Draft Compatibility Determination

Title

Draft Compatibility Determination for Non-Commercial and Commercial Tree Harvest, Mingo National Wildlife Refuge

Refuge Use Category

Agriculture, Aquaculture, and Silviculture

Refuge Use Type(s)

Tree harvesting (non-commercial and commercial)

Refuge

Mingo National Wildlife Refuge

Refuge Purpose(s) and Establishing and Acquisition Authority(ies)

Mingo National Wildlife Refuge was established in 1944 under the authority of the Migratory Bird Treaty Act.

"…for the use as an inviolate sanctuary or for any other management purpose, for migratory birds" 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"…suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species." 16 U.S.C. § 460k-1 (Refuge Recreation Act)

"…the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors…" 16 U.S.C. § 460k-2 (Refuge Recreation Act (16 U.S.C. § 460k-4), as amended)

"… to secure for the American people of present and future generations the benefits of an enduring resource of wilderness…wilderness areas… shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness…" 16 U.S.C. §1131 (Wilderness Act)

National Wildlife Refuge System Mission

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where

appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (Pub. L. 105-57; 111 Stat. 1252).

Description of Use

Is this an existing use?

Yes. This compatibility determination reviews, replaces and combines the 2010 non-commercial and commercial tree harvest compatibility determination and the 2016 firewood harvest compatibility determination (USFWS, 2010; 2016b).

This use is being reevaluated in conjunction with the 2023 Mingo National Wildlife Refuge Forest Management Plan and is consistent with the 2007 comprehensive conservation plan and associated environmental assessment and the 2011 habitat management plan (USFWS, 2007; 2011; 2023).

What is the use?

Non-commercial tree harvest is defined as the cutting and removing of trees by various techniques, such as selective cutting, for personal use as wood, paper, chips, other fiber products, Christmas trees or firewood.

Commercial tree harvest is defined as the cutting and removing of trees by various techniques, such as selective cutting or clear cutting, for sale or commercial use as wood, paper, chips, other fiber products, Christmas trees or firewood.

Commercial tree harvest is considered a refuge management economic activity.

Is the use a priority public use?

No

This use is not considered one of the legislated priority wildlife-dependent public uses of the National Wildlife Refuge System (i.e., hunting, fishing, wildlife observation and photography or environmental education and interpretation).

Where would the use be conducted?

Mingo National Wildlife Refuge protects a remnant of the bottomland hardwood forest and cypress tupelo swamp ecosystem that once formed a 2.5 million-acre contiguous natural landscape throughout the Mississippi River basin. The 21,592-acre refuge touches the southeast boundary of the Ozark Plateau and slopes abruptly from an upland oak-hickory forest to a bottomland hardwood forest, lower marsh and expansive swamp and ditch system (USFWS, 2007). The refuge contains approximately 16,000 acres of bottomland and upland hardwood forest, 3,000 acres

of marsh and open water, 1,800 acres of cropland and moist soil units and 170 acres of grassy openings (USFWS, 2011).

Non-commercial Tree Harvest

Non-commercial tree harvest would occur on or adjacent to 45 miles of roadway open to the general public and would only be allowed in the footprint and shoulder of existing roads within the refuge. This includes Bluff Road, Ozark Highlands Auto Tour Route, Redmill Drive, Flatbanks Road and any other small roads associated with parking areas. Only fallen trees blocking roadways or within a road right-of-way would be authorized for removal. The areas open to non-commercial tree harvest would be specifically defined at the time the special use permit is issued.

No tree harvest would be allowed in the wilderness or research natural areas.

Commercial Tree Harvest

Commercial tree harvest would occur on approximately 11,500 forested acres of the refuge (Figure 1). However, harvest would focus on specific management units including Pool 5, Pool 7, Pool 8, Gum Stump Pool and Sandblow Ridge Pool (Pool 4) as outlined in the forest management plan (USFWS, 2023). Commercial tree harvest could occur anywhere within these units where the refuge has determined that a management need exists and would be specifically defined at the time the special use permit or contract is issued. Tree harvest could occur in areas that are open or closed to the public.

Pool 5, Pool 7, Pool 8, Gum Stump Pool and Sandblow Ridge Pool are dominated by bottomland hardwood forest and are managed as priority habitat for waterfowl and other migratory birds. Bottomland hardwood forests are deciduous forested wetlands, which can survive in areas that are either seasonally flooded or covered with water most of the year. They often occur along rivers, streams and their associated floodplains (EPA, 2022). The goal of bottomland hardwood forest restoration is to achieve desired forest conditions and enhance the survival of red oak tree species by removing undesirable trees and opening the forest canopy.

Pools 5, 7, 8 and Gum Stump Pool are classified as green tree reservoir habitat management units. Green tree reservoirs are characterized by the presence of live trees and the ability to manipulate water levels. These units are flooded annually between November and March for no more than 130 consecutive days and are drained during the growing season to encourage regeneration and avoid killing trees (USFWS, 2007).

Gum Stump Pool is a natural backwater whose water level fluctuates with water level management on Monopoly Marsh. About half of the pool is dominated by oak forest, approximately 40% is covered by scrub/shrub vegetation and the remaining 10% is a mix of bald cypress and tupelo (USFWS, 2007).

Sandblow Ridge is a bottomland hardwood pool with limited control of water levels. It

functions in a similar manner to the green tree reservoirs but is not completely leveed around its exterior. Vegetation is similar to surrounding pools and is dominated by oak species.

In the upland forests, three community types are recognized including old fields, xeric ridge crests and mesic slopes. In general, these areas are predominated by oak-hickory forests. (USFWS, 2011).

Trees that pose a threat to visitor safety or impede public use could also be removed.

No commercial tree harvest would be allowed in the wilderness or research natural areas.

When would the use be conducted?

Non-commercial Tree Harvest

Non-commercial tree harvest could occur during any season. Only fallen trees blocking roadways or within refuge road rights-of-ways would be authorized for removal. Timing of harvest would be dependent on specific circumstances such as storm damage and weather, but in general would occur during daylight hours (sunrise to sunset). A special use permit would indicate the dates, times and location when tree harvest would be allowed.

Commercial Tree Harvest

Depending on the goals and objectives of the commercial tree harvest, activities could be authorized to occur during any season but would be prioritized when soil moisture is sufficiently dry for management activities. Tree harvest would occur when silvicultural objectives can be met and ground conditions facilitate access and prevent damage to roads and infrastructure, hydrology, soil, vegetation and cultural resources. A special use permit would indicate the dates, times, conditions and location where tree harvest would be permitted. Commercial tree harvest would generally occur during refuge open hours.

How would the use be conducted?

Both uses would be overseen by the refuge manager and their designee, usually the refuge biologist or assistant refuge manager. The number of people participating in either activity varies from year to year depending on the need and local conditions.

Non-commercial tree harvest

Special use permits would be issued to individuals for non-commercial tree harvest of firewood after completing an application. The number of permittees for non-commercial tree harvest typically varies from zero to ten annually, and individuals would be selected on an as needed basis dependent on storm related tree falls. The specific details and restrictions governing non-commercial tree harvest would be

outlined in the special use permit to ensure the activity is appropriate and compatible with the refuge's mission and purpose.

Operations would typically involve individuals using chainsaws, handsaws or axes to cut (i.e., buck up) fallen trees and their branches into shorter lengths. Cut sections of trees would then be loaded into personal vehicles and hauled off-site for personal use as firewood. No standing trees would be cut under this use.

Commercial Tree Harvest

Forest stand prescriptions, or treatments designed to change current stand structure or condition at a particular forest site, would be developed to achieve habitat and forest management plan goals and objectives (USFWS, 2011; 2023). At the time of implementation, refuge staff would evaluate each stand within a management unit using forest inventory data, regeneration surveys and real-time stand observations. Ecological forestry prescriptions would be developed using the template found in the refuge's forest management plan (USFWS, 2023). The volume and categories of wood products that would go to bid would be tallied and included within the prescription. Select trees would generally be sold and removed by commercial tree harvest operations.

Contractors would be selected using a competitive process that examines bid price, tree harvest experience and other factors. Contractors must be on the Missouri Department of Conservation's list of conservation foresters. The refuge would issue up to three special use permits a year for this commercial tree harvest.

Cutting strategies would be handled on a case-by-case basis within the guidelines of the Mingo National Wildlife Refuge Forest Management Plan (USFWS, 2023). The specific details and restrictions governing commercial tree harvest would be outlined in a special use permit to ensure the activity would be consistent with the goals and objectives of the forest management plan as well as appropriate and compatible with the refuge's mission and purpose.

Trees needing to be removed or manipulated to improve forest habitat for wildlife or to restore the integrity of the forested wetlands ecosystem would be the focus of tree harvest. Certain situations such as severe weather damage, fire, insect and/or disease outbreak, encroachment on hiking and administrative trails or other extenuating circumstances could justify removal or salvage of trees. Operations would involve numerous individuals, heavy equipment typical of traditional logging (e.g., feller-bunchers, log skidders, bulldozers, etc.) and hand tools (e.g., chainsaws, etc.). Access to sites would occur by truck, trailers and/or larger logging equipment such as semi-tractor trailer combinations. Differences in required equipment would occur depending on the amount and type of wood being removed.

Harvest strategies could include uneven-age methods (e.g., single tree, group

selection, patch cuts, etc.) and even-age methods (e.g., shelterwood, clearcut, etc.; Clatterbuck and Meadows, 1993; Meadows and Stanturf, 1997). Techniques could include midstory removal, timber stand improvement or understory removal, girdling and the use of pre-approved chemicals (USFWS, 2011; 2023). All techniques would be used to reach desired forest conditions. All contractors must follow permit requirements and best practices to ensure equipment is clean and free of plant material and soil before starting work. Additional best management practices can be found in the forest management plan and ecological forestry prescription document (USFWS, 2023).

Why is this use being proposed or reevaluated?

This use is being reevaluated because the 10-year renewal period for the 2010 non-commercial and commercial tree harvest compatibility determination ended in 2020, as described in agency policy (603 FW2.11 H). This document renews the 2010 non-commercial and commercial tree harvest compatibility determination and combines it with the 2016 firewood harvest compatibility determination (USFWS, 2010; 2016b). This use is being reevaluated in conjunction with the 2023 Mingo National Wildlife Refuge Forest Management Plan (USFWS, 2023). No administrative changes would occur regarding how this use has previously been conducted on the refuge.

The goals of forest management as outlined in the forest management and habitat management plans are to:

- Goal 1 (migratory waterfowl): Provide a complex of managed wintering and migration habitats for waterfowl.
- Goal 2 (priority resources of concern and threatened and endangered species): Protect, manage and enhance refuge habitats in a manner that will sustain or increase species' populations.
- Goal 3 (migratory landbirds): Provide a complex of habitats which meet the breeding, migration and wintering needs of species of management concern.
- Goal 6 (resident wildlife): Provide a complex of habitats suitable for a wide range of resident (endemic) wildlife species, while achieving habitat management objectives and biological integrity of other native flora and fauna (USFWS, 2011; 2023).

The management of forests using commercial and non-commercial mechanical methods would be administered in accordance with wildlife and ecosystem management principles, on-going research and land management demonstrations. The use of regulated, well-planned forest management is critical to the sustainability of bottomland hardwood forest habitat (USFWS, 2011; 2023).

Availability of Resources

Annual Administration Costs: Administration of non-commercial and commercial tree harvest programs would require a commitment of staff hours and other resources. By permitting tree harvest, the manager has identified a management need and would have secured and prioritized the necessary station resources.

Non-commercial Tree Harvest

For non-commercial tree harvest, refuge staff would be responsible for reviewing applications and preparing special use permits. The refuge typically issues zero to ten permits annually for non-commercial tree harvest. For example, in a year where ten non-commercial tree harvest permits are issued, the refuge would expend approximately $2,500 in staff time and office resources. No fees would be charged for issued permits and no off-setting revenue would be generated.

Commercial Tree Harvest

Periodic small-scale commercial tree harvest operations would be adequately administered with existing staff resources. Administering a small-scale tree harvest program would require approximately $9,000-$10,000, per event, in staff salary and equipment costs. This cost includes plan development, surveying the area, issuing the permit and tree harvest monitoring. Generally, zero to three small-scale commercial harvests would occur annually.

Large-scale commercial tree harvest operations would require additional staff time and resources. Refuge staff would be responsible for developing a harvest plan (e.g., ecological forestry prescription) and bid prospectus, surveying and marking the harvest area, monitoring harvest operations, reviewing permit applications and proposals and issuing permits. Administering a large-scale tree harvest program would require $18,000-$20,000 per event in staff salary and equipment costs. Refuge biology program staff would spend approximately 50% of their time monitoring commercial tree harvest during tree harvest operations. The duration of large-scale tree harvest operations would fluctuate but a typical operation would last approximately 30–60 days. Generally, zero to three large-scale commercial harvests would occur annually.

Missouri Department of Conservation and regional U.S. Fish and Wildlife Service foresters would assist with commercial tree harvest activities, but their time would not be charged to the refuge unless a project specific cost code is available.

Maintenance, special equipment, facilities and infrastructure:

Non-commercial and commercial tree harvest would be supported by existing refuge facilities and infrastructure (e.g., roads, levees, parking areas).

Commercial Tree Harvest

All repairs, maintenance and other costs of facilities used by permittees would be identified in the special use permit, and permittees would be solely responsible for any maintenance and repairs as a result of or required during and immediately after the use. Areas such as loading areas and skid trails created during commercial tree harvest would be restored to their natural or agreed upon state once the use had been completed.

Offsetting revenue:

Commercial Tree Harvest

Revenue would generally be determined by market value per cord and the funds would be managed by the agency. The refuge would receive a small percentage from tree harvest sales in a contributed fund account.

A portion of small-scale commercial harvest funds would be returned to the refuge and may or may not cover the cost associated with administering the activity, depending on the sale, markets and volume harvested.

A portion of large-scale commercial harvest funds would be returned to the refuge and would usually meet or exceed the costs associated with administering the activity.

Anticipated Impacts of the Use

The effects and impacts of the proposed use on refuge resources, whether adverse or beneficial, would be those that are reasonably foreseeable and have a close causal relationship to the proposed use. This compatibility determination includes the written analyses of the environmental consequences on a resource only when the impacts on that resource could be more than negligible and therefore considered an "affected resource."

Tree harvest would maintain healthy forest habitat on the landscape, and the impacts from management activities would be beneficial or mitigated through careful planning and implementation. Tree harvest would be conducted in a manner that avoids or mitigates potentially adverse short- and long-term impacts. Restrictions imposed by the refuge manager and special use permits would reduce any anticipated negative effects to refuge resources.

Potential impacts of a proposed use on the refuge's purpose(s) and the National Wildlife Refuge System mission

Non-commercial and commercial tree harvest provides important tools for forest management and conservation, which benefit wildlife and their habitats, and furthers

the mission of the National Wildlife Refuge System and the U.S. Fish and Wildlife Service. Tree harvest was evaluated in the 2007 comprehensive conservation plan environmental assessment and is consistent with the comprehensive conservation, habitat management and forest management plans (USFWS, 2007; 2011; 2023). The 2007 environmental assessment determined tree harvest would not significantly impact the human environment and a finding of no significant impact was issued (USFWS, 2007). The analyses below are supplemental to the environmental effects described in those documents and where applicable, are incorporated by summary and reference. This compatibility determination was developed using the most recent refuge biological information and data, scientific literature and habitat management principles. Forested units on the refuge would be managed, enhanced and restored for native fish, wildlife and plants.

Mingo National Wildlife Refuge protects a modern remnant of the bottomland hardwood forest and cypress-tupelo swamp ecosystem. The refuge represents the largest area of remaining habitat for numerous native and threatened plant and animal species in southeast Missouri (USFWS, 2007; 2011). Of the original 2.5 million acres of this bottomland forest located in Missouri, less than 1% remains in forest cover (Nelson, 2010). The remaining 99% was converted to agriculture and rural settlements. This unique juxtaposition between two distinct physiographic regions gives Mingo National Wildlife Refuge exceptional biological diversity that is reflected in its forests and forest dependent wildlife species.

Potential positive impacts of tree harvest include restoration, maintenance and enhancement of habitats and increased habitat diversity (e.g., age, species and structure). Tree harvest would open the canopy and improve recreational opportunities, mainly waterfowl hunting and bird watching conditions. The removal of trees in these areas would have an overall positive outcome in working towards the goal of restoring the refuge back to its original state by encouraging the growth and establishment of natural communities.

Over the last ten years there have been no commercial tree harvest activities on the refuge, and the refuge averaged less than 10 non-commercial tree harvest activities annually.

Mitigation: Restrictions and conditions identified in special use permits, ecological forestry prescriptions and the forest management plan would be implemented to minimize and mitigate impacts to refuge resources (USFWS, 2023). The refuge would follow best management practices and policies established by the agency as well as guidance established by the Missouri Department of Conservation (MDC, 2014). These guidelines, along with other tenets of ecological forestry, would be used on forestry prescriptions.

Short-term impacts

Wildlife Species

Terrestrial Species

Mingo National Wildlife Refuge lies in the heart of the Mississippi Flyway, and its bottomland hardwood forests are critical to migratory and wintering waterfowl. They provide thermal, loafing and escape cover for waterfowl and an abundance of food in the form of mast produced primarily by red oak, white oak and tupelo and invertebrates (USFWS, 2007; 2011).

A total of 292 resident and migratory bird species use refuge habitats throughout the year. The refuge is important for passerine and neotropical species during the nesting season and migration (USFWS, 2007; 2011).

The refuge supports numerous species of resident wildlife. White-tailed deer, a species popular for hunting and viewing, are abundant at a population density of up to 35 per square mile. A variety of small mammals including three species of squirrels, several species of bats and various mice, rats and voles inhabit the refuge. The refuge is one of the few places in Missouri where the swamp rabbit is known to occur (USFWS, 2007; 2011). The refuge contains 25 species of amphibians and 40 species of reptiles. (USFWS, 2007; 2011).

Impacts: Forests provide habitat for many wildlife species, and the quantity, quality and distribution of those habitats changes when trees are harvested. The response of wildlife to forest management activities, including tree harvest, varies depending on forest type and harvest intensity (Fredericksen and Mostacedo, 2000). Even within groups of wildlife species (e.g., birds, mammals, etc.) the effects are variable and often species-specific. Management activities could have a positive impact on some species and a negative effect on others.

Tree harvest could temporarily disturb or displace wildlife due to an increase in motion (e.g., people, equipment, vehicles, etc.), noise (Campbell et al., 2007, deMaynadier and Hunter Jr., 1995; Holmes and Pitt, 2007) and ground disturbing activities (e.g., removing vegetation or logs). Individuals could be directly impacted via displacement to adjacent areas, loss of nesting habitat or injury or mortality from equipment or vehicle strikes.

Wildlife-related components of forests could be altered during management activities including damage to understory vegetation (Scheller and Mladenoff, 2004), modifications to microhabitat environments (deMaynadier and Hunter Jr., 1995), changes in the abundance and type of coarse woody debris (deMaynadier and Hunter Jr., 1995; Siitonen, 2001) and snag removal. Tree harvest or timber stand improvement activities could temporarily change the vertical structure and canopy of the forest, which could impact forest interior bird species (USFWS, 2006). Removal of mast producing trees and shrubs could impact the short-term availability of food resources

for wood ducks, forest passerines and a variety of mammals.

A wide array of vertebrate and invertebrate taxa relies on different classes and species of coarse woody debris to fulfil life history requirements. Invertebrates play a key role in the decomposition and nutrient cycling of woody material, and in turn provide forage for higher taxa. Studies of insect richness in forested wetlands have demonstrated a diverse community of aquatic, wetland and terrestrial invertebrates directly associated with coarse woody debris (Braccia and Batzer, 2001).

Short-rotation harvest (i.e., less than 50 years), whole-tree harvest and selective cuts can alter soil moisture regimes by reducing the abundance of downed wood and large-diameter logs necessary for forest floor amphibians and small mammals (Gore and Patterson III, 1986; deMaynadier and Hunter Jr., 1995). Ectotherm species could be susceptible to changes in microclimates, which could result in exposure to temperature extremes (Currylow et al., 2012).

Although tree harvest could disrupt wildlife, most of the effects would be short-term and temporary, lasting approximately the amount of time it would take to treat a site.

Mitigation: Forest management guidelines provided by state fish and wildlife agencies and statewide forestry councils would be implemented where appropriate and feasible to mitigate wildlife impacts (MDC, 2014; MFRC, 2013; 2014). Mitigation measures to reduce, limit and minimize negative impacts to wildlife and tree harvest related disturbance would be outlined in a special use permit. Restrictions could include limiting the duration and timing of harvest, equipment type and number of individuals participating in an activity at one time.

Commercial tree harvest would occur in relatively small sections (e.g., 500 acres or less) of green tree reservoirs, bottomland hardwood forests or uplands forests. Forestry treatments would equate to a small percentage of forested habitats on the refuge, and sufficient refugia would be available adjacent to active sites to provide habitat for dispersed wildlife. All motor vehicle use associated with tree harvest would be restricted to designated roads, skid trails, levees and parking areas (USFWS, 2011; 2023). Harvest strategies would consider retention or creation of coarse woody debris and slash to provide habitat for reptiles and amphibians, as well as food and cover for invertebrates, soil organisms, plants, small mammals and birds. Mast retention would be considered during tree harvest planning and prioritized based on the surrounding habitat types and abundance of other mast producing trees and shrubs. Converting forests to more desirable oak species (e.g., red oak) would provide additional forage and cover for waterfowl (USFWS, 2011; 2023).

Management considerations for dead wood retention would consider both structural as well as compositional legacies that address not only variable size classes but also decay classes and species diversity (Adams et al., 2021). Where safety permits, snags, dens and leave trees, leave tree clumps or legacy patches, which are undisturbed sites, would be preserved during tree harvest and thinning, especially those being used by cavity nesting wildlife (USFWS, 2011; 2023). A mix of poor and good quality

trees would be desirable to provide diverse habitat, however, diseased trees would typically be removed. Retention of leave trees and snags during tree harvest would provide perches, cavities and foraging sites during forest regeneration and mimic natural disturbance (MDC, 2014; MFRC, 2013). Providing and maintaining old tree forest structure and trees, living or dead, with nesting habitat would be considered when planning tree harvest activities (USFWS, 2011; 2023).

Threatened and Endangered Species

Federally threatened, endangered, candidate and proposed species occur on the refuge, but this use would not be expected to conflict with the recovery or protection of these species.

Listed species:

- Northern long-eared bat (endangered)
- Gray bat (endangered)
- Indiana bat (endangered)
- Tricolored bat (proposed endangered)
- Alligator snapping turtle (proposed threatened)
- Monarch butterfly (candidate)

The gray bat has been documented in Wayne County, Missouri, however, no gray bats have been confirmed on the refuge. There is a slight chance gray bats may occasionally forage or use caves located on the south or west side of the refuge (USFWS, 2011). No tree harvest would occur on the west or south portions of the refuge as the area is either wilderness or outside of inventoried areas.

Northern long-eared and Indiana bats may occur within the refuge from March to October. Northern long-eared bats and Indiana bats roost under the peeling bark of dead and dying trees during the summer months and overwinter in large colonies in caves (USFWS, 2006). The primary habitat type present on the refuge would be summer roost trees (USFWS, 2011). Indiana bats eat a variety of flying insects and typically forage along rivers or lakes and in uplands, while northern long-eared bats primarily forage in the understory of forested areas (USFWS, 2006; 2015)

Overall impacts to northern long-eared and Indiana bats from forest management would be expected to range from positive (e.g., maintaining or increasing suitable roosting and foraging habitat within home ranges) to neutral (e.g., minor amounts of forest removal, forest management in areas outside of summer home ranges, forest management away from hibernacula) to negative (e.g., death of adult females or pups or both resulting from the removal of maternity roost trees; USFWS, 2016a).

Best management practices would be followed to retain legacy trees categorized as structural wildlife habitat including snags, cavity trees and trees with a measured health class rating of “significant decline” (USFWS, 2023). To reduce impacts to listed bat species, at least six trees per acre in the “snag” or “significant decline” categories with a diameter at breast height greater than 9 inches would be retained. Preferred

roost tree species would be prioritized for retention and enhancement for both short- and long-term roost use (USFWS, 2008; 2014).

Although no longer applicable to incidental take, to minimize negative impacts the stipulations of the 4(d) Rule for the northern long-eared bat would be followed to the extent possible (USFWS, 2016a). Tree harvest would not occur within a 0.25-mile radius of known hibernacula and would not cut or destroy known occupied maternity roost trees or any other trees within a 150-foot radius from a known maternity tree during the pup season (June 1 through July 31). No harvest would occur in areas with suitable habitat for maternal roosting trees during the summer months, unless a thorough inventory and monitoring of bats has been conducted pre-harvest, during harvest and post-harvest and the presence of northern long-eared bats was not detected. Removal and management of hazardous trees would be allowed. Whenever possible, removal of these trees would be conducted in the winter when they would not be occupied by northern long-eared bats.

Many of the best management practices for northern long-eared are applicable to Indiana bats. Consultation with the U.S. Fish and Wildlife Service's Ecological Services Field Office would occur for all bat species to establish additional mitigation measures and minimize potential impacts to these species.

Candidate and proposed species include alligator snapping turtle, tricolored bat and monarch butterfly. These species could be present on the refuge year around.

The tricolored bat likely uses forests and adjacent open areas for foraging on the refuge between spring and fall. Typically, the species roosts in dead leaves suspended in the canopies of deciduous trees, dead pine needles suspended in branches, in the bole of large pine trees and within lichens suspended in tree canopies. Roosts may be found in man-made structures in summer months, including in caves, abandoned mines, old houses, sheds, barns, wells, road culverts and dams (Taylor et al., 2020). Foraging habitats consist of open areas adjacent to forested roost habitats, with abundant water. They feed along roads and watercourses, over lakes and ponds, and along transitional edges, forested corridors and buffer strip areas (Taylor et al., 2020). Best management practices and guidance would be followed to minimize impacts to tricolored bats (see information above for northern long-eared and Indiana bats).

Although monarch butterflies generally inhabit prairie environments, they can be found in forested areas and may be temporarily displaced by tree harvest activities. Trampling of host plants during tree harvest could occur. However, areas likely containing these plants would not be targeted for treatment and would not generally be found in current forest conditions.

Despite the short-term disturbance, tree harvest could improve habitat conditions for monarch butterflies. Thinning dense forest stands creates canopy gaps, which mimics natural disturbance processes and allows for more sunlight to reach the forest floor. This stimulates herbaceous vegetation growth and increases host plant and food sources for monarch butterflies. The diversification of forest structure

through active management provides habitat for obligate host and flowering plants, such as swamp milkweed and aquatic milkweed, for several years until the regenerating forest shades out the herbaceous understory (USFS, 2015).

Alligator snapping turtles are generally found in deeper water of large rivers and their major tributaries but can also be found in a wide variety of habitats, including small streams, bayous, canals, swamps, lakes, reservoirs, ponds and oxbows (Ernst and Lovich, 2009). Structural features such as woody debris, undercut banks and large rocks found throughout the rivers are important components of alligator snapping turtle habitat (Enge et al., 2014). Deadhead logs and fallen riparian woody debris provide refugia during low-water periods, resting areas for all life stages and support important feeding areas for hatchlings and juveniles (Enge et al., 2014; Ewert et al., 2006). Alligator snapping turtles also select sites with a high percentage of canopy cover compared to open water (Howey and Dinkelacker, 2009).

Habitat alteration is a concern for the alligator snapping turtle. Activities that can alter alligator snapping turtle habitat include stream bank erosion, siltation and land use adjacent to rivers. Erosion can change the stream bank structure, affecting the substrate that may be suitable for nesting. Siltation affects water quality and may reduce the health and availability of prey species. These activities could negatively affect habitat suitability for alligator snapping turtles (USFWS, 2021).

The refuge would follow best management practices to reduce impacts to alligator snapping turtles. Herbicide application would follow the chemical label and appropriate application rates. Silviculture practices and forest management activities would follow approved best management practices to protect water quality and riparian habitat (USFWS, 2021).

Mitigation: Special use permit stipulations (e.g., timing) would be used to reduce potential effects to listed species unless reasons for human safety or maintenance requirements would dictate otherwise. All tree harvest activities would consider the lifecycle and habitat requirements of the Indiana bat, Northern long-eared bat, tricolored bat, alligator snapping turtle and monarch butterfly.

Consultation with the Ecological Services Field Office would be re-initiated prior to the implementation of forestry prescriptions if there could be potential impacts to listed species that were not fully considered during the original consultation.

Other Special Status Species

Although no longer threatened or endangered, bald eagles are referenced here due to their protection under the Bald and Golden Eagle Protection Act. Migrating and breeding raptors, including bald eagles, can be found throughout the refuge. Multiple active nest sites are monitored during the breeding season to determine activity and success (USFWS, 2007). Trees with eagle nests would not be selected for harvest and a buffer area would be established to mitigate nest disturbance.

Habitat and vegetation

Non-commercial tree harvest

Non-commercial tree harvest would remove several trees per year along previously disturbed or high use areas such as trails, roads and firebreaks or wherever there is a need to remove downed trees (e.g., blocked roadways). No standing trees would be cut under this use. Removing trees for personal firewood or use would have a minimal impact on habitat and vegetation on the refuge.

Commercial tree harvest

Commercial tree harvest could substantially alter habitat and vegetation of forested areas throughout the refuge to achieve management objectives as outlined in the Mingo National Wildlife Refuge Habitat Management Plan (USFWS, 2011; 2023). Forest management activities would range from passive management to promote natural forest development to active tree harvest, which encourages rapid forest development by emulating natural

Refuge vegetation may be broadly divided into wetlands, which are comprised mainly of bottomland mixed hardwood forests, and upland oak-hickory forests (USFWS, 2007; 2011). The following habitat management objectives describe how forested habitats would be manipulated and expected to change over the next 15 years.

Habitat management objective 1.3: Achieve a mosaic of bottomland hardwood stands of different age and structural classes on 70% of refuge bottomland, including green tree reservoirs, over a narrow elevation gradient within 100-200 years (USFWS, 2011; 2023).

- Objective 1.3.A: Convert 20-40% of stands in green tree reservoirs that are dominated by overcup oak, red maple and associated species to red oak (e.g., pin oak and willow oak) and associated species within 15 years (USFWS, 2011; 2023).
- Objective 1.3.B: Use regeneration harvest systems to establish red oak regeneration and recruitment on areas where mature red oak canopy is present over the next 15 years (USFWS, 2011; 2023).

Habitat management objective 3.1: Restore and protect up to 21,592 acres to provide sufficient habitat to support migratory landbirds, specifically species of conservation concern (USFWS, 2011; 2023).

Habitat management objective 3.2: Manage, restore and maintain 1,315 acres of upland forests over the next 15 years to provide quality habitat for migratory birds.

Habitat management objective 3.4: Manage and maintain 765 acres of pole (e.g., regenerating forest) and early successional forested areas.

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

Impacts: Disturbance to terrestrial vegetation could result from permittees conducting commercial tree harvest. Some herbaceous vegetation could be trampled from equipment driving over it or from the establishment of trails and pads to allow for loading and movement of trees. Impacts of construction and placement of infrastructure could be short to long-term depending on the treatment type. This disturbance would be limited in scope by only occurring during active management activities. Trampled vegetation would likely recover once the disturbance had ended.

Damage to uncut trees from heavy equipment could create entry points for invasion by insects or disease (Nichols et al., 1994). Harvest could also leave the remaining trees more susceptible to wind throw (Ruel, 1995) and facilitate the spread of invasive plants (Sakai et al., 2001) such as Japanese stiltgrass, sericea lespedeza, autumn olive and multiflora rose.

Mitigation: Conditions identified in special use permits, forestry prescriptions and the forest management plan would be implemented to minimize and mitigate impacts to habitat and vegetation (USFWS, 2023). Incorporating buffer zones around sensitive areas, placing temporary facilities on higher ground and using or improving existing infrastructure would be used to reduce impacts. The refuge would follow guidance practices established by the Missouri Department of Conservation including "Best Management Practices for Harvesting Woody Biomass" (MDC, 2014). Activities would be spread across several areas so as not to overstress or overuse any one resource.

All hauling operations with skidders, loaders and other equipment would be limited to identified trails. Permittees would be restricted to specific areas when hauling logs out of the forest. All other vehicle use would occur on existing roads, levees and other established transportation routes.

The refuge would protect forest health by preventing, where possible, the introduction of invasive species and diseases. Equipment used for commercial tree harvest would be required to be free of vegetation from previous work sites before entering the refuge.

Aquatic Species and Water quality

The refuge has 77 miles of flowing water and 387 acres of total open water bodies. The refuge is within the lower portion of the St. Francis River basin and acts as a reservoir during periods of flooding. The dynamic nature of this flooding regime along with the associated creeks, sloughs, marshes, ditches and ponds provide a constant and renewable fisheries resource within the numerous aquatic features on the refuge (USFWS, 2011).

Amphibians and reptiles are abundant on the refuge with more than 30 species of frogs, toads, salamanders and snakes (USFWS, 2007). Reptiles and amphibians are important food sources for many mammals, birds and fish. Their numbers and diversity are often indicators of the health of an ecosystem. At least 66 species of fish can be found on the refuge (USFWS, 2011).

Fish, reptiles, amphibians and other aquatic resources are dependent upon maintaining or enhancing the integrity of the watershed. Aquatic species should benefit from watershed management and restoration efforts of the Mingo and St. Francis Rivers, bottomland hardwoods and associated wetlands, creeks, sloughs, oxbows, lakes and chutes. Seasonal flooding of bottomland hardwoods provides shallow areas which serve as breeding habitats, nurseries or feeding areas for many fish such as alligator gar, invertebrates, reptiles and amphibians (USFWS, 2011). The deep, moist soils found in streamside forests provide excellent growing sites for high-quality and bottomland tree species (USFWS, 2023).

Impacts: Forest management operations could impact both water quantity and quality. Data from forested experimental watersheds in the eastern United States indicated that leaching of nutrients tends to increase after tree harvest (Bormann et al., 1968; 1974) and increases in stream water temperature were highest where revegetation of cutover areas was delayed (deMaynadier and Hunter Jr., 1995). These factors could have negative impacts on stream organisms, including fish, invertebrates and amphibians (Campbell and Doeg, 1989).

A slight, temporary decrease in water quality due to increased turbidity and sedimentation could occur during harvest activities as a result of siltation or erosion. Impacts would be limited to the time of harvest. Any increase in sediment would begin to settle out once the disturbance had ended.

Mitigation: Conditions identified in special use permits, forestry prescriptions and the forest management plan would be implemented to minimize and mitigate impacts to aquatic species, their habitats and water quality (USFWS, 2023). Incorporating buffer zones around sensitive areas, placing temporary facilities on higher ground and using or improving existing infrastructure would be used to reduce impacts. The refuge would follow guidance practices established by the Missouri Department of Conservation including “Missouri Watershed Protection Practices” and “Best Management Practices for Harvesting Woody Biomass.” These best management practices describe procedures for how and where to construct, use and retire logging roads, how to prevent loss of soil productivity by avoiding over-harvesting biomass, specifications on streamside management zones and other considerations when conducting forest management operations (MDC, 2014).

Streamside management zones are areas along intermittent and perennial streams and rivers that are important in maintaining water quality. Trees and other plants in streamside management zones function by slowing floodwater, filtering and trapping sediment and creating rich bottomland soil. When harvesting trees or woody biomass, streamside management zones would help protect stream banks from erosion, prevent soil compaction and provide shade to reduce increases in water temperature. Sloughs, vernal pools, ditches and seasonal depressions within management units would provide services similar to streamside management zones (USFWS, 2023).

Within ecological forestry prescriptions, a no cut or limited cut buffer of 100 feet or more would be established around ditches and sensitive areas within management units. The use of directional felling techniques would prevent woody material from entering streams and ditches. Canopy closure of 70% or more would be retained over sloughs and ditches and within 300 feet of streams. In particularly hydric soils, additional stipulations would prevent rutting by heavy machinery and interruptions to groundwater flow. Log landings and staging areas would not be permitted in streamside management zones to reduce soil compaction and rutting, the spread of invasive species and runoff from petroleum products (USFWS, 2023).

Geology and Soils

The refuge lies in an abandoned channel of the Mississippi River known as the Advance Lowlands, bounded by the limestone bluffs of Crowley's Ridge to the south and east, and the Ozark Escarpment to the north and west (USFWS, 2007).

The Calhoun-Forestdale-Amagon soil series complex dominates the refuge bottomland forest communities and consists of level, poorly drained and slowly permeable soils (USFWS, 2023). The Clarksville-Scholten soil series is the most prevalent upland soil type and supports dry oak woodlands and associated herbaceous communities. This series formed on hillslopes and consists of very deep, somewhat excessively drained soils with a stony surface as a result of historic grazing practices and erosion (USFWS, 2023).

Soil has important functions related to storing, regulating and cycling water and chemical elements.

Commercial tree harvest

Impacts: Soil disturbance could occur as a result of commercial tree harvest activities and could be short to long term. Impacts could include compaction, rutting and erosion and would be temporary for tree harvest activities and mid to long term for infrastructure related actions.

Temporary trails, haul roads, landings, and loading zones could be subject to erosion, rutting and compaction from heavy equipment use and parking (Helfrich et al., 2009; NHDFL and UNH, 2016; Wiest, 1998). The water holding capacity of bottomland soils makes it vulnerable to deep rutting by heavy equipment if saturated (USFWS, 2023). The development of skid trails and pads could alter soil structure and elevation. Compaction and erosion could occur along unimproved trails, banks and waterway access areas. Soil disturbance following tree harvest could increase the export of particulate matter and soil nutrients (Bormann et al., 1968; 1974).

Mitigation: Conditions identified in special use permits, forestry prescriptions and the forest management plan would be implemented to minimize and mitigate impacts to soils and geology (USFWS, 2023). Incorporating buffer zones around sensitive areas,

placing temporary facilities on higher ground and using or improving existing infrastructure would be used to reduce impacts. The refuge would follow guidance practices established by the Missouri Department of Conservation including "Missouri Watershed Protection Practices" and "Best Management Practices for Harvesting Woody Biomass." These best management practices describe procedures for how and where to construct, use and retire logging roads, how to prevent loss of soil productivity by avoiding over-harvesting biomass and other considerations when conducting forest management operations (MDC, 2014).

To mitigate potential impacts and minimize erosion, tree harvest would follow best management practices as recommended by the Missouri Department of Conservation (MDC, 2014). Harvesting would use existing forest roads where possible, however, the construction of trails could occasionally be necessary to provide access to some forest stands. Some trails and pads would be used over a long period of time to allow for reuse during tree harvest activities on adjacent treatment areas. By reusing infrastructure for management units that are in close proximity to each other, the overall footprint of disturbance would be reduced.

These temporary trails would be decommissioned and restored to native vegetation upon harvest completion. New roads, temporary trails and landings would follow guidelines for size and placement (MDC, 2014). Any disturbance would be managed with regular maintenance, and damage would be remediated once activities had stopped. Permittees could also be responsible for monetary costs to mitigate impacts such as buying gravel or repairing roads after a project had been completed.

To reduce potential soil impacts, tree harvesting is recommended during late summer and fall (July through November), when conditions are driest to reduce soil compaction, rutting and erosion. Tree harvest would occur during dry periods to the extent possible. Forest management activities would be avoided when a unit becomes too wet or inundated, when soils are saturated or prone to rutting and in areas with hydric, steep, shallow or easily erodible soils unless deemed necessary for management purposes. Some tree harvest could be authorized throughout the year depending on the management objective, habitat or cover type, harvest technique, equipment type (i.e., low-impact equipment that does not tear up the soil or cause rutting) or known presence/absence of wildlife or sensitive plants.

Following the forest management plan, when green tree reservoir forests are too wet, upland forests could be inventoried and treated (USFWS, 2023). This would provide flexibility to continue forest management activities during wet seasons and periods where active management of lowlands would be infeasible or cause permanent damage to soils and geology.

Additional erosion controls could be incorporated such as water bars, broad based

dips in roads or trails, cross drain culverts, excelsior rolls, brush and slash barriers and regeneration of native vegetation to minimize soil erosion where necessary. Soil and understory vegetation disturbance would be limited in filter strips and riparian areas to avoid soil compaction.

Air quality

Equipment used for non-commercial tree harvest would be limited to small engines, such as chainsaws, and personal vehicles. Emissions would be less than or comparable to those typically emitted by general visitor use and would minimally affect air quality.

Due to the infrequency, limited duration and localized area of commercial tree harvest activities on the refuge, negative effects to air quality through slight increases in atmospheric pollution would be minimal and temporary. Heavy equipment, gas-powered tools and vehicle exhaust could temporarily increase emissions while in use. Air quality would improve once the emission-emitting equipment stopped operating.

The use of motorized and mechanized equipment is prohibited in wilderness areas (USFS, 2023). Any effect from emissions on adjacent areas would be negligible and not affect the air quality over the wilderness area.

Visitor Use and Experience

Consistent with its authorizing legislation, Mingo National Wildlife Refuge conducts a broad array of wildlife and habitat management activities while providing for a variety of visitor services. Each year thousands of people visit Mingo National Wildlife Refuge. The refuge provides opportunities for six wildlife dependent public uses including wildlife observation, photography, fishing, hunting, environmental education and interpretation. Many of these visitors come to pursue game species such as waterfowl, white-tailed deer and turkey. Refuge forests also attract hikers, birdwatchers, photographers and other outdoor enthusiasts.

The wilderness area, Red Mill Drive, a portion of the auto tour route and the Boardwalk Nature Trail are open year-round to visitors. Some areas and uses are subject to seasonal closures and other restrictions (USFWS, 2007).

Trees that could be a hazard to property and human safety would be removed under specific circumstances to create a safer environment for the visiting public.

Non-commercial tree harvest

Non-commercial tree harvest would be limited to established roads and trails. Some visitors could be temporarily disrupted by the sound of power saws during wood collection, but the activity would not have a detrimental effect on their overall experience.

Commercial tree harvest

Impacts: Commercial tree harvest could interrupt some visitor uses in forested areas, except for designated wilderness where tree harvest would not occur. Active forest management activities could temporarily disrupt visitor experiences but would be limited to the time it takes to treat a management site. Interruptions could include temporary closures to areas generally open to the public, increased vehicle traffic during tree removal, increased noise from machinery and equipment and disruption to wildlife dependent recreation (e.g., displacing wildlife for observation and photography or closures during hunting seasons). Impacts to visitor use would be infrequent and minimal.

Commercial tree harvest activities could disrupt familiar recreational patterns of visitors by altering the seral stage of a habitat, but would ultimately provide new, unique opportunities for wildlife-related recreation. Long term benefits of forest management in green tree reservoir units would result in higher waterfowl use and better access for hunters. Forest management techniques that offer earlier succession habitats would benefit both deer and turkeys, improving wildlife dependent recreational opportunities.

To ensure the safety and awareness of visitors, areas of the refuge undergoing active forest management would be signed if occurring in places normally open to the public and all notification procedures would be followed. Trails would be shared by the public and logging equipment until harvest operations were complete.

Mitigation: This use would take place in a controlled area of the refuge, and most closures would occur on less than 2% of the refuge at any one time. Enough locations would remain open to visitors to minimize the impact to recreational opportunities. Tree removal could temporarily detract from the aesthetics of an area but would improve once revegetation begins. Depending on the silvicultural treatment being used, visual buffers (e.g., leave patches or strips) adjacent to roads or other access point would be retained to maintain aesthetic viewscapes.

Cultural Resources

The refuge has a rich history of human use by many cultures spanning thousands of years. Partial and completed archeological surveys of the Mingo National Wildlife Refuge have covered nearly 7,200 acres. These surveys and other sources have identified more than 140 cultural resources sites on the refuge. These sites represent cultural periods from the earliest Paleo-Indian through the 20th century (USFWS, 2007). The refuge contains one property, the Mingo National Wildlife Refuge Archeological District, listed under the National Register of Historic Places.

The North American Consultation Database, which is managed by the National Park Service, assists federal agencies in fulfilling the requirements of the Native American Graves and Protection and Repatriation Act. No tribes with identified interests in Stoddard and Wayne counties have been identified by the database. However, this information is not a comprehensive list and is based on a limited number of legal

sources (USFWS, 2007).

Non-commercial tree harvest

Non-commercial tree harvest of fallen trees would occur along well-established roadways and trails without the use of heavy equipment. The potential to encounter or effect cultural resources for this use are negligible.

Commercial tree harvest

The National Historic Preservation Act requires Mingo National Wildlife Refuge to consider potential affects to cultural resources when undertaking a management action. Planning for commercial tree harvests and issuing permits would include coordination and clearance from the Regional Historic Preservation Officer. Once a potential tree harvest site has been identified, a request for review would be provided to the officer to ensure compliance with the National Historic Preservation Act. Commercial tree harvest would only be conducted in areas where the potential to encounter cultural resources is minimal.

Mitigation: Commercial tree harvest would only be conducted in areas where the potential to encounter cultural resources is minimal. When possible, forest management would primarily be conducted in the winter months when the soil is frozen and on dry ground, which further mitigates potential disturbance to cultural resources.

All management actions would stop immediately if unknown or unanticipated cultural resources were discovered. The Regional Historic Preservation Officer would be contacted as soon as possible to ensure compliance with the National Historic Preservation Act.

Refuge Management and Operations

Mingo National Wildlife refuge has five public access roads. Each green tree reservoir unit is bordered on at least one side by a raised levee or hard-base road. These structures are available for administrative and management use.

A series of ditches, levees and water control structures manipulate water flow on the refuge, mimicking once natural water fluctuations, and provide habitat for wildlife (USFWS, 2007).

Commercial tree harvest

Interruption to some management and operations would occur while implementing forest management activities in green tree reservoirs. Interruptions would be temporary, lasting approximately the amount of time it would take treat the desired site. Interruptions would include closure of areas to the other management activities and increased traffic during tree removal for both the public and staff.

Socioeconomics

Mingo National Wildlife Refuge is located in Wayne and Stoddard counties and is adjacent to Bollinger and Butler counties. Compared to the state of Missouri, this four-county area has a smaller population growth rate and is less racially and ethnically diverse. The area's population has a lower average income, and less high school and college education than the state's population (USFWS, 2007).

Each year the refuge attracts thousands of visitors, and these visitors bring socioeconomic activity to the surrounding communities as people purchase fuel, outdoor gear and visit local establishments.

Indirect effects of non-commercial tree harvest removal could lead to personal gain by individuals that are permitted to remove trees. For example, firewood harvested from the refuge could be used to offset home heating costs, for recreational campfires and/or for personal hobbies or crafts.

Commercial tree harvest would result in economic benefit to the operator. Harvest activities also provide an economic return to the community through the operation of sawmills to process wood and fuel costs.

Wilderness

Congress designated 7,730 acres as the Mingo Wilderness Area in the western portion of the refuge in 1976. Wilderness policy permits hiking, backpacking, fishing, wildlife observation, environmental education and interpretation. Motorized activities are generally prohibited except tools like chainsaws may be used in wildland fire management after a minimum impact suppression tactics analysis has been completed.

Non-commercial and commercial tree harvest would not occur in the Mingo National Wildlife Refuge Wilderness Area.

Floodplains

This project would occur in a floodplain. Tree harvest activities would not contribute to flood damage or negative impacts to the floodplain. Mitigation and avoidance measures are outlined in this document and the forest management plan (USFWS, 2023).

Long-term impacts

This compatibility determination includes the written analyses of the environmental consequences on a resource only when long-term impacts on that resource could be more than negligible and therefore considered an "affected resource." Air quality, floodplains, wilderness, cultural resources, refuge management and operations and socioeconomics would not be more than negligibly impacted by the action, as there are mitigation measures in place to reduce long-term impacts and have been dismissed from further analyses.

Wildlife (terrestrial species), Threatened and Endangered Species, Habitat and Vegetation and Aquatic Species

Land use practices and modifications to the hydrology of the Mingo basin over the past 120 years impeded drainage, causing seasonal flooding to persist for longer than had occurred historically (Heitmeyer et al., 1989). The prolonged flooding helped shift composition of bottomland hardwood forests towards species with greater water tolerances, and largely eliminated regeneration resulting in single-aged mature stands. Changes to the drainage system now allow for water management that more closely resembles those earlier conditions and the restoration of species associated with those conditions. One of the refuge's objectives would be to more actively manage bottomland forest habitat to benefit forest-dependent wildlife, especially certain species of migratory waterfowl, neotropical migratory birds and mammals (USFWS, 2007).

Although tree removal can alter forested landscapes, most wildlife species would not be negatively affected long-term by tree harvest activities on the refuge. Carefully managed harvest would provide lasting benefits to wildlife by restoring or enhancing habitats and increasing or maintaining habitat diversity (e.g., forest stand age, species and structure). Active wildlife management practices are essential as natural ecological processes (e.g., fire regimes) and habitats have been degraded and eliminated in some cases. Actions proposed in the forest and habitat management plans, such as increasing forest compositional diversity, contribute to promoting resiliency and adaptive capacity of the existing forest ecosystems.

Wildlife, threatened and endangered species, aquatic species, habitat and vegetation would see a beneficial, long-term impact from forest management activities. All bottomland habitat types within the modern-day refuge have been altered by unnatural flood regimes and past land-use history. Implementing the ecological forestry prescriptions outlined in the forest management plan would meet desired forest conditions. These desired conditions would be based on the ecological and habitat needs of wildlife on the refuge. Management efforts for priority wildlife species, which were historically found in the Mississippi Alluvial Valley and Central Hardwoods, should benefit from these prescriptions through improved habitat and vegetative conditions of forested areas (USFWS, 2011; 2023).

Commercial tree harvest decisions would be based on sound science and the best available information and technology to ensure quality management for priority natural resources. Management efforts would focus on meeting forest and habitat plan objectives (USFWS, 2011; 2023).

Managing refuge habitat for priority resources of concern yields the greatest benefit to trust resources and maintains and enhances the biological integrity, diversity and environmental health of the refuge (USFWS, 2023). Carefully managed tree harvest would provide long-term benefits to wildlife and plants by improving overall forest health.

Water Quality

Maintaining forested buffers near streams and other aquatic resources would minimize long-term impacts on water resources and water quality. Carefully considered access points, skid trail planning and harvest operations would follow best management practices provided by the agency to minimize the alteration of hydrology and the impacts of siltation on water quality (MDC, 2014; MFRC, 2014).

Geology and Soils

Maintaining soil productivity is critical to sustainable forest management because of its capacity to support plant growth and habitat for wildlife. Careful planning minimizes the forested area occupied by roads, landings and skid trails, and their location would be based on topography and soil types. Alternating between equipment and techniques (i.e., mechanical harvesters, forwarders or other low-impact or low-ground pressure equipment) would avoid soil compaction, rutting and erosion. Distributing slash across the site would reduce nutrient depletion and sedimentation (MDC, 2014; MFRC, 2013; 2014).

Visitor Use and Experience

The long-term impacts associated with other refuge user groups would be anticipated to positive as forest management would increase presence and therefore observation of bird or other wildlife species, provide for enhanced opportunities for environmental education regarding the benefits of forest management to wildlife habitat and improved hunting opportunities and access.

Climate Change

Climate change is a growing concern for land managers regarding long-term forest management. Although exact future climatic conditions are uncertain, some predictions can be made regarding how forested vegetation and habitats will respond to various climate change scenarios and their vulnerability to these changes (Handler et al., 2014).

Forests remove carbon from the atmosphere and store it in vegetative tissue such as stems, roots, barks and leaves. Through photosynthesis, all green vegetation removes carbon dioxide and releases oxygen into the atmosphere. The remaining carbon is used to create plant tissues and store energy (Eve et al., 2014).

Some of the carbon in forests is released to the atmosphere after tree harvest. The amount of carbon released, and when, depends on how the removed trees are used. If trees are used to make wood products, a portion of the sequestered carbon will remain stored for up to several decades or longer. If trees are burned and used to produce energy, carbon will be released through combustion but may also prevent

carbon emissions that would have been released through the burning of fossil fuels (Eve et al., 2014).

Forestry practices typically trigger ecosystem responses that change over time. For example, a newly established forest will take up carbon at a low rate initially, and then pass into a period of relatively rapid carbon accumulation. The carbon uptake rate will then typically decline as heterotrophic and autotrophic respiration increase and growth is balanced against mortality in the older forest (Eve et al., 2014).

Many of the strategies and techniques mentioned in this compatibility determination would favor conditions that decrease climate risk impacts to vegetation. These strategies would include increasing species and structural diversity, managing for natural conditions and disturbance regimes and maintaining deer and pest populations or disease at levels that would not exacerbate the effects of climate change (Handler et al., 2017; Swanston et al., 2016).

Public Review and Comment

The draft compatibility determination will be available for public review and comment for 15 days from July 26, 2023 to August 9, 2023. The public will be made aware of this comment opportunity through newspapers, radio, television, postings at local libraries, letters to potentially interested stakeholders such as adjacent landowners, states and public listening sessions. The compatibility determination was posted at the Mingo National Wildlife Refuge Office/Visitor Center at 24279 State Highway 51, Puxico, MO 63960, Refuge website, Puxico Public Library at 201 Hickman Street, Puxico, MO 63960 and made available by the refuge manager, Ben Mense at (573) 222-3589; or ben_mense@fws.gov, upon request. Notification about public comment opportunities and electronic versions of the draft compatibility determination are available online: https://www.fws.gov/refuge/mingo/. Please let us know if you need the documents in an alternative format. Concerns expressed during the public comment period will be addressed in the final compatibility determination.

Determination

Is the use compatible? Yes

Choose an item.

Stipulations Necessary to Ensure Compatibility

To ensure compatibility with the National Wildlife Refuge System Improvement Act and refuge establishing purposes, goals and objectives, non-commercial and commercial tree harvest can only occur with the following stipulations:

1. All tree harvest requires compliance with a special use permit. The permit stipulates the applicable requirements based on the forest and habitat

management plans.

2. Special use permits will be issued by the refuge manager and list special conditions that must be met to avoid, mitigate or minimize adverse impacts to habitat, fish and wildlife resources, cultural resources and the visiting public.
3. Each special use permit will be issued to minimize or eliminate site specific impacts, to meet specific habitat and related wildlife objectives, to respond to maintenance and safety needs and to contribute to the purposes of the refuge.
4. All tree harvest is monitored by the refuge staff for compliance with the special use permit.
5. For commercial tree harvest, no harvest of standing trees will occur from June 1 through July 31 to adhere to Northern long-eared bat guidelines (see threatened and endangered species section above).
6. Standing cavity trees and snags actively being used by wildlife will be marked and protected.
7. When possible, access for tree removal will be limited to existing roads, trails or fire breaks.
8. When possible, timing of tree removal activities will be restricted to late summer, which is typically dry following the growing season, or winter when the ground is frozen, to prevent excessive damage to actively growing vegetation, disturbance to wildlife, the spread of tree disease(s), site damage and soil rutting. Additional restrictions may be required in areas with hydric soils to minimize soil compaction, erosion and impacts to cultural resources.
9. No motorized vehicles can be used beyond existing roads or trails for non-commercial tree harvest (e.g., firewood collection).
10. Permittees will be required to follow all state and federal quarantine measures regarding movement of firewood.
11. Commercial equipment must be cleaned prior to entering the refuge to prevent the spread of invasive plant species and is subject to inspection.
12. Commercial tree harvest will use management techniques that emulate natural disturbance regimes.
13. Each tree harvest sale must have a detailed plan that outlines the specific goals and objectives of the management action, existing stand conditions, silvicultural treatment to be used, logger guidelines that consider equipment limitations, projected outcomes and any other relevant concerns.

Justification

The stipulations outlined above would help ensure that the use is compatible at Mingo National Wildlife Refuge. Non-commercial and commercial tree harvest as

outlined in this compatibility determination, would not conflict with the national policy to maintain the biological diversity, integrity and environmental health of the refuge. Based on available science and best professional judgement, the agency has determined that non-commercial and commercial tree harvest at Mingo National Wildlife Refuge, in accordance with the stipulations provided here, would not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purpose of Mingo National Wildlife Refuge. Rather, appropriate and compatible non-commercial and commercial tree harvest would be a use of Mingo National Wildlife Refuge that maintains healthy, productive habitats and provides the public with an opportunity to enjoy wildlife and wild lands.

Signature of Determination

Refuge Manager Signature and Date

Signature of Concurrence

Assistant Regional Director Signature and Date

Mandatory Reevaluation Date: 2031

Literature Cited/References

Adams, M. B., Jurgensen, M., Palik, B., Miller, C., and Page-Dumroese, D. 2021. Woodstake decomposition twenty years after organic matter removal at the Lake States LTSP sites. *Forest Ecology and Management* 496: 119456. https://doi.org/10.1016/j.foreco.2021.119

Bormann, F. H., Likens, G. E., Fisher, D W., and Pierce, R. S. 1968. Nutrient loss accelerated by clear-cutting of a forest ecosystem. *Science* 159(3817): 882-884. https://doi.org/10.1126/science.159.3817.882

Bormann, F. H., Likens, G. E., Siccama, T. G., Pierce, R. S., and Eaton, J. S. 1974. The export of nutrients and recovery of stable conditions following deforestation at Hubbard Brook. *Ecological Monographs* 44(3): 255-277. https://doi.org/10.2307/2937031

Braccia, A., and Batzer, D. P. 2001. Invertebrates associated with woody debris in a southeastern U.S. forested floodplain wetland. *Wetlands* 21: 18–31. https://link.springer.com/content/pdf/10.1672/0277-5212%282001%29021%5B0018:IAWWDI%5D2.0.CO%3B2.pdf 456

Campbell, I. C. and Doeg, T. J. 1989. Impact of timber harvesting and production on streams: A review. *Australian Journal of Marine and Freshwater Research* 40(5): 519-539. https://doi.org/10.1071/MF9890519

Campbell, S. P., Witham, J. W., and Hunter Jr, M. L. 2007. Long-term effects of group-selection timber harvesting on abundance of forest birds. *Conservation Biology* 21(5): 1218-1229. https://dio.org/10.1111/j.1523-1739.2007.00768.x

Clatterbuck, W. K. and Meadows, J. S. 1993. Regenerating oaks in the bottomlands. Oak Regeneration: Serious Problems, Practical Recommendations, Symposium Proceedings. United States Department of Agriculture. Forest Service General Technical Report. SE-84: 84-195.

Currylow, A. F., MacGown, B. J., and Williams, R. N. 2012. Short-term forest management effects on a long-lived ectotherm. *Plos ONE* 7(7): *e*40473. https://doi.org:10.1371/journal.pone.0040473

deMaynadier, P. G., and Hunter Jr., M. L. 1995. The relationship between forest management and amphibian ecology: A review of the North American literature. *Environmental Review* 3(3-4): 230-261. https://www.researchgate.net/publication/237154451_The_relationship_between_forest_management_and_amphibian_ecology_a_review_of_the_North_American_Literature

Environmental Protection Agency. 2022. Bottomland hardwoods. https://www.epa.gov/wetlands/bottomland-hardwoods

Enge, K. M., Thomas, T. M, and Suarez, E. 2014. Population status, distribution, and movements of the alligator snapping turtle in the Suwannee River, Florida. Final report, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Wildlife Research Laboratory.

Ernst, C. H. and Lovich, J. E. 2009. Turtles of the United States and Canada (2nd ed.). The John Hopkins University Press.

Eve, M., Pape, D., Flugge, M., Steele, R., Derina, M., Riley-Gilbert, M., and Biggar, S. (Eds.). 2014. Quantifying greenhouse gas fluxes in agriculture and forestry: Methods for entity-scale inventory. United States Department of Agriculture Technical Bulletin 1939. https://www.usda.gov/sites/default/files/documents/USDATB1939_07072014.pdf

Ewert, M.A., Jackson, D. R., and Moler, P. E. 2006. *Macrochelys temminckii* -Alligator Snapping Turtle. In P.A. Meylan (Ed.), *Biology and conservation of Florida turtles. Chelonian Research Monographs* 3. Chelonian Research Foundation.

Fredrickson, L. H. 1979. Floral and faunal changes in lowland hardwood forests in Missouri resulting from channelization, drainage, and impoundment. U.S. Fish and Wildlife Service, Biological Services Program. FWS/OBS-78/9

Fredericksen, T. S., and Mostacedo, B. 2000. Regeneration of timber species following selection logging in a Bolivian tropical dry forest. *Forest Ecology and Management* 131(1-3): 47-55. https://doi.org/10.1016/S0378-1127(99)00199-1

Gore, J. A., and Patterson III, W. A. 1986. Mass of downed wood in northern hardwood forests in New Hampshire: Potential effects of forest management. *Canadian Journal of Forest Research* 16(2): 335-339. https://cdnsciencepub.com/doi/abs/10.1139/x86-

057

Handler, S., Marcinkowski, K., Janowiak, M., and Swanston, C. 2017. Climate change field guide for northern Minnesota forests: Site-level considerations and adaptation. Technical Report #2. U.S. Department of Agriculture, Forest Service, Northern Research Station and University of Minnesota College of Food, Agricultural and Natural Resource Sciences. www. forestadaptation.org/MN_field_guide.

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

Heitmeyer, M. E., Nelson, F. A., and Fredrickson, L. H. 2006. An Evaluation of ecosystem restoration and management options for the duck Creek/Mingo Basin Area of Southeast Missouri. Special Publication No. 12. https://ecos.fws.gov/ServCat/DownloadFile/102052?Reference=5830

Helfrich, L. A., D. L. Weigmann, and Neves, R. J. 2009. Landowner's guide to managing streams in the Eastern United States. Virginia Cooperative Extension.

Holmes, S. B., and Pitt, D. G. 2007. Response of bird communities to selection harvesting in northern tolerant hardwood forest. *Forest Ecology and Management* 238: 280-292.

Howey, C. A. F. and Dinkelacker, S. A. 2009. Habitat selection of the alligator snapping turtle (*Macrochelys temminckii*) in Arkansas. *Journal of Herpetology* 43(4): 589-596. http://www.jstor.com/stable/25599260

Meadows, J. S. and Stanturf, J. A. 1997. Silvicultural systems for southern bottomland hardwood forests. *Forest Ecology and Management* 90: 127-140.

Minnesota Department of Natural Resources. 1995. Protecting water quality and wetlands in forest management: Best management practices in Minnesota. Minnesota Department of Natural Resources, Division of Forestry. https://www.lrl.mn.gov/docs/2015/other/155132.pdf

Minnesota Forest Resources Council. 2013. Sustaining Minnesota forest resources: Voluntary site-level forest management guidelines for landowners, loggers and resource managers. https://mn.gov/frc/assets/MFRC_Revised_Forest_Management_Guidelines_w_links_tcm1162-507039.pdf

Minnesota Forest Resources Council. 2014. Minnesota's forest management guidelines: Quick reference field guide. https://mn.gov/frc/assets/MFRC_Forest_Mangement_Field_Guides_2014-1_With-Bookmarks_tcm1162-502201.pdf

Missouri Department of Conservation. 2014. Missouri Forest Management Guidelines. https://mdc.mo.gov/trees-plants/forest-care/missouri-forest-management-

guidelines

Nelson, P. W. 2010. The terrestrial natural communities of Missouri. Missouri Natural Areas Committee.

New Hampshire Division of Forest Lands and University of New Hampshire Cooperative Extension. 2016. New Hampshire Best management practices for erosion control on timber harvesting operations. https://extension.unh.edu/sites/default/files/migrated_unmanaged_files/Resource000247_Rep266.pdf

Nichols, M. T., Lemin Jr., R., and Ostrofsky, W. D. 1994. The impact of two harvesting systems on residual stems in a partially cut stand of northern hardwoods. *Canadian Journal of Forest Research* 24:350–357.

Phillips, M. J. 1997. Forestry best management practices for wetlands in Minnesota. *In C. C. Trettin (Ed.), Northern forested wetlands ecology and management (1st edition)*. Routledge. https://doi.org/10.1201/9780203745380

Ruel, J. C. 1995. Understanding windthrow: Silvicultural implications. *The Forestry Chronicle* 71(4): 434-445. https://doi.org/10.5558/tfc71434-4

Sakai, A. K., Allendorf, F. W., Holt, J. S., Lodge, D. M., Molofsky, J., With, K. A., Baughman, S., Cabin, R. J., Cohen, J. E., Ellstrand, N. C., McCauley, D. E., O'Neil, P., Parker, I. M., Thompson, J. N., and Weller, S. G.. 2001. *The population biology of invasive species. Annual Review of Ecology and Systematics* 32:305–332. https://doi.org/10.1146/annurev.ecolsys.32.081501.114037

Scheller, R. and Mladenoff, D. 2004. A forest growth and biomass module for a landscape simulation model, LANDIS: Design, validation, and application. *Ecological Modelling* 180: 211-229. 10.1016/j.ecolmodel.2004.01.022

Siitonen, J. 2001. Forest management, coarse woody debris and saproxylic organisms: Fennoscandian boreal forests as an example. *Ecological Bulletins* 49: 11-41. http://www.jstor.org/stable/20113262

Swanston, C. W., Janowiak, M. K., Brandt, L. A., Butler, P. R., Handler, S. D., Shannon, P. D., Derby Lewis, A., Hall, K., Fahey, R. T., Scott, L., Kerber, A., Miesbauer, J. W., Darling, L., Parker, L., and St. Pierre, M. 2016. Forest adaptation resources: Climate change tools and approaches for land managers, 2nd edition. General Technical Report NRS-GTR-87-2. U.S. Department of Agriculture, Forest Service, Northern Research Station. http://dx.doi.org/10.2737/NRS-GTR-87-2

Taylor, D. A. R., Perry, R. W., Miller, D. A., and Ford, W. M. 2020. Forest management and bats. White-nose Syndrome Response Team. https://ecos.fws.gov/ServCat/DownloadFile/102052?Reference=5830

Twedt, D. J., Pashley, D., Hunter, J. C., Mueller, A., Brown, C., and Ford, B. 1999. Partners in flight bird conservation plan for the Mississippi Alluvial Valley.

United States Fish and Wildlife Service. 2006. Indiana bat fact sheet. https://www.fws.gov/sites/default/files/documents/508_Indiana%20bat%20fact%20sheet.pdf

United States Fish and Wildlife Service. 2007. Mingo, Pilot Knob and Ozark Cavefish National Wildlife Refuges: Comprehensive conservation plan and environmental assessment. https://ecos.fws.gov/ServCat/Reference/Profile/5975

United States Fish and Wildlife Service. 2008. Forest management practices for conserving Indiana bats and summer habitat. https://www.fws.gov/sites/default/files/documents/Indiana%20Bat%20Timber%20Management%20Guidelines%20Maternity.pdf

United States Fish and Wildlife Service. 2010. Mingo National Wildlife Refuge compatibility determination: Timber harvesting (commercial and non-commercial). https://ecos.fws.gov/ServCat/DownloadFile/180845

United States Fish and Wildlife Service. 2011. Mingo National Wildlife Refuge habitat management plan. https://ecos.fws.gov/ServCat/DownloadFile/16134

United States Fish and Wildlife Service. 2014. The northern long-eared bat interim conference and planning guidance. https://www.fws.gov/sites/default/files/documents/Northern%20Long%20Eared%20Bat%20Interim%20Conference%20and%20Planning%20Guidance.pdf

United States Fish and Wildlife Service. 2015. Northern long-eared bat fact sheet. https://www.fws.gov/sites/default/files/documents/508_NLEB%20fact%20sheet.pdf

United States Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants; 4(d) Rule for the Northern Long-Eared Bat. 81 Federal Register 1900 (February 16, 2016) (to be codified at 50 CFR 17).

United States Fish and Wildlife Service. 2016. Mingo National Wildlife Refuge compatibility determination: Firewood harvest. https://ecos.fws.gov/ServCat/DownloadFile/180827

United States Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Threatened species status with Section 4(d) Rule for alligator snapping turtle. 86 Federal Register 214 (November 9, 2021). Docket No. FWS–R4–ES–2021–0115; FF09E21000 FXES1111090FEDR 223

United States Fish and Wildlife Service. 2023. Mingo National Wildlife Refuge forest management plan. In progress.

United States Forest Service. 2015. Conservation and management of monarch butterflies: A strategic framework. United States Department of Agriculture.

United States Forest Service. Accessed 5-15-2023. Wilderness know before you go –

USDA Forest Service.
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd1053987.pdf

Wiest, R. L. 1998. A Landowner's Guide to Building Forest Access Roads. U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forest

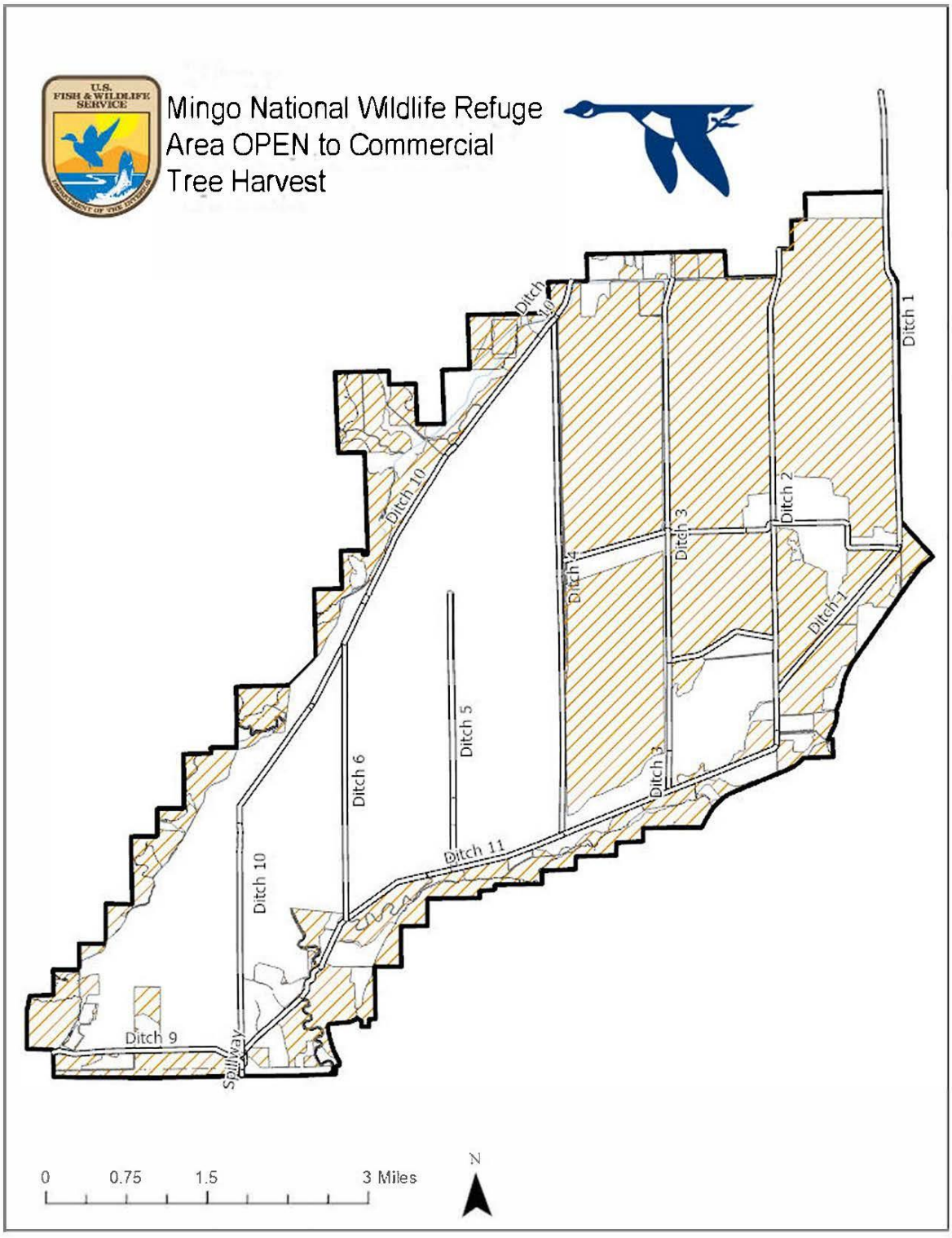

Figure 1. Management units open to commercial tree harvest (diagonal lines) on Mingo National Wildlife Refuge.