U.S FISH & WILDLIFE SERVICE

MINGO

NATIONAL WILDLIFE REFUGE

REPORT ON WILDERNESS CHARACTER MONITORING

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Executive Summary

The Mingo National Wildlife Refuge is primarily bottomland hardwood forest and upland hardwood forest, with some marsh and open water. The Refuge is bordered to the west by the Ozark Plateau and to the east by Crowley's Ridge, a prominent landform in the otherwise level Mississippi floodplain. Congress designated 7,730 acres of the Refuge on October 19, 1976 as wilderness under the Wilderness Act of 1964. In order to preserve the wilderness character and uphold the legislative mandate of the Wilderness Act, an evaluation of current conditions and a plan for monitoring long-term trends in wilderness are essential.

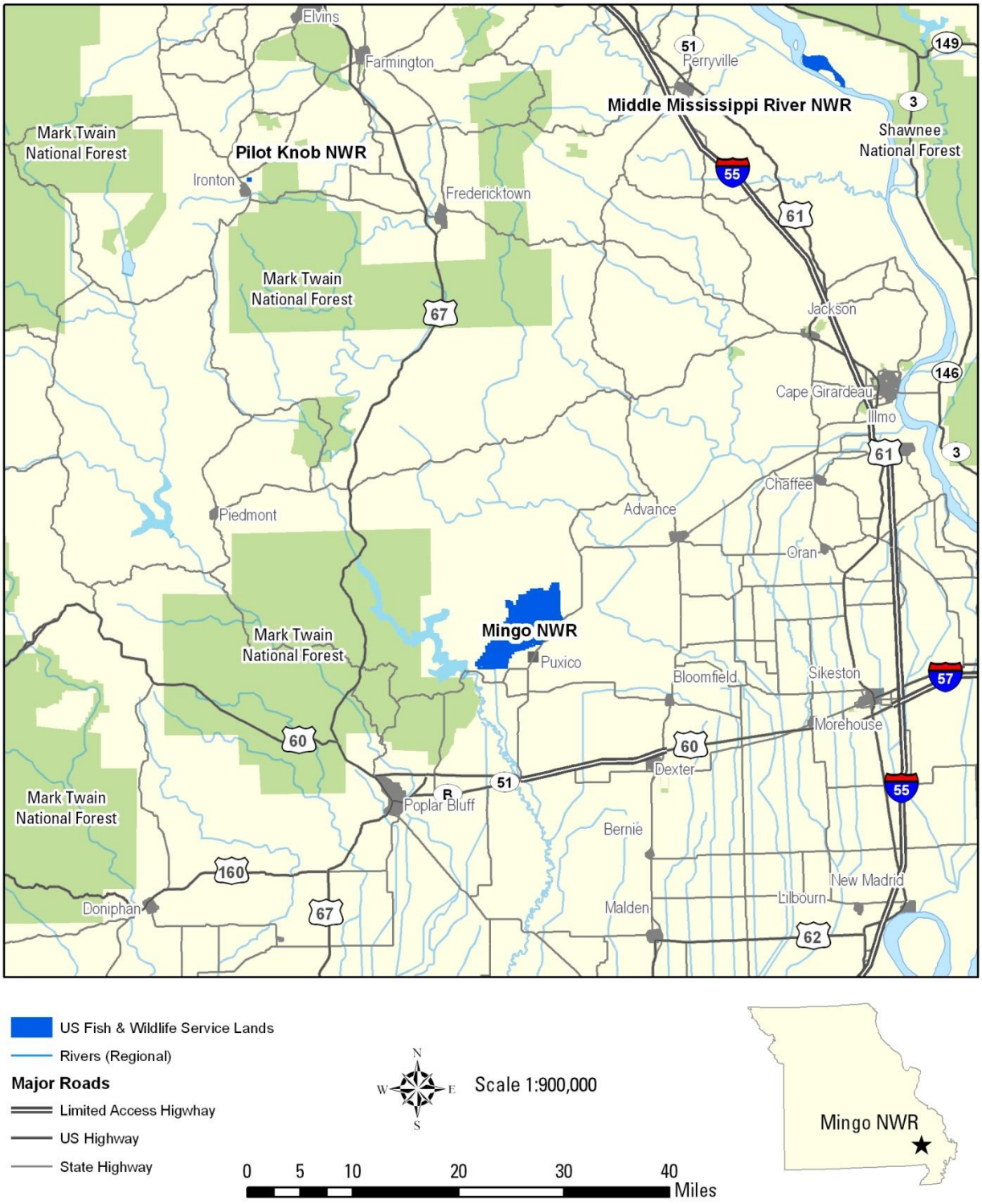
An interagency team, representing the U.S. Fish & Wildlife Service (USFWS), National Park Service (NPS), U.S. Forest Service (USFS), and Bureau of Land Management (BLM), developed a guide for wilderness character monitoring. This national strategy is described in the 2008 "Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System" publication, and will be followed herein.

The purpose of this document is to describe a wilderness character monitoring program for the Mingo Wilderness. The designed 25 measures were developed with staff to best utilize monitoring efforts already occurring on the Refuge. They are composed of readily available data such as field surveys, management policies, documented uses, and professional judgment.

First, the setting of the Wilderness is described, including its ecology, legislative history, and Refuge purposes. Second, the process used to develop the monitoring framework is explained. Third, a suite of potential indicators and measures are proposed in order to conduct an initial wilderness character baseline assessment and subsequent monitoring. This section includes all chosen measures to represent the Mingo Wilderness. Fourth, a list of all measures ultimately not chosen for inclusion are discussed, along with concluding thoughts on the proposed monitoring program.

In effect, this document provides a 2012 baseline assessment and describes the wilderness character monitoring program for the Mingo National Wildlife Refuge Wilderness.

Figure 1. Map of the Mingo National Wildlife Refuge and surrounding land area.



Setting of the Mingo Wilderness

Refuge History and Establishment

About 25,000 years ago, the Mississippi River ran between the Ozark Mountains and Crowley's Ridge. Approximately 18,000 years ago, the river shifted, slicing its way through Crowley's Ridge to join the Ohio River farther north. The abandoned river bed developed into a rich and fertile swamp. Native Americans were attracted to the swamp because of the abundant wildlife. Water-loving animals, such as beaver, river otter, raccoons, and rabbit thrived. White-tailed deer, Wild Turkey, Ruffed Grouse and timber wolves were common on the edges of the swamp and nearby bluffs.

Settlers first approached the swamp because of its extensive old-growth cypress and tupelo forests. From the late 1880s to early 1930s the lumber industry thrived in the area, producing railroad ties and building lumber from the massive cypress trees. However, by 1935 most of the large operations ceased and the once prominent bottomland hardwood forest of the Missouri Bootheel had been decimated.

Lumber companies then switched focus to agriculture as the next profit generator. After inefficient attempts to drain the swampy land, State Legislature passed an act that allowed the formation of drainage districts, financed by long-term bonds. For the first time, drainage projects could be adequately financed and many drainage districts were created in the Bootheel. One of them was the Mingo Drainage District, a small district in the Advance Lowlands near Puxico. A system of seven major north-south ditches was constructed to drain water from the swamp into the St. Francis River. These ditches are still used to this day by the Refuge for water control and management.

During the Great Depression, land values plummeted and many of the large landholders (lumber companies) defaulted on payment of taxes rather than continue to maintain unprofitable investments in the land. The Mingo District became insolvent due to poor drainage and low soil productivity. The remaining timber was cut by anyone without regard to ownership and the area essentially became open range county. To maintain this grassy condition, the land was burned frequently. Hogs and cattle became numerous and indiscriminate shooting of waterfowl was common. Beaver and deer had disappeared and Wild Turkey had nearly been extirpated from the swamp.

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

Geographic Setting

The 21,592-acre Mingo National Wildlife Refuge is located in Stoddard and Wayne counties in southeast Missouri approximately 150 miles south of St. Louis and 40 miles west of the Mississippi River (Figure 1). The Refuge lies in an abandoned channel of the Mississippi River known as the Mingo Basin. The Refuge is bordered to the west by the Ozark Plateau and to the east by Crowley's Ridge, a prominent landform in the otherwise level Mississippi floodplain. This area is known as the Bootheel region of southeast Missouri. Once an expansive swamp of bottomland hardwoods, the Bootheel was converted to agriculture during the last century and today is largely farmed for row crops. Waters from the refuge flow south to the St. Francis River via Mingo Creek and a series of drainage ditches.

Ecological Setting

Mingo National Wildlife Refuge protects a remnant of the bottomland hardwood and cypress-tupelo swamp ecosystem that once formed a 2.5 million-acre contiguous natural landscape throughout the Mississippi River basin. The Refuge represents the largest area in southeast Missouri of remaining habitat for numerous native and threatened plant and animal species. The Refuge touches the southeast boundary of the Ozark Plateau and slopes abruptly from an upland oak-hickory forest to bottomland hardwood forest, lower marsh, and expansive swamp and ditch system. Since the beginning of the 20th century, these lands have been drained and deforested for agricultural purposes, which has highly modified the natural landscapes and ecosystem functions.

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.

The Mingo 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.

Bottomland hardwood forest of the Mingo Wilderness during flooding (USFWS)

Establishing the Mingo Wilderness

Section 3(c) of the Wilderness Act of 1963 required the Secretary of the Interior to review national wildlife refuges to determine if they contained areas suitable for preservation as wilderness. The Department completed its survey of Mingo National Wildlife Refuge in 1972 and concluded that a 1,700 acre designated natural area was the only portion of the Refuge that met the criteria of the Wilderness Act. However, subsequent public meetings revealed the majority of the public favored a larger area than the 1,700 acres recommended. One intricate participant in this movement was Dr. Leigh Frederickson, director of the University of Missouri's Gaylord Memorial Laboratory, who generated a lot of support for the larger wilderness area proposal.

After failing to introduce legislation proposing an 8,000 acre wilderness area in 1974; in 1975, Congressman Bill Burlison entered legislation calling for a wilderness area of approximately 8,000 acres. Along with Congressman Burlison, Senator Thomas Eagleton, Arthur Wright, conservation consultant for the Wilderness Society, and Dr. Frederickson all testified in favor of the new proposal. The 7,730-acre Mingo Wilderness was established on October 19, 1976 by Public Law 94-557.

This law also established wilderness areas on fifteen other national wildlife refuges, three national forests, and listed eight other Forest Service areas for study to determine their suitability as wilderness. The law directed the administering agencies to prepare a map and legal description of each wilderness area. The boundary description for the Mingo Wilderness was written with special provisions concerning active water management on the Refuge. This description delineated the Wilderness in such that water control structures and drainage ditch maintenance would not interfere with wilderness policies. The map and legal description for the Mingo Wilderness were completed in April of 1977.

Refuge Purposes

Beginning in 1944, land was acquired for Mingo NWR with the approval of the Migratory Bird Conservation Commission. The purpose of the Refuge derives from the Migratory Bird Conservation Act, "... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds" (16 U.S.C. 715d). In acquiring the first tract for the Refuge, the land was identified as "urgently needed for the protection and conservation of migratory waterfowl and other wildlife." In a 1954 presentation to the Migratory Bird Conservation Commission, the Refuge was described as an "important unit in the Mississippi Flyway" and "an important wintering ground for many species of waterfowl." One tract of the Refuge was acquired with Bureau of Outdoor Recreation funds. The purpose associated with this funding derives from the Refuge Recreation Act and includes lands "...suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the

Flock of mallards on the Mingo Refuge (USFWS)

protection of natural resources, (3) the conservation of endangered species or threatened species ...” 16 U.S.C. 460k-1 (Refuge Recreation Act (16 U.S.C. 460k-460k-4), as amended).

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

Documents Consulted

The following is a list of paper and electronic documents that were referenced to help identify and prepare measures:

Mingo National Wildlife Refuge – Wilderness Management Plan – USDOI-FWS – October 1978

Retrieved from the Mingo headquarters, this document outlines the future authorized uses, potential issues, and management goals for the Wilderness. The report also includes the original Mingo Wilderness Study Proposal and Draft Environmental Statement. Along with supporting documents, the management plan helped to clarify the history of the area since its designation as wilderness.

An Evaluation of Ecosystem Restoration and Management Options for the Duck Creek/Mingo Basin Area of Southeast Missouri – Heitmeyer et al. – December 2006

Retrieved from the Mingo headquarters, this document offers a very detailed description of the Mingo Basin ecosystem including: climate and hydrology, ecological attributes and processes of presettlement habitats, and animal communities.

Mingo, Pilot Knob and Ozark Cavefish National Wildlife Refuges –Comprehensive Conservation Plan – USDOI-FWS – April 2007

Retrieved from the Mingo headquarters, this document serves as a guide to the management of Mingo NWR and plans for the following 15 years after its publication in 2007. This document was useful in understanding the history, purpose, and goals of the Refuge. It served as a reference for nearly all fundamental functions of the Refuge.

Technical Guide for Monitoring Selected Conditions Related to Wilderness Character – USDA – Landres, et. al. – June 2009

This electronic document was used as a reference in establishing the protocol for certain wilderness character measurements. It can be consulted as a manuscript for monitoring trends in wilderness character from a very general approach.

Mingo National Wildlife Refuge – Habitat Management Plan – USDOI-FWS – July 2011

Retrieved from headquarters, this document was useful for understanding specific management practices utilized for the different habitats found on the Refuge. It also discusses the current resources of concern and the different threats to those resources.

Other Documents Consulted

Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System – USDA – July 2008

Rising to the Urgent Challenge, Strategic Plan for Responding to Accelerating Climate Change – USDOI – September 2010

Adaptive Management of Invasive Forest Plants, Project Record – USDOI – April 2012

Mingo National Wildlife Refuge – Hunting Chapter of Visitor Services Plan Draft – September 2012

Staff Consulted

Table 1. Staff members that helped to identify and prepare measures.

Staff	Position Titles
Ben Mense	Refuge Manager, USFWS Mingo NWR
Lindsey Landowski	Assistant Refuge Manager, USFWS Mingo NWR
Brad Pendley	Wildlife Biologist, USFWS Mingo NWR
Ryan Seward	Law Enforcement Officer, USFWS Mingo NWR
Peter Rae	Visitor Center Park Ranger, USFWS Mingo NWR

Process Used for Identifying Measures

Table 2. Timeline of significant actions connected to identifying measures for wilderness character monitoring.

Date	Type of Event	Hours	Attendance	Comments
9/10/2012	Informal meeting with staff	1	Ben Mense, *Refuge Manager* Lindsey Landowski, *Assistant Refuge Manager*	Met with Lindsey and Ben upon arriving at Mingo to briefly explain the goals and duties of my position. I also outlined wilderness character monitoring and informed them about the programs history and intentions.
9/18/2012	Formal meeting with staff	1.75	Ben Mense, *Refuge Manager* Lindsey Landowski, *Assistant Refuge Manager* Brad Pendley, *Wildlife Biologist* Peter Rea, *Park Ranger* Ryan Seward, *Park Ranger (LE)*	I met with the entire staff, excluding the two maintenance mechanics and the administrative technician, to give a formal presentation on wilderness character monitoring so everyone is on the same page. I spent the first 45 minutes explaining wilderness character, my duties, and the process needed to create a WCM Plan. The second half of the meeting was spent on choosing potential measures for Mingo's WCM Plan.
9/21/2012	Paddle through the wilderness	4	Lindsey Landowski, *Assistant Refuge Manager* Peter Rea, *Park Ranger*	Lindsey, Peter, and I took the kayaks to the southern region of the Wilderness and launched in Ditch 10. We paddled up Ditch 10 all the way to Stanley Creek and took that Southeast to the Mingo River. The Mingo River took us south to Flat Banks where we finished our paddle. This trip was my first opportunity to gain perspective of the Mingo Wilderness. We encountered a couple cottonmouths, two beaver dams, and a variety of waterfowl. The landscape varied from bald cypress stands with old sloughs mixed with button bush and transitioned into oak stands.
9/26/2012	Informal meeting with staff	2	Brad Pendley, *Wildlife Biologist*	I met with Brad to discuss many of the natural quality measures and a few of the untrammeled. He was very insightful and worked with me to develop a long list of potential measures based on the current refuge priorities and management practices.

10/3/2012	Formal meeting with staff	3	Ben Mense, *Refuge Manager* Lindsey Landowski, *Assistant Refuge Manager* Brad Pendley, *Wildlife Biologist* Peter Rea, *Park Ranger*	I met with the management staff to discuss the current list of measures and assign priorities. Through this process we were able to drop certain measures, brainstorm how some would be defined, and create the final list for measuring Wilderness Character on the Mingo Refuge. This was perceived as an efficient process for prioritizing measures, compared to having staff do it individually.
10/24/2012	Informal meeting with staff	1.5	Brad Pendley, *Wildlife Biologist*	I met with Brad to discuss the protocols and data sources for many of the untrammeled and natural quality measures. We decided that significant change for all measures would have to be decided upon by all members of the staff.
10/31/2012	Formal meeting with staff	2	Ben Mense, *Refuge Manager* Lindsey Landowski, *Assistant Refuge Manager* Brad Pendley, *Wildlife Biologist* Peter Rea, *Park Ranger*	Met with entire staff to discuss the definitions I chose for all of the measures as well as establish what will be considered a significant change for each measure. We also eliminated measures that we decided were unnecessary. This will be the final formal meeting; we set a deadline of November 9th for the report to be completed for review.

Wilderness Character Monitoring

Wilderness character monitoring is based on the following five qualities interpreted from the Wilderness Protection Act of 1964:

UNTRAMMELED
Wilderness is "...an area where the earth and its community of life are untrammeled by man..." and "...generally appears to have been affected primarily by the forces of nature."

Wilderness is essentially unhindered and free from the <u>actions</u> of modern human control or manipulation.

NATURAL
Wilderness "...is protected and managed so as to preserve its natural conditions."

Wilderness ecological systems are substantially free from the <u>effects</u> of modern civilization.

UNDEVELOPED
Wilderness is "...an area of undeveloped Federal land...without permanent improvement or human habitation" and "...where man himself is a visitor who does not remain."

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation.

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION
Wilderness "…has outstanding opportunities for solitude or a primitive and unconfined type of recreation. "

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.

OTHER FEATURES
Wilderness "…may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Wilderness preserves other tangible features that are of scientific, educational, scenic, or historical value.

Indicators and Measures

Untrammeled Quality *Wilderness is essentially unhindered and free from modern human control or manipulation.*		
What are the trends in actions that control or manipulate the "earth and its community of life" inside wilderness?	Actions authorized by the Federal land manager that manipulate the biophysical environment.	1-1. Number of actions to suppress naturally ignited fire within wilderness
		1-2. Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat
		1-3. Number of permitted special uses that manipulate the biophysical environment
		1-4. Number of actions taken to chemically immobilize, capture, remove, collar, band, and/or mark animals within the wilderness boundary
	Actions NOT authorized by the Federal land manager that manipulate the biophysical environment.	1-5. Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire

1-1. Number of actions to suppress naturally ignited fire within wilderness

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: Natural fires are an infrequent disturbance in the Mingo Wilderness. Due to historical and present periods of flooding associated with bottomland hardwood forests, ignitions are rare, and high intensity wildfires are even less common. Future changes in climate may alter fire frequency, intensity, and character. Only fires that were naturally ignited are included in this measure, fires that were human-caused are to be counted in measure 1-5. A suppression response counts only if the action is taken within the Wilderness Area, it is not counted if it occurs outside the boundary. The untrammeled quality is degraded by an increasing number of natural fire starts that are suppressed.
Relevance: This measure is relevant to the indicator because it captures authorized large-scale or significant actions that manipulate fire within wilderness, thus manipulating the biophysical environment.
Significant Change: Any
Data Adequacy: High-Although it is possible for small fires to go undetected, any fires of a larger scale, and the associated actions, are noticed and well recorded.
Data Source(s): Annual Narrative, Law Enforcement Report
Data Collection Protocol: A Minimum Tools Analysis will be performed immediately after fire suppression, all tools and equipment used will be included in the undeveloped quality

"Minimum Tool Analysis" measure. Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.

1-2. Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat

Baseline Data Value [2012]: 3
Frequency: 1 yr.
Context: Many agency and non-agency research, survey, and monitoring projects take place on the Refuge that include, but are not necessarily exclusive to the Wilderness Area. This measure aims to capture a wide range of actions that happen throughout the Refuge, including the Wilderness Area, which have an impact on the biophysical environment of wilderness. Only projects, which significantly manipulate plants or wildlife habitat, will be considered. Strictly observational and interpretive projects do not have a significant effect on the biophysical environment. The untrammeled quality will be degraded if a significant number of research, survey, and monitoring projects are authorized in a single year.
Relevance: As per the intention of the indicator this measure captures all research, survey, and monitoring projects that pose significant manipulation to the biophysical environment.
Significant Change: >5
Data Adequacy: High – all authorized research, survey, and monitoring performed in wilderness is well documented.
Data Source(s): SUPs, Annual Narrative
Data Collection Protocol: SUPs (Special Use Permits) can be approved by Refuge staff for non-agency research, survey, or monitoring projects conducted on the Refuge. Professional judgment must be used to determine if the research causes a disturbance in the Wilderness. The project information section of the SUP will state which projects include the Wilderness Area. Electronic copies of all SUPs and Annual Narratives can be found at – Special Use Permit and Annual Narratives.

1-3. Number of permitted special uses that manipulate the biophysical environment

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: This measure includes all uses of the Wilderness approved by Refuge management, which do not fit the general authorized uses of the Mingo Wilderness. Only special uses beyond approved scientific research, survey, and monitoring projects that affect the biophysical environment will be considered for this measure. The untrammeled quality will be degraded if a significant number (>5) of non-research SUPs are authorized in a single year.
Relevance: This measure is relevant to the indicator because it tracks specific authorized uses that manipulate the biophysical environment and impact the untrammeled quality.

Significant Change: >5
Data Adequacy: High – an SUP must be completed and approved by Refuge staff before any authorized special uses of wilderness can commence.
Data Source(s): SUPs, Annual Narrative
Data Collection Protocol: Follow the protocol for measure 1-2, count all special uses authorized for actions unrelated to research, survey, or monitoring projects.

1-4. Number of actions taken to chemically immobilize, capture, remove, collar, band, and/or mark animals within the wilderness boundary

Baseline Data Value [2012]: 1
Frequency: 1 yr.
Context: Various agency and non-agency projects have involved the chemical immobilization, capture, removal, collaring, banding, and marking of animals on the Mingo Refuge. Recent examples of this include baited feral hog snares and traps, and the release of alligator gar with transmitters. This measure goes beyond scientific research associated with manipulations to animal habitat and focuses on these specific actions that have a direct effect on animals. The untrammeled quality will be degraded if a significant number of actions to chemically immobilize, capture, remove, collar, band and/or mark animals within the wilderness boundary are authorized. At the time of the baseline assessment, 1 action to capture and remove a feral hog was executed.
Relevance: This measure is relevant to the indicator because it tracks influences on animals inside the wilderness, which indicates a manipulation in the biophysical environment, thus impacting the untrammeled quality.
Significant Change: >5
Data Adequacy: High – all actions
Data Source(s): SUP, Annual Narrative, Wildlife Biologist
Data Collection Protocol: Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.

Releasing an alligator gar with a tracking device on the Refuge (USFWS)

1-5. Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: Known unauthorized actions are limited within wilderness. This measure would allow flexibility to monitor any unauthorized actions as they may arise. This measure tracks unauthorized actions rather than only tracking violations because some actions may not be citable yet still be unauthorized actions that trammel the Wilderness. The untrammeled quality is degraded if the number of unauthorized actions that manipulate the biophysical environment increases.
Relevance: The measure is relevant to the indicator because it tracks large-scale unauthorized actions manipulating the biophysical environment.
Significant Change: Any
Data Adequacy: This measure is based on the number of known incidences and therefore is dependent on the effort of law enforcement. An increase in monitoring/enforcement presence on the Wilderness Area may result in higher detected unauthorized actions.
Data Source(s): LEO Report
Data Collection Protocol: Measures monitored by Refuge law enforcement officials are recorded as "incidents". In the case of wilderness character monitoring, "incidents" will be considered the same as "actions". Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.

Natural Quality *Wilderness ecological systems are substantially free from the effects of modern civilization.*		
Monitoring Question	**Indicator**	**Measure**
What are the trends in terrestrial, aquatic, and atmospheric natural resources inside wilderness?	Plant and animal species and communities	2-1. Non-native vertebrate species
		2-2. Non-native plant species
		2-3. Presence of T & E species
	Physical Resources	2-4. Air quality
		2-5. Number of contaminants above EPA guidelines
		2-6. Water quantity
What are the trends in terrestrial, aquatic, and atmospheric natural processes inside wilderness?	Biophysical Processes	2-7. Climate change parameters

2-1. Non-native vertebrate species

Baseline Data Value [2012]: 9
Frequency: 1 yr.
Context: Non-native vertebrate species have been sighted on the Mingo Refuge in recent years. However, the abundance of these species is yet to be quantified. If the number of known non-native vertebrate species increases, the natural quality will be degraded. At the time of this baseline assessment, the following lists all non-native vertebrate species found on the Refuge and potentially in wilderness:

Table 3. Non-native vertebrate species found on the Mingo Refuge.

Scientific Name	Common Name
Sus scrofa	Feral Hog
Strunus vulgaris	European Starling
Hypophthalmichthys nobilis	Bighead Carp
Passer domesticus	House Sparrow
Myocastor coypus	Nutria (Coypu)
Cygnus olor	Mute Swan
Streptopelia decaocto	Eurasian Collared Dove
Felis catus	Domestic Cat
Canis lupus	Domestic Dog

Relevance: This measure is relevant to the indicator because it monitors selected invasive and non-native vertebrate species that impact the natural quality of wilderness.
Significant Change: Any
Data Adequacy: High – all invasive species sighting are reported to the Refuge staff and well documented.
Data Source(s): Habitat Management Plan (HMP), Annual Narrative, Wildlife Biologist
Data Collection Protocol: Count all non-native vertebrate species that are confirmed to be on the Mingo Refuge and report the total number.

2-2. Non-native plant species

Baseline Data Value [2012]: 24%
Frequency: TBD
Context: At present, invasive non-native plant distribution in wilderness is moderate. However, many non-native plants possess the ability to shift native flora composition if not carefully monitored and managed. This often results in a loss of biodiversity, which can be detrimental to the entire wilderness ecosystem. If the percentage of wilderness containing non-native plant species increases, the natural quality will be degraded. At the time of this baseline assessment, the following list of invasive plant species are found on the Refuge and potentially in wilderness:

Table 4. Non-native (invasive) plant species found on the Mingo Refuge.

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

Relevance: This measure is relevant to the indicator because it monitors selected invasive and non-native plant species that impact the natural quality of wilderness.
Significant Change: TBD

Data Adequacy: Moderate – value is based on estimated level of invasive infestation Refuge-wide.
Data Source(s): Wildlife Biologist, HMP
Data Collection Protocol: To view the protocol used for the 2009-2010 invasive species survey refer to the Invasive Forest Plants Project Record located at: Invasive Forest Plants Project Record.
Notes: If the invasive forest plants monitoring protocol used to create the baseline value for this measure is adopted, certain aspects of the measure will need to be reformed. Significant change, frequency, and collection protocol cannot be established until a decision is made to adopt or refuse the monitoring plan.

2-3. Presence of T & E species

Baseline Data Value [2012]: 1
Frequency: 1 yr.
Context: The Wilderness may offer suitable habitat, temporary shelter or feeding grounds for threatened and endangered (T & E) species. A variation in the number of T & E species could certainly be caused by actions not under the control of the wilderness manager. Nonetheless, an increase in the number of T & E species in the Wilderness will be considered an improvement in the natural quality. If the species number decreases, it will indicate a degrading trend in the wilderness character, unless the species is delisted and no longer considered threatened or endangered.

At the time of the baseline assessment, there is one federally listed species that is known to occur on the refuge: the Indiana bat (*Myotis sodalis*). It is currently listed as endangered, and is potentially present on the refuge from April through October. The main habitat type for Indiana bats at Mingo are summer roost trees. The gray bat (*Myotis grisescens)* has been documented in Wayne County, Missouri. No gray bats have been confirmed on Mingo NWR. There is a slight chance gray bats may occasionally forage or use caves located on the South or West side of the refuge.
Relevance: This measure is relevant to the indicator because it tracks the number of sensitive wildlife and plant species.
Significant Change: Any
Data Adequacy: Moderate – there is a possibility that more T & E species exist in the Mingo Wilderness than are accounted for.
Data Source(s): HMP, Wildlife Biologist, USFWS Missouri list of T&E species
Data Collection Protocol: Only T & E species confirmed to be present on the Mingo Refuge will be included in this measure. Known T & E species found on a county by county basis in Missouri can be found at: FWS-Federally Listed Threatened, Endangered, Proposed, and Candidate Species. This database serves as a reference for T & E species established in Stoddard and Wayne Counties.

2-4. Air quality

Baseline Data Value [2009]:

Table 5. Air quality data and related condition.

Air quality metric	2009 value	Condition
Ozone air pollution	76.8 ppb	Significant Concern
Total nitrogen wet deposition	4.2 kg/ha	Significant Concern
Total sulfur wet deposition	4.4 kg/ha	Significant Concern
Visibility	12.7 dV	Significant Concern

Frequency: 5 yr.

Context: Air quality, while largely beyond the control of refuge management, is an important aspect of wilderness character. Diminishing air quality is a growing concern within the Mingo Wilderness Area in part because of proposed coal-burning power plants in the region that could further aggravate problems with haze and deposition of contaminants like mercury, nitrates, and sulfates emitted from their smokestacks. A significant decrease in any air quality metric will indicate an improving trend in the natural quality.

Relevance: This measure is relevant to the indicator in that it addresses effects on a physical resource and contributes to an evaluation and understanding of the natural quality.

Significant Change: Any increase or decrease resulting in a change in the "condition" of the data value according to the scoring range will be considered significant.

Data Adequacy: High – an air quality monitoring station is maintained by Refuge staff in close proximity to the Wilderness Area.

Data Source(s): FWS NWRS Branch of Air Quality

Data Collection Protocol: All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent the 5-year averages for each metric. Condition of the air quality related value is based on the following parameters:

Ozone:

- < 60 ppb - Good
- 61-75 - Moderate
- > 76 - Significant Concern

Visibility:

- < 2 dV - Good
- 2-8 - Moderate
- > 8 - Significant Concern

Total-N and S:

- <1 kg/ha - Good
- 1-3 - Moderate
- > 3 - Significant Concern

2-5. Number of contaminants above EPA guidelines

Baseline Data Value [2011]: 2
Frequency: 10 yr.
Context: Atmospheric pollutants can drastically affect the biota of an area, especially fish and amphibians, which are directly impacted by the build-up of pollutants in aquatic environments. Mercury (Hg), a particularly hazardous substance to every form of life, is accumulating in the biota of Mingo NWR. Predatory species on the Mingo Refuge, investigated in a 2007-2009 contaminants study, had consistently elevated levels of Hg in their tissues. Number of fish species showing concentrations of Hg above USEPA's consumption advisory level will be used to monitor Hg effects on the natural quality of the Mingo Wilderness. If there is an increase in the number of fish species added to this advisory list, the natural quality will be degraded. At the time of the baseline assessment bass and bowfin populations expressed concentrations of Hg above USEPA's consumption advisory level.
Relevance: This measure is relevant to the indicator because it represents effects of contaminated physical resources on the wilderness biota, and contributes to an evaluation and understanding of the natural quality.
Significant Change: Any
Data Adequacy: High – data is derived from a USFWS-Environmental Contaminants Program study. Adequacy of future data may vary depending on source.
Data Source(s): Wildlife Biologist, Baseline data is found at:
Data Collection Protocol: Contaminants research is inconsistent on the Mingo Refuge and therefore unpredictable as to which strata may be measured for contaminants from year to year. Data will be reported as a count of total fish species showing concentrations of Hg above the USEPA's consumption advisory level. To view the protocol used for the 2007-2009 contamination investigation refer to the FY10 Environmental Contaminants Program located at: 2010 Contaminants Report. To Missouri Department of Health and Senior Services – 2012 Missouri fish advisory may serve as a reference: Missouri Fish Advisory.
Notes: This measure is based on a 10-year frequency in hopes to obtain a consistent measure of one contamination parameter. Accumulation of Hg is fish is likely to be continually monitored because of the inherent risk to a variety of animal species and humans.

2-6. Water quantity

Baseline Data Value [2012]: TBD
Frequency: 1 yr.
Context: Manipulation of annual flooding in the Mingo Refuge is critical in achieving the Refuge's primary purpose to provide suitable habitat for migratory waterfowl. However, when not done correctly, sustained flooding of the Wilderness Area poses potential risks to forest health. If wilderness is flooded during the growing season, many tree species struggle to regenerate creating even aged timber stands. An increase in the number of days the Wilderness is flooded during the growing season will degrade the natural quality.

Relevance: This measure is relevant to the indicator because it addresses the direct manipulation of a physical resource, and contributes to an evaluation and understanding of the natural quality.
Significant Change: >60
Data Adequacy: High – during periods of flooding, the water level of Monopoly Marsh is frequently recorded.
Data Source(s): Wildlife Biologist, Monopoly Marsh stage data
Data Collection Protocol: Calculate the number of days the Monopoly Marsh water monitoring station reports water levels ≥336 MSL (mean sea level) during the growing season. For the purpose of consistency the growing season will be the dates of March 16 through November 20, a period of 250 days. This is the average growing season for southeastern Missouri determined by the National Climatic Data Center.

2-7. Climate change parameters

Baseline Data Value [2012]: TBD
Frequency: 1
Context: Attempting to monitor climate change and its widespread effects on wildlife is a national priority for many organizations, but there is no set protocol for how to do this in a cohesive manner. While the weather data measures described here are admittedly simplified proxies for representing climate change, they are an efficient means for Refuge staff to gather data directly linked to climate change and weather patterns. A significant deviation from the historic average will degrade the natural quality.
Relevance: This measure is relevant to the indicator in that it addresses effects on a biophysical process and contributes to an evaluation and understanding of the natural quality.
Significant Change: 10% deviation from historical average
Data Adequacy: High
Data Source(s): TBD
Data Collection Protocol: Analyze weather data for the following records: mean summer temperature, mean winter temperature, and total annual precipitation. Summer is defined as the months of June, July, and August. Winter is defined as the months of December, January, and February. Mean summer and winter temperatures should be calculated for each year. These seasonal means are then averaged over a five-year time interval. Since the year changes in the middle of the winter season, mean winter temperatures for any given year are calculated using data from December of the previous year and data from January and February of the target year. Total annual precipitation is calculated and seasonal totals are averaged over a five-year time interval.

Undeveloped Quality *Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation.*		
Monitoring Question	**Indicator**	**Measure**
What are the trends in non-recreational development and mechanization inside wilderness?	Non-recreational installations, structures, developments	3-1. Number of authorized physical structures, installations, or developments
		3-2. Miles of administrative travel routes and access roads adjoined to the wilderness
		3-3. Number of unauthorized physical structures, installations, or developments
	Inholdings	3-4. Acres of inholdings within the Wilderness
What are the trends in mechanization inside wilderness?	Use of motorized vehicles, motorized equipment, or mechanical transport	3-5. Number of actions requiring a minimum tool analysis
		3-6. Miscellaneous unauthorized uses

3-1. Number of authorized physical structures, installations, or developments

Baseline Data Value [2012]: 15
Frequency: 1 yr.
Context: Research is a priority at Mingo NWR and there are often both internal and external research projects that include the Wilderness Area. Along with standard monitoring of aspects such as water level; installations, structures and developments are often associated with such efforts. While these projects are often executed with the intent to further our understanding of the natural features and processes inside the wilderness or greater ecosystem, it is vital that we monitor these anthropogenic factors for impact on the wilderness character. A significant increase in the number of physical structures, installations, and developments in the Mingo Wilderness during the course of a year will degrade the undeveloped quality. At the time of the baseline assessment, the following list of physical structures have been sited within the wilderness boundary:

Table 6. Physical structures found in the Mingo Wilderness.

Structure	Count
Water monitoring station (permanent, Refuge owned)	1
Acorn traps (temporary, research purposes)	8
Trail camera (temporary, hog study)	5
Feral hog snare (temporary)	1

Relevance: This measure is relevant to the indicator in that it addresses an increase or decrease of physical developments, installations, or structures within the Wilderness Area, and contributes to an evaluation and understanding of the undeveloped quality
Significant Change: TBD
Data Adequacy: High – all authorized structures, installations, and developments are well documented by Refuge staff.
Data Source(s): Annual Report, Minimum Tool Analysis, SUP's
Data Collection Protocol: This measure consists of a count of each structure, development, or installation found inside the Wilderness. A structure, development, or installation includes all permanent, semi-permanent, and temporary entities. Any length of time that a structure, installation, or development is inside the Wilderness boundary will consider it eligible for inclusion in this measure.
Notes: A significant change will be determined after a 5-year average is obtained for authorized physical structures, installations, and developments.

3-2. Miles of administrative travel routes and access roads adjoined to the Wilderness

Baseline Data Value [2012]: 16.8 miles
Frequency: 10 yr.
Context: There are currently multiple travel routes and access roads used by refuge staff and the public which impact the wilderness. All Refuge roads technically lay outside the wilderness boundary due to a "cherry stemmed" approach used for the original description of the Mingo Wilderness boundary. These roads still pose a significant impact to the undeveloped character of the Wilderness. The undeveloped quality of the Wilderness will be improved if the mileage of travel routes and access roads adjoined to the Wilderness is decreased.
Relevance: This measure is relevant to the indicator in that it addresses an increase or decrease of physical developments within the Wilderness Area.
Significant Change: Any
Data Adequacy: High – all travel routes and access roads on the refuge are known and
Data Source(s): Refuge GIS data, Annual Narratives
Data Collection Protocol: Calculate the total miles of administrative travel routes and access roads adjacent to the Wilderness Area. This includes the following sections of road:

- Ozark Highland Auto Tour Route (including Ditch 6 Road)
- All of Ditch 5 Road
- All of Ditch 4 Road
- Flatbanks Road (from the bridge to the boat launch)

3-3. Number of unauthorized physical structures, installations, or developments

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: Known unauthorized physical structures, installations, or developments are limited within wilderness. This measure would allow flexibility to monitor any entity as they may arise. The undeveloped quality is degraded if the number of unauthorized physical structures, installations, or developments increases.
Relevance: This measure is relevant to the indicator in that it addresses any unauthorized physical developments, installations, or structures within the Wilderness Area, and contributes to an evaluation and understanding of the undeveloped quality.
Significant Change: Any
Data Adequacy: This measure is based on the number of known incidences and therefore is dependent on the effort of law enforcement. An increase in monitoring/enforcement presence on the Wilderness Area may result in higher detected unauthorized actions.
Data Source(s): LEO Report, Refuge staff
Data Collection Protocol: Any known unauthorized physical structure, installation, or development is likely to be included in the LEO Report if the person(s) responsible are discovered. If an unauthorized entity is found in any other circumstance it is likely to be reported to Refuge management. Count the total unauthorized structures, installations or developments for the purposes of this measure.

3-4. Acres of inholdings within the Wilderness

Baseline Data Value [2012]: 0
Frequency: 10 yr.
Context: There are currently no private or public inholdings within the Mingo Wilderness. This is highly unlikely to change given that the entire wilderness is under the control of the Federal government and protected under the Wilderness Act of 1964. This measure has low significance to this particular wilderness and has been included only in order to represent this indicator within the wilderness character monitoring framework.
Relevance: A summation of the area of inholdings is directly linked to the indicator. Many wilderness areas across the U.S. have acres of privately or publicly owned land inside their borders. When the land management practices of inholdings are inconsistent with refuge goals there are obvious impacts to the Wilderness Area.
Significant Change: Any
Data Adequacy: High – the Mingo Refuge is composed of a single tract of land with no inholdings.
Data Source(s): Refuge staff, GIS data
Data Collection Protocol: Total the acreage of inholdings within wilderness every 10 years.

3-5. Number of actions requiring a minimum tool analysis

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: This measure covers all authorized motorized vehicles, motorized equipment, or mechanical transport that enters the Mingo Wilderness. A Minimum Tool Analysis is required during the preparation for management projects, research, or other. Minimum Tool Analyses are also required following emergency circumstances such as wildfires or serious injury to visitors. A significant increase in the number of actions requiring a Minimum Tool Analysis will degrade the undeveloped quality.
Relevance: This measure is relevant to the associated indicator in that it accounts for authorized use of motorized vehicles, motorized equipment, or mechanical transport that occurs in the Wilderness, and contributes to an evaluation and understanding of the undeveloped quality of the wilderness.
Significant Change: TBD
Data Adequacy: High – all actions that require a Minimum Tool Analysis are recorded with detailed description of the associated activity and location.
Data Source(s): Refuge data files – Minimum Tool Analysis
Data Collection Protocol: The following processes can serve as a general outline in accounting for all related actions:

- Review of all minimum tool analyses conducted over the past fiscal year.
- Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character,* to determine what is counted as one action or many.
- Total all actions requiring a Minimum Tool Analysis.

Notes: A significant change will be determined after a 5-year average is obtained for actions requiring a Minimum Tool Analysis.

Using dynamite to clear beaver dams (USFWS)

3-6. Miscellaneous unauthorized uses

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: The intention of this measure is to cover all unauthorized uses of the Wilderness relating to the use of mechanical transport, motorized vehicles or motorized equipment. The undeveloped quality is degraded if the number of unauthorized actions increases.
Relevance: The measure is relevant to the indicator because it tracks all unauthorized uses of mechanical transport, motorized vehicles, or motorized equipment that take place in the Wilderness Area.
Significant Change: Any
Data Adequacy: Moderate – this measure is based on the number of known incidences and therefore is dependent on the effort of law enforcement. An increase in monitoring/enforcement presence on the Wilderness Area may result in higher detected unauthorized actions.
Data Source(s): LEO Report
Data Collection Protocol: Measures monitored by refuge law enforcement officials are recorded as "incidents". In the case of wilderness character monitoring, "incidents" will be considered the same as "actions". Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.

Solitude or Primitive and Unconfined Recreation Quality *Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.*		
Monitoring Question	**Indicator**	**Measure**
What are the trends in outstanding opportunities for solitude inside wilderness?	Remoteness from sights and sounds of people inside the wilderness	4-1. Visitors to wilderness area
	Remoteness from occupied and modified areas outside of the wilderness	4-2. Percent of wilderness away from access or travel routes
	Facilities that decrease self-reliant recreation	4-4. User-created recreation facilities
	Management restrictions on visitor behavior	4-5. Management restrictions

4-1. Visitors to wilderness area

Baseline Data Value [2012]: 9,176
Frequency: 1 yr.
Context: Annual visits to the Refuge are currently estimated using a series of traffic counters placed at key locations throughout the Refuge. The traffic counters that best represent the visitors to the Wilderness Area are located in the Flat Banks area and near Stanley Creek along the auto tour route. Annual totals for each traffic counter are multiplied by an estimated average of occupants per vehicle to derive the total number of visitors. A significant increase in the total number of annual visitors to the Wilderness Area will degrade the solitude or primitive and unconfined recreation quality.
Relevance: This measure is relevant to the indicator because it tracks the amount of visitor use and therefore the amount of actual or potential recreation use that diminishes opportunities for solitude.
Significant Change: 10% deviation from 5-year average
Data Adequacy: Moderate – this is only an estimate of the annual total for visitors to the Wilderness based on a vehicle count. This does not account for how many visitors physically enter the Wilderness on foot.
Data Source(s): Visitor Services Park Ranger, Traffic Counter Data
Data Collection Protocol: Calculate the total visits persons recorded by the Auto tour Route Entrance and Flatbanks Road traffic counters for the fiscal year.
Notes: The 2008-2012, 5-year average for total visitors to the Wilderness Area = 10,614.

4-2. Percent of wilderness away from access or travel routes

Baseline Data Value [2012]: 61.6%
Frequency: 10 yr.
Context: All Refuge access and travel routes are technically excluded from the wilderness in the original boundary description set-forth by the Mingo Wilderness Management Plan. These travel routes have the most impact on the feeling of remoteness from occupied and modified areas outside of the wilderness. Due to the rural location of the Mingo Refuge, other Refuge visitors and administrative use of Refuge roads pose the only threat to a feeling of solitude from outside influences. This measure aims to capture the amount of wilderness where these developments have little to no influence on the visitor experience. A decrease in percentage of wilderness away from access or travel routes will degrade the solitude or primitive and unconfined recreation quality.
Relevance: This measure is relevant to the associated indicator because it relates to the remoteness from sights and sounds of people inside the wilderness, and contributes to an evaluation and understanding of the undeveloped quality of the wilderness.
Significant Change: Any
Data Adequacy: Moderate – the measure only accounts for disturbance caused by vehicle traffic on adjacent Refuge roadways and does not include over flights.

Data Source(s): Refuge GIS data

Data Collection Protocol: A spatial analysis, using Refuge GIS data, must be performed to calculate the percentage of wilderness away from access or travel routes. Utilizing ArcGIS, an analyst must perform the following task in order to calculate the percentage of wilderness away from access or travel routes:

1. Acquire GIS layers for all travel routes
2. Create a buffer of appropriate size around each travel route.
3. Subtract the buffers from the wilderness polygon using the erase tool.
4. Calculate the area of remaining wilderness after all the travel route buffers have been erased.

The following distances away from access and travel routes were subjectively chosen for the Mingo Wilderness:

- Open automobile roads – ¼ miles

Refer to the guidelines set forth on pages 188-191 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character* for further information.

4-3. User-created recreation facilities

Baseline Data Value [2012]: 0

Frequency: 1 yr.

Context: This measure includes the number and type of installed or built facilities, including trails and travel routes, not approved by the land management agency, that reduce opportunities for primitive and unconfined recreation. User-created recreation facilities are currently of little concern for the Refuge management. However, this issue has potential to become more prevalent with the recent reformation of the Refuge Hunt Plan. If the proposed action to expand the General Hunt Area to include the area between Ditches 4 and 6 (Wilderness Area) is authorized, it will increase the amount of visitor recreation use. Deer hunters often utilize portable stands, which under the new hunt plan, will be required to be removed daily after each use. Unapproved use of portable deer stands, the employment of permanent stands, or other user-created recreation facilities found in wilderness will degrade the solitude and unconfined recreation quality.

Relevance: This measure is relevant to the associated indicator because it relates to facilities that decrease self-reliant recreation wilderness, and contributes to an evaluation and understanding of the undeveloped quality of the wilderness.

Significant Change: Any

Data Adequacy: Moderate – this measure is based on the number of known incidences and therefore is dependent on the effort of law enforcement. An increase in monitoring/enforcement presence on the Wilderness Area may result in higher detected unauthorized actions.

Data Source(s): LEO Report, Refuge staff

Data Collection Protocol: Calculate the total number of user-created recreation facilities found in wilderness for the fiscal year.

4-4. Management restrictions

Baseline Data Value [2012]: 23
Frequency: 5 yr.
Context: Based on the Wilderness Act of 1964, and reinforced through the operational definitions proposed by this monitoring program, outlets for primitive and unconfined recreation represent a major contributing quality to the overall character of wilderness. Management of wilderness includes the creation and enforcement of visitor use/behavior restrictions, which ultimately affect the quality of a visitor's recreational experience. This measure indicates the scope of management restrictions for the Mingo Wilderness that function beyond the limitations determined for all wilderness areas by the Wilderness Act. An increase in the management restrictions index indicates an improving trend for the solitude and unconfined recreation quality.
Relevance: This measure is relevant to the associated indicator in that it addresses management restrictions on visitor behavior, which contributes to enhanced solitude, and contributes to an evaluation and understanding of the solitude or primitive and unconfined quality of wilderness.
Significant Change: Any
Data Adequacy: High – all restrictions in the wilderness are documented in a variety of Refuge documents and enforced by Refuge management.
Data Source(s): CCP, HMP, Hunt Plan
Data Collection Protocol: Table 7, sourced from the Forest Service's *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*, contains a list of management restrictions placed on visitor behavior, as well as scores assigned based on the degree of restriction, and the significance of their impact on opportunities for primitive and unconfined recreation. When scoring the restrictions of a given wilderness, a geographical weight is also applied: 1 = restriction applies only to a portion of the wilderness; 2 = restriction applies throughout entire wilderness. Based on the stipulations of management policy within a given monitoring period, the wilderness will be scored, and the total score will serve as the data value. Table 7 illustrates this scoring process for the Mingo Wilderness based on management restrictions in place at the time of this report.

Table 7. Index of management restrictions for the Mingo Wilderness.

Category	Type of Restriction	Score	Geographic Weight (1= subarea, 2= entire wilderness)	Index Score
Small game hunting during state season	No restrictions	0		
	Permitted but restricted	1		
	Not permitted	2	2	4
Big game hunting during state season (Deer only)	No restrictions	0		
	Permitted but restricted	1	1	2
	Not permitted	2		

Fishing	No restriction	0		
	Permitted but restricted	1	1	2
	Prohibited	2		
Fees	No fees	0		
	Fees charged of selected user type	1		
	Fees charged of all visitors	2	2	4
Permits for general use	No permit or registration	0	-	0
	Voluntary self-registration	1		
	Mandatory; non-limiting registration	2		
	Mandatory; use limited	3		
Human waste	No regulation	0	-	0
	Pack out required	1		
Length of stay	No restrictions	0		
	Length of stay limited	1	2	3
Group size limit	No restrictions	0	-	0
	Group size limits in place	1		
Horseback riding/domesticated animals	No restrictions	0		
	Permitted but restricted	1		
	Prohibited	2	2	4
Camping	No restrictions	0		
	Permit required	1		
	Prohibited	2	2	4
			Total Score =	**23**

Other Features Quality *Wilderness "…may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."*		
Monitoring Question	**Indicator**	**Measure**
What are the trends in loss of geological and cultural resources?	Loss of paleontological or geological resources	5-1. Number of unauthorized removals of paleontological or geological resources
	Loss of statutorily protected cultural resources	5-2. Number of unauthorized removals of cultural resources

5-1. Number of unauthorized removals of paleontological or geological resources

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: The unauthorized removal of paleontological or geological resources
Relevance: This measure is relevant to the indicator because it accounts for losses of paleontological or geological resources, and contributes to an evaluation and understanding of the other features quality of wilderness.
Significant Change: Any
Data Adequacy: Moderate – this measure is based on the number of known incidences and therefore is dependent on the effort of law enforcement. An increase in monitoring/enforcement presence on the Wilderness Area may result in higher detected unauthorized actions.
Data Source(s): LEO Report
Data Collection Protocol: Calculate the total number of unauthorized removals of paleontological or geological resources in wilderness for the fiscal year.

5-2. Number of unauthorized removals of cultural resources

Baseline Data Value [2012]: 0
Frequency: 1 yr.
Context: The Refuge has completed archeological surveys for almost 7,200 acres on the Refuge, including the Mingo Job Corps campus prior to its transfer to the U.S. Forest Service. The surveys and other sources have identified more than 140 cultural resources sites on the Refuge, including some located in the Wilderness. Cultural resources are not only important parts of the nation's heritage, but are also an integral part of the wilderness character. Any unauthorized removal of cultural resources in the Wilderness will degrade the other features quality.
Relevance: This measure is relevant to the indicator because it accounts for losses of cultural resources, and contributes to an evaluation and understanding of the other features quality of wilderness.
Significant Change: Any
Data Adequacy: Moderate – this measure is based on the number of known incidences and therefore is dependent on the effort of law enforcement. An increase in monitoring/enforcement presence on the Wilderness Area may result in higher detected unauthorized actions.
Data Source(s): LEO Report
Data Collection Protocol: Calculate the total number of unauthorized removals of cultural resources in wilderness for the fiscal year.

Dropped Measures

Table 8. Dropped measures and reasons for rejection.

UNTRAMMELED QUALITY	
Measure	Reason(s) measure was dropped
Number of actions to manipulate plants, wildlife, insects, fish, pathogens, soil, water, or fires	Any authorized management of wilderness is monitored through the other measures already included under the "actions authorized by the federal manager…" indicator.
Acreage of wilderness burned due to human ignited fires	This is covered in the more inclusive chosen measure for the "actions not authorized by the federal manager…" indicator. Due to the moist environment of the Mingo Wilderness, wildfires are highly unlikely.
NATURAL QUALITY	
Measure	Reason(s) measure was dropped
Deer surveys or harvest amounts	All of these measures scored high for reliability during the prioritization process due to long-term efforts to monitor each set. However, overall importance and vulnerability of these measures was ranked low among staff. The three measures chosen to represent the "plant and animal species…" indicator truly embody the subjects most likely to impact the wilderness character.
Breeding bird surveys	
Snake mortality rate	
Number of bat species	
Pathways for invasives	This is currently a non-issue on the Mingo Refuge. There is also a lack of sufficient data that would be needed to monitor pathways.
Landscape fragmentation	Landscape fragmentation is not a current concern for refuge staff, and is unlikely to become an issue in the future. The Mingo Wilderness is essentially a continuous land parcel surrounded by a buffer of Refuge-owned land on all sides.
UNDEVELOPED QUALITY	
Measure	Reason(s) measure was dropped
Index of abandoned structures	This is a non-issue in the Mingo Wilderness. The only structures remaining from previous ownership are located outside of the Wilderness boundary. Due to the relatively small size of the Wilderness, it is unlikely that any unknown structures exist.
Authorized administrative uses	All authorized uses of motorized vehicles, motorized equipment, or mechanical transport, including emergency uses, are documented using Minimum Tool Analyses. An index of actions requiring a Minimum Tool Analysis was chosen to satisfy the indicator.
Authorized emergency uses	
SOLITUDE, PRIMITIVE & UNCONFINED RECREATION QUALITY	
Measure	Reason(s) measure was dropped
Viewshed	These subjects have been measured in the past and deemed a non-issue for the Mingo Wilderness. Due to the buffer of refuge land surrounding the wilderness, these are likely to stay a non-issue.
Soundscape	

Night sky light pollution	The Mingo Wilderness is located in a very rural area and sky light pollution is not relevant. The refuge is also closed a half hour past sunset, so it is unlikely to affect visitor experience.
Travel routes adjacent to wilderness	The measure “percent of wilderness away from access…” was moved to satisfy the indicator. The measures were very similar and it was decided that only one was needed.
Agency-provided recreation facilities	There are no existing recreation facilities in the wilderness provided by FWS. This is highly unlikely to change.

Conclusions

The suite of measures adequately represents the wilderness character of the Crab Orchard NWR Wilderness. A total of 25 measures are incorporated into the monitoring protocol (Untrammeled quality = 5, Natural quality = 7, Undeveloped quality = 6, Opportunities for Solitude or Primitive and Unconfined Recreation quality = 5, and Other Features quality = 2). This list was created in anticipation that it will be feasible for Refuge staff to monitor over time. Most measures were designed to satisfy the indicators by assessing broad trends in wilderness. There are opportunities to incorporate other measures through relatively easy means if new monitoring projects are established that include wilderness.

For many years the largest threat to the character of the Mingo Wilderness was poor water management. Tree regeneration was suppressed due to early flooding and extended periods of saturation. Even-aged stands of hardwood trees are currently established throughout the Wilderness Area with little to no regeneration aside from softwood species. If this trend were to continue, a permanent shift in the forest ecosystem is possible. Projects in other areas of the refuge, Pool 8, have been initiated to help spur regeneration through the creation of gaps in the tree canopy. A water quantity measure was created to help monitor the effect of water manipulation on the wilderness character. The Wilderness is managed to avoid having standing water when trees are actively growing.

Another concern for the Mingo Wilderness is increasing presence of invasive vertebrate species, particularly feral hogs. Feral hogs are extremely invasive and can adapt to a variety of environments. Feral hogs pose a threat to native biota because they reproduce quickly and compete for food sources. Projects are currently being conducted to assess the extent of this hog invasion and to help guide future management decisions.

The wilderness character monitoring strategy described in this report adequately captures the character of the Mingo Wilderness. The measures selected, although not exhaustive, thoroughly capture the most important qualities of the Mingo Wilderness’ character. This was accomplished because of the valuable assistance offered by Refuge staff. Wilderness stewardship is a high priority at the Mingo Refuge and any indirect administrative degradation is well-thought-out before authorized.

Appendix A: Priority Ranking of Measures

In each row, write the potential measure in the left column under the appropriate indicator. Add or delete rows as needed. Use the criteria and ranking guide below to create an overall score for each measure. If the combined score for criteria A and B is ≤ 2, STOP and do not score criteria C and D. Those measures with the highest overall scores should be the highest priority for assessing trends in wilderness character.

A. Level of significance (the measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness):
High = 3 points, Medium = 2 points, Low = 1 point

B. Level of vulnerability (measures an attribute of wilderness character that currently is at risk, or might likely be at risk over 10-15 years): High = 3 points, Medium = 2 points, Low = 1 point

C. Degree of reliability (the measure can be monitored accurately with a high degree of confidence, and would yield the same result if measured by different people at different times):
High = 3 points, Medium = 2 points, Low = 1 point

D. Degree of feasibility (the measure is related to an existing effort or could be monitored without significant additional effort):
High = 1 point, Low = 0 point (if 0 is given, do not use)

POTENTIAL MEASURE	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	A. Significance	B. Vulnerability	C. Reliability	D. Feasibility	
UNTRAMMELED QUALITY					
Indicator: Authorized actions that manipulate the biophysical environment **Measure:** Number of actions to manage fire (natural ignitions and human-caused)	1	2	3	1	7
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fires	3	1	3	1	8
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat	2	1	3	1	7
Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of permitted special uses that manipulate the biophysical environment	3	1	3	1	8

Indicator: Authorized actions that manipulate the biophysical environment **Measure**: Number of actions taken to chemically immobilize, capture, remove, collar, band, and/or mark animals within the wilderness boundary	3	2	3	1	9
Indicator: Unauthorized actions that manipulate the biophysical environment **Measure:** Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	3	2	1	1	7
Indicator: Unauthorized actions that manipulate the biophysical environment **Measure:** Acreage of wilderness burned due to human ignited fires	2	1	3	1	7
NATURAL QUALITY					
Indicator: Plant and animal species and communities **Measure:** Deer surveys or harvest amounts	1	1			X
Indicator: Plant and animal species and communities **Measure:** Breeding bird surveys	1	1			X
Indicator: Plant and animal species and communities **Measure:** Snake mortality rate	1	1			X
Indicator: Plant and animal species and communities **Measure:** Number of bat species	1	1			X
Indicator: Plant and animal species and communities **Measure:** Non-native vertebrate species	2	3	2	1	8
Indicator: Plant and animal species and communities **Measure:** Non-native plant species	2	3	2	1	8
Indicator: Plant and animal species and communities **Measure:** Presence of T & E species	2	3	2	1	8
Indicator: Physical resources **Measure:** Air quality	3	3	3	1	10
Indicator: Physical resources **Measure:** Number of contaminants above EPA guidelines	3	3	2	1	9
Indicator: Physical resources **Measure:** Water quantity	3	3	2	1	9
Indicator: Biophysical processes **Measure:** Climate change parameters	3	2	3	1	9

Indicator: Biophysical processes **Measure:** Pathways for invasives	1	2	1	0	4
Indicator: Biophysical processes **Measure:** Landscape fragmentation	1	1			X
UNDEVELOPED QUALITY					
Indicator: Non-recreational structures, installations, or developments **Measure:** Number of authorized physical structures, installations, or developments	2	1	3	1	7
Indicator: Non-recreational structures, installations, or developments **Measure:** Miles of administrative travel routes and access roads adjoined to the wilderness	2	2	3	1	8
Indicator: Non-recreational structures, installations, or developments **Measure:** Number of unauthorized physical structures, installations, or developments	3	2	2	1	8
Indicator: Non-recreational structures, installations, or developments **Measure:** Index of abandoned structures	1	1			X
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Authorized administrative uses	1	1			X
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Miscellaneous unauthorized uses	3	2	2	1	8
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Authorized emergency uses	1	1			X
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport **Measure:** Number of actions requiring a minimum tool analysis	3	1	3	1	8
SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY					
Indicator: Remoteness from sights and sounds of people inside the wilderness **Measure:** Visitors to wilderness areas	2	2	2	1	7
Indicator: Remoteness from sights and sounds of people inside the wilderness **Measure:** Percent of wilderness away from access or travel routes	3	2	3	1	9

Indicator: Remoteness from sights and sounds of people inside the wilderness **Measure:** Viewshed	1	1			X
Indicator: Remoteness from sights and sounds of people inside the wilderness **Measure:** Soundscape	1	1			X
Indicator: Remoteness from occupied and modified areas outside the wilderness **Measure:** Travel routes adjacent to wilderness	2	2	3	1	8
Indicator: Remoteness from occupied and modified areas outside the wilderness **Measure:** Night sky light pollution	1	1			X
Indicator: Facilities that decrease self-reliant recreation **Measure:** Agency-provided recreation facilities	1	1			X
Indicator: Facilities that decrease self-reliant recreation **Measure:** User-created recreation facilities	2	2	2	1	7
Indicator: Management restrictions on visitor behavior **Measure:** Management restrictions	3	2	3	1	9
Other Features Quality					
Indicator: Loss of cultural resources **Measure:** Number of unauthorized removals of paleontological or geological resources	2	3	2	1	8
Indicator: Loss of paleontological resources **Measure:** Number of unauthorized removals of cultural resources	3	3	2	1	9

Appendix B: Summary of Effort Required for Wilderness Character Monitoring

Quality	Indicator	Measure	Estimated time required to gather and interpret data (1 = minimal, 2 = moderate, 3 = high)	Comments
Untrammeled	Authorized actions	1.1 Number of actions to suppress naturally ignited fire within wilderness	1	
Untrammeled	Authorized actions	1.2 Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat	3	This measure requires researching all current and ongoing projects and the use of professional judgment in determining the associated impact.
Untrammeled	Authorized actions	1.3 Number of permitted special uses that manipulate the biophysical environment	3	This measure requires review of all authorized SUPs to determine the uses related to wilderness.
Untrammeled	Authorized actions	1.4 Number of actions taken to chemically immobilize, capture, remove, collar, band, and/or mark animals within the wilderness boundary	2	This information is more likely to be readily known by staff, review of current external and internal projects may still be necessary.
Untrammeled	Unauthorized actions	1.5 Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	1	

Quality	Indicator	Measure	Estimated time required to gather and interpret data (1 = minimal, 2 = moderate, 3 = high)	Comments
Natural	Plant/animal species/communities	2-1. Non-native vertebrate species	1	
Natural	Plant/animal species/communities	2-2. Non-native plant species	3	This measure originally required an extensive survey of the Mingo Refuge, if this protocol is adopted data collection will be time intensive.
Natural	Plant/animal species/communities	2-3. Presence of T & E species	1	
Natural	Physical resources	2-4. Air quality	1	
Natural	Physical resources	2-5. Number of contaminants above EPA guidelines	3	This measure requires scientific research, including fish tissue sampling, time commitment for reviewing research will be moderate.
Natural	Physical resources	2-6. Water quantity	2	This measure requires some data interpretation.
Natural	Biophysical processes	2-7. Climate change parameters	3	This measure requires some data interpretation.
Undeveloped	Non-recreational structures, installations, and developments	3-1. Number of authorized physical structures, installations, or developments	2	

Quality	Indicator	Measure	Estimated time required to gather and interpret data (1 = minimal, 2 = moderate, 3 = high)	Comments
Undeveloped	Non-recreational structures, installations, and developments	3-2. Miles of administrative travel routes and access roads adjoined to the wilderness	2	This measure requires GIS analysis.
Undeveloped	Non-recreational structures, installations, and developments	3-3. Number of unauthorized physical structures, installations, or developments	1	
Undeveloped	Inholdings	3-4. Acres of inholdings within the wilderness	1	
Undeveloped	Use of motorized vehicles, motorized equipment, or mechanical transport	3-5. Number of actions requiring a minimum tool analysis	2	This measure requires a review of all minimum tool analysis completed over the fiscal year.
Undeveloped	Use of motorized vehicles, motorized equipment, or mechanical transport	3-6. Miscellaneous unauthorized uses	1	
Solitude +	Remoteness from sights and sounds of people inside the wilderness	4-1. Visitors to wilderness area	3	This measure requires some data interpretation and comparison.

Quality	Indicator	Measure	Estimated time required to gather and interpret data (1 = minimal, 2 = moderate, 3 = high)	Comments
Solitude +	Remoteness from occupied and modified areas outside of the wilderness	4-2. Percent of wilderness away from access or travel routes	2	This measure requires GIS analysis.
Solitude +	Facilities that decrease self-reliant recreation	4-3. User-created recreation facilities	1	
Solitude +	Management restrictions on visitor behavior	4-4. Management restrictions	2	This measure requires review of current Refuge policies.
Other Features	Loss of paleontological or geological resources	5-1. Number of unauthorized removals of paleontological or geological resources	1	
Other Features	Loss of statutorily protected cultural resources	5-2. Number of unauthorized removals of cultural resources	1	

Title of staff involved in identifying, prioritizing, and selecting measures	Staff time to identify, prioritize, and select measures (hours)	Comments
Refuge Manager	8	Consulted in formal meetings for identification, prioritization and ultimate selection and definition of measures.

Assistant Refuge Manager	15	Consulted in formal and informal meetings for identification, prioritization and ultimate selection and definition of measures. Assisted with the review and completion of the final report.
Wildlife Biologist	13	Consulted in formal and informal meetings for identification, prioritization and ultimate selection and definition of measures. Worked closely on which measures best represent the natural quality of the Wilderness and data collection.
Visitor Services Park Ranger	9	Consulted in formal and informal meetings regarding any measures related to visitor usage.
Federal Wildlife Officer	2	Consulted in formal meetings regarding any measures related to law enforcement on the Refuge.

Time you spent to identify, prioritize, and select all the measures (in whole hours)	**Time you spent to learn how to enter data into the WCM database application (in whole hours)**	**Time you spent to enter all data into the WCM database application (in whole hours)**	**Time you spent on other tasks directly related to WCM (e.g., reading CCP, giving presentations, talking with staff) (in whole hours)**	**Time you spent doing <u>other</u> Refuge tasks not directly related to WCM (in whole hours)**
160	8	8	80	110

Appendix C: Summary of Data Source(s) and Data Collection Protocols for All Measures

Measure	Data Source(s) and Collection Protocol
1-1. Number of actions to suppress naturally ignited fire within wilderness	**Data Source(s):** Annual Narrative, Law Enforcement Report **Data Collection Protocol:** A Minimum Tools Analysis will be performed immediately after fire suppression, all tools and equipment used will be included in the undeveloped quality "Minimum Tool Analysis" measure. Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.
1-2. Number of research, survey, and monitoring projects that manipulate plants or wildlife habitat	**Data Source(s):** SUPs, Annual Narrative **Data Collection Protocol:** SUPs (Special Use Permits) can be approved by Refuge staff for non-agency research, survey, or monitoring projects conducted on the Refuge. Professional judgment must be used to determine if the research causes a disturbance in the Wilderness. The project information section of the SUP will state which projects include the Wilderness Area. Electronic copies of all SUPs and Annual Narratives can be found at – Special Use Permit and Annual Narratives.
1-3. Number of permitted special uses that manipulate the biophysical environment	**Data Source(s):** SUPs, Annual Narrative **Data Collection Protocol:** Follow the protocol for measure 1-2, count all special uses authorized for actions unrelated to research, survey, or monitoring projects.
1-4. Number of actions taken to chemically immobilize, capture, remove, collar, band, and/or mark animals within the wilderness boundary	**Data Source(s):** SUP, Annual Narrative, Wildlife Biologist **Data Collection Protocol:** Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.
1-5. Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	**Data Source(s):** LEO Report **Data Collection Protocol:** Measures monitored by Refuge law enforcement officials are recorded as "incidents". In the case of wilderness character monitoring, "incidents" will be considered the same as "actions". Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.
2-1. Non-native vertebrate species	**Data Source(s):** Habitat Management Plan (HMP), Annual Narrative, Wildlife Biologist **Data Collection Protocol:** Count all non-native vertebrate species that are confirmed to be on the Mingo Refuge and report the total number.

2-2. Non-native plant species	**Data Source(s):** Wildlife Biologist, HMP **Data Collection Protocol:** To view the protocol used for the 2009-2010 invasive species survey refer to the Invasive Forest Plants Project Record located at: Invasive Forest Plants Project Record.
2-3. Presence of T & E species	**Data Source(s):** HMP, Wildlife Biologist, USFWS Missouri list of T&E species **Data Collection Protocol:** Only T & E species confirmed to be present on the Mingo Refuge will be included in this measure. Known T & E species found on a county by county basis in Missouri can be found at: FWS-Federally Listed Threatened, Endangered, Proposed, and Candidate Species. This database serves as a reference for T & E species established in Stoddard and Wayne Counties.
2-4. Air quality	**Data Source(s):** FWS NWRS Branch of Air Quality **Data Collection Protocol:** All data required will be provided by the FWS NWRS Branch of Air Quality. Data values reported represent the 5-year averages for each metric. Condition of the air quality related value is based on the following parameters: Ozone: < 60 ppb - Good 61-75 - Moderate > 76 - Significant Concern Visibility: < 2 dV - Good 2-8 - Moderate > 8 - Significant Concern Total-N and S: <1 kg/ha - Good 1-3 - Moderate > 3 - Significant Concern
2-5. Number of contaminants above EPA guidelines	**Data Source(s):** Wildlife Biologist, Baseline data is found at: **Data Collection Protocol:** Contaminants research is inconsistent on the Mingo Refuge and therefore unpredictable as to which strata may be measured for contaminants from year to year. Data will be reported as a count of total fish species showing concentrations of Hg above the USEPA's consumption advisory level. To view the protocol used for the 2007-2009 contamination investigation refer to the FY10 Environmental Contaminants Program located at: 2010 Contaminants Report. To Missouri Department of Health and Senior Services – 2012 Missouri fish advisory may serve as a reference: Missouri Fish Advisory.
2-6. Water quantity	**Data Source(s):** Wildlife Biologist, Monopoly Marsh stage data **Data Collection Protocol:** Calculate the number of days the Monopoly Marsh water monitoring station reports water levels ≥336 MSL (mean sea level) during the growing season. For the purpose of consistency the growing season will be the dates of March 16 through November 20, a period of 250 days. This is the average growing season for southeastern Missouri determined by the National Climatic Data Center.

2-7. Climate change parameters	**Data Source(s):** TBD **Data Collection Protocol:** Analyze weather data for the following records: mean summer temperature, mean winter temperature, and total annual precipitation. Summer is defined as the months of June, July, and August. Winter is defined as the months of December, January, and February. Mean summer and winter temperatures should be calculated for each year. These seasonal means are then averaged over a five-year time interval. Since the year changes in the middle of the winter season, mean winter temperatures for any given year are calculated using data from December of the previous year and data from January and February of the target year. Total annual precipitation is calculated and seasonal totals are averaged over a five-year time interval.
3-1. Number of authorized physical structures, installations, or developments	**Data Source(s):** Annual Report, Minimum Tool Analysis, SUP's **Data Collection Protocol:** This measure consists of a count of each structure, development, or installation found inside the Wilderness. A structure, development, or installation includes all permanent, semi-permanent, and temporary entities. Any length of time that a structure, installation, or development is inside the Wilderness boundary will consider it eligible for inclusion in this measure.
3-2. Miles of administrative travel routes and access roads adjoined to the wilderness	**Data Source(s):** Refuge GIS data, Annual Narratives **Data Collection Protocol:** Calculate the total miles of administrative travel routes and access roads adjacent to the Wilderness Area. This includes the following sections of road: • Ozark Highland Auto Tour Route (including Ditch 6 Road) • All of Ditch 5 Road • All of Ditch 4 Road • Flatbanks Road (from the bridge to the boat launch)
3-3. Number of unauthorized physical structures, installations, or developments	**Data Source(s):** LEO Report, Refuge staff **Data Collection Protocol:** Any known unauthorized physical structure, installation, or development is likely to be included in the LEO Report if the person(s) responsible are discovered. If an unauthorized entity is found in any other circumstance it is likely to be reported to Refuge management. Count the total unauthorized structures, installations or developments for the purposes of this measure.
3-4. Acres of inholdings within the Wilderness	**Data Source(s):** Refuge staff, GIS data **Data Collection Protocol:** Total the acreage of inholdings within wilderness every 10 years.

3-5. Number of actions requiring a minimum tool analysis	**Data Source(s):** Refuge data files – Minimum Tool Analysis **Data Collection Protocol:** The following processes can serve as a general outline in accounting for all related actions: • Review of all minimum tool analyses conducted over the past fiscal year. • Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character,* to determine what is counted as one action or many. • Total all actions requiring a Minimum Tool Analysis.
3-6. Miscellaneous unauthorized uses	**Data Source(s):** LEO Report **Data Collection Protocol:** Measures monitored by refuge law enforcement officials are recorded as "incidents". In the case of wilderness character monitoring, "incidents" will be considered the same as "actions". Refer to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character.* See Table 11 for general rules for counting and reporting number of actions for the untrammeled quality.
4-1. Visitors to wilderness area	**Data Source(s):** Visitor Services Park Ranger, Traffic Counter Data **Data Collection Protocol:** Calculate the total visits persons recorded by the Auto tour Route Entrance and Flatbanks Road traffic counters for the fiscal year.
4-2. Percent of wilderness away from access or travel routes	**Data Source(s):** Refuge GIS data **Data Collection Protocol:** A spatial analysis, using Refuge GIS data, must be performed to calculate the percentage of wilderness away from access or travel routes. Utilizing ArcGIS, an analyst must perform the following task in order to calculate the percentage of wilderness away from access or travel routes: 5. Acquire GIS layers for all travel routes 6. Create a buffer of appropriate size around each travel route. 7. Subtract the buffers from the wilderness polygon using the erase tool. 8. Calculate the area of remaining wilderness after all the travel route buffers have been erased. The following distances away from access and travel routes were subjectively chosen for the Mingo Wilderness: • Open automobile roads – ¼ miles Refer to the guidelines set forth on pages 188-191 of the Forest Service *Technical Guide for Monitoring Select Conditions Related to Wilderness Character* for further information.
4-4. User-created recreation facilities	**Data Source(s):** LEO Report, Refuge staff **Data Collection Protocol:** Calculate the total number of user-created recreation facilities found in wilderness for the fiscal year.

4-5. Management restrictions	**Data Source(s):** CCP, HMP, Hunt Plan **Data Collection Protocol:** Table 7, sourced from the Forest Service's *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*, contains a list of management restrictions placed on visitor behavior, as well as scores assigned based on the degree of restriction, and the significance of their impact on opportunities for primitive and unconfined recreation. When scoring the restrictions of a given wilderness, a geographical weight is also applied: 1 = restriction applies only to a portion of the wilderness; 2 = restriction applies throughout entire wilderness. Based on the stipulations of management policy within a given monitoring period, the wilderness will be scored, and the total score will serve as the data value. Table 7 illustrates this scoring process for the Mingo Wilderness based on management restrictions in place at the time of this report.
5-1. Number of unauthorized removals of paleontological or geological resources	**Data Source(s):** LEO Report **Data Collection Protocol:** Calculate the total number of unauthorized removals of paleontological or geological resources in wilderness for the fiscal year.
5-2. Number of unauthorized removals of cultural resources	**Data Source(s):** LEO Report **Data Collection Protocol:** Calculate the total number of unauthorized removals of cultural resources in wilderness for the fiscal year.