperature of 77.7 F. Rainfall is fairly heavy with mean annual precipitation of 39.74 inches and is rather evenly distributed throughout the year with an average of 3.3 inches per month. Mean length of the growing season in Lawrence County is 189 days with the average first freeze date occurring October 14 and the average last freeze date occurring April 28.

Geology and Soils

Wilderness cherty silt loam, the primary soil type found on the Refuge, has 2 to 9 percent slopes. It is deep, gently or moderately sloping, and moderately well drained. Some areas have small and large sinkholes. Coarse fragments of chert are on the surface. Generally, the surface layer is dark grayish brown cherty silt loam about 2 inches thick. The subsurface layer is brown cherty silt loam about 8 inches thick. The subsoil above the fragipan is about 11 inches thick, with the upper part being a yellowish brown, friable cherty silt loam, and the lower part a brown, firm cherty silty clay loam. The fragipan is about 35 inches thick. The upper part is pale brown, firm, cherty silt loam, and the lower part is mottled, multicolored, firm very cherty silty clay loam. The subsoil below the fragipan is dark red, very firm cherty clay to a depth of 72 inches. Some areas are stony. This soil is moderately permeable and surface runoff is medium.

Water and Hydrology

Turnback Cave is developed in Mississippian Burlington-Keokuk Limestone on the west side of Turnback Creek in Lawrence County. It is an extensive cave containing over 3,000 feet of interconnect-

ing passages. The stream passage is a few hundred feet from the main entrance and trends roughly north. Water enters the stream passage at the southern end, and exits the cave through a spring along Turnback Creek to the north. Turnback Creek originates in northwestern Christian County about 12 miles southeast of Turnback Cave.

Refuge Resources

Plant Communities

Wetlands

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 ouata*), Bitternut Hickory (*Carya cordiformis*)
Sweetgum (*Liquidambar styraciflua*)
American Elm (*Ulmus americana*)
Hackberry (*Celtis occidentalis*)
Box Elder (*Acer negundo*)
Chinkapin Oak (*Q. muehlenbergii*)
Blackgum (*Nyssa sylvatica*)
Black Walnut (*Juglans nigra*)
Butternut (*Juglans cinerea*)
Black Cherry (*Prunus serotina*)
Bur Oak (*Q. macrocarpa*)
Swamp Red Oak (*Q. falcata*)

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.

Forests

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

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 (*Ulmus* spp.) 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*).

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 (*Quercus alba*), Mockernut Hickory (*Carya alba*) Shagbark Hickory (*Carya ovata*)
Chinkapin Oak (*Quercus muehlenbergii*)
White Ash (*Fraxinus americana*), Sassafras (*Sassafras albidum*), Flowering Dogwood (*Cornus florida*)
Mulberry (*Morus spp.*)

Blue Jay. USFWS

- Pawpaw (*Asimina triloba*)
- Bladdernut (*Staphylea trifolia*)
- Spicebush (*Lindera spp.*)
- Devil's Walking Stick (*Aralia spinosa*)
- Wild Hydrangea (*Hydrangea arborescens*).

Fish and Wildlife Communities

Birds

The Service has no information on the species of birds that may be present on the Refuge; the Refuge has no bird list. However, a number of avian species nest or migrate through the area and these may be expected to occur at least seasonally on Ozark Cavefish NWR.

Mammals

At this time, the Refuge does not have a mammal list, though a number of species would be expected to occur at Ozark Cavefish NWR.

Amphibians and Reptiles

At this time, the Refuge does not have a list of amphibians and reptiles, though a number of species would be expected to occur at Ozark Cavefish NWR.

Fish

At this time, the Refuge does not have a list documenting which species of fish are present.

Invertebrates

There is not a complete list of invertebrates occurring on the Refuge, but the Bristle Cave crayfish (*Cambarus setosus*), a state-listed endangered species in Missouri, is known to occur within Turnback Creek Cave Spring.

Threatened and Endangered Species

Two species that are listed as endangered, threatened, or rare species occur on Ozark Cavefish NWR.

A population of federally-listed threatened Ozark cavefish (*Amblyopsis rosae*) inhabits Turnback Creek Cave Spring within the Ozark Cavefish NWR. The Ozark cavefish was listed as threatened in 1984. A colorless fish about 2 and one-quarter-inches long, its head is flattened, and it has a slightly protruding lower jaw. The fish has no pelvic fin and its dorsal and anal fins are farther back than on most fish. The Ozark cavefish has only rudimentary or vestigal eyes and no optic nerve. However, it is well-adapted to dark environment of caves through well-developed sensory papillae. The reproductive rate of Ozark cavefish is comparatively low (USFWS, 1992).

The Ozark cavefish lives its entire life in cave streams, underground waters, and springs. It uses sense organs located on the sides of its head, body, and tail to find food. Its range is restricted to caves in Missouri, Arkansas, and Oklahoma; as of 1992, 15 caves had verified populations. Ozark cavefish rely heavily on microscopic organisms like plankton as a food source, but also feed on small crustaceans, salamander larvae, and bat guano.

Factors that have led to the decline of the Ozark cavefish include habitat destruction, collecting of specimens, and disturbance by spelunkers (cavers). In terms of its recovery, protection of caves containing cavefish is the most important task. This includes monitoring the quality of water flowing into these caves, and erecting fences or gates that limit access by humans but that do not interfere with bat populations. In many caves, the principal source of energy for the organisms on which cavefish feed is bat guano. Therefore, Ozark cavefish survival depends on the survival of bats.

The federally-listed endangered gray bat utilizes Turnback Cave in the summer for reproductive and rearing purposes. As mentioned above, guano produced by the bats provides an important food source for Ozark cavefish.

Cotton-tail rabbit. USFWS

Threats to Resources

Invasive Species

No invasive species are known to occur on Ozark Cavefish NWR.

Contaminants

The situation with regard to contaminants on the Refuge is unknown.

Administrative Facilities

No administrative facilities are present on the Refuge. The Refuge is managed entirely by staff from Mingo NWR 200 miles to the east.

Archeological and Cultural Values

No archeological investigations have occurred at Ozark Cavefish NWR, and no cultural resources have been identified on the Refuge.

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

Visitation

The Refuge is not open to the public, and no visitor services are provided.

Current Management

Ozark Cavefish NWR is not managed for, nor is open to the public. It is managed strictly to protect and enhance Refuge habitat to maintain or increase use by endangered species, in particular the fish for which it is named – the Ozark cavefish, and the Federally endangered gray bat, on whose guano the cavefish depends in part. Scientific investigations, research, and monitoring are allowed by permit only.

Specific objectives include, but are not limited to:

Ensure protection of the federally-listed endangered gray bat maternity colony inhabiting the cave and utilizing the Refuge.
Ensure protection of the federally-listed endangered Ozark cavefish population inhabiting the cave stream.
Protect the uncommon bristle cave crayfish population inhabiting the cave stream.
Prohibit recreational visitation to the site.
Prevent potentially adverse impacts on the site and its ecosystem from surface management practices.

Habitat Management

There is no active habitat management program at Ozark Cavefish NWR at the present time.

Fire Management

Fire management at Ozark Cavefish NWR is guided by a Fire Management Plan (FMP) adopted in 2003 (USFWS, 2003c). The FMP describes the responsibilities of each member of the fire management team, including training, experience, physical fitness requirements, and fire duty assignments.

All wildland fires are suppressed at Ozark Cavefish and wildland fire use for resource benefit is not be utilized at the present time. Currently prescribed fire is not used either for fuel reduction or habitat management on the Refuge.

Fish and Wildlife Monitoring

Other than observation and monitoring of the rare, threatened and endangered species that exist on the Refuge, no additional fish and wildlife monitoring takes place.

Visitor Services

The Refuge is not open to the public, and no visitor services are provided. Priority public uses including hunting, fishing, wildlife observation and photography, and environmental education and

interpretation are not allowed. Non-wildlife dependent recreation is not permitted at present.

There is an underwater camera installed at Hearell Springs. Visitors to the Neosho National Fish Hatchery have an opportunity to view a video image of this elusive species. Approximately 40,000 to 45,000 people visit the hatchery annually.

Pest Management

No pest management is conducted on the Refuge.

Archeological and Cultural Resources

No management of archeological or cultural resources takes place on the Refuge.

Special Management Areas

The Refuge has no special management areas.