Draft Environmental Assessment

Big Oaks National Wildlife Refuge
Continued Herbicide Application

July 2022

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Environmental Assessment for Continued Herbicide Application on Big Oaks National Wildlife Refuge

Date: July 15, 2022

This Draft Environmental Assessment (EA) is being prepared to evaluate the effects associated with the proposed action and complies with the National Environmental Policy Act in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (43 CFR 46; 516 DM 8) and U.S. Fish and Wildlife Service (550 FW 3) regulations and policies. The National Environmental Policy Act (NEPA) requires examination of the effects of proposed actions on the natural and human environment.

Proposed Action

The U.S. Fish and Wildlife Service (USFWS, Service) is proposing the continued use of herbicides on Big Oaks National Wildlife Refuge (NWR, refuge) for vegetation management. Both ground and aerial herbicide applications would continue to control, prevent, and limit the spread of invasive species and other undesirable vegetation within all habitat management units and for use on or around refuge roads and facilities needed for visitor use. Herbicide application is often the most logistically feasible and cost-effective management tool to control vast expanses of invasive and other undesirable vegetation located in remote areas of the refuge. Aerial herbicide application and prescribed fire are the only habitat management tools available on much of Big Oaks NWR due to the presence of munitions and unexploded ordnance (UXO) associated with past land use.

A different or revised proposed action may evolve during the NEPA process as the agency refines its proposal and gathers feedback from the public, tribes, and other agencies. Therefore, the final proposed action may be different from the original. The proposed action will be finalized at the conclusion of the public comment period for the EA.

Background

National wildlife refuges are guided by the mission and goals of the National Wildlife Refuge System (NWRS), the purposes of an individual refuge, Service policy, and laws and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of

1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations and USFWS Manual.

Establishment of Big Oaks NWR (Figure 1) was made possible in 2000 when the U.S. Army, USFWS, and U.S. Air Force signed a Memorandum of Understanding (MOU). The MOU was developed under the general authority of the Fish and Wildlife Act of 1956 [16 USC 742a-742j] as amended and the Endangered Species Act of 1973 [16 U.S.C. 1531-1544]. The MOU resulted in a 25-year real estate permit from the U.S. Army for establishment of a national wildlife refuge on a portion of the former Jefferson Proving Ground munitions testing facility. The MOA was revised in 2020 and resulted in the 99-year permit for management of U.S. Army lands as Big Oaks NWR (United States Department of the Army et al. 2020).

The purpose of Big Oaks NWR is, "*For development, advancement, management, conservation, and protection of fish and wildlife resources and to conserve fish, wildlife, and plants, including those which are listed as endangered or threatened*." The purpose is derived directly from the refuge's enabling authorities. The Fish and Wildlife Act of 1956 authorizes the Secretary of the Interior to acquire interests in property "...*for the development, advancement, management, conservation, and protection of fish and wildlife resources*..." The Endangered Species Act of 1973 authorizes the Secretary of Interior to acquire interests in lands "*to conserve fish, wildlife, and plants, including those which are listed as endangered or threatened*..." Other activities may also be accommodated, provided they are compatible with the refuge purpose (as per Service Compatibility Policy, Federal Register 65 (202): 62484-62496).

Big Oaks NWR's mission statement derives from its purpose and is, *''To preserve, conserve, and restore biodiversity and biological integrity for the benefit of present and future generations of Americans*." Management goals for the refuge were established in 2000 with an Interim Comprehensive Conservation Plan (CCP) (USFWS 2000) and include:

- **Goal 1** -To preserve, conserve, and restore fish, wildlife, and plants listed as endangered and threatened and those species of management concern whose populations are declining.
- **Goal 2** - To preserve, conserve, and restore a natural diversity and abundance of fish, wildlife, and plants by protecting, restoring, and managing large blocks of forest, grassland, shrub land habitats.

The mission of the NWRS, as outlined by the National Wildlife Refuge System Administration Act (NWRSAA), as amended by the National Wildlife Refuge System Improvement Act (16 U.S.C. 668dd et seq.), 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." Additionally, the NWRSAA mandates the Secretary of the Interior in administering the NWRS (16 U.S.C. 668dd(a)(4)) to:

- Provide for the conservation of fish, wildlife, and plants, and their habitats within the NWRS
- Ensure that the biological integrity, diversity, and environmental health of the NWRS are maintained for the benefit of present and future generations of Americans
- Ensure that the mission of the NWRS described at 16 U.S.C. 668dd(a)(2) and the purposes of each refuge are carried out
- Ensure effective coordination, interaction, and cooperation with owners of land adjoining refuges and the fish and wildlife agency of the states in which the units of the NWRS are located
- Assist in the maintenance of adequate water quantity and water quality to fulfill the mission of the NWRS and the purposes of each refuge
- Recognize compatible wildlife-dependent recreational uses as the priority public uses of the NWRS through which the American public can develop an appreciation for fish and wildlife
- Ensure that opportunities are provided within the NWRS for compatible wildlife-dependent recreational uses
- Monitor the status and trends of fish, wildlife, and plants in each refuge

Big Oaks NWR has long used herbicides to meet the conservation and facility maintenance obligations detailed in the MOU and with the Interim CCP goals. The refuge is re-evaluating the use of herbicides in response to increased pressure from invasive species and other undesirable vegetation resulting from range expansions and environmental alterations associated with climate change. The threats posed by emerging invasive species and other undesirable vegetation are expected to continue and potentially increase.

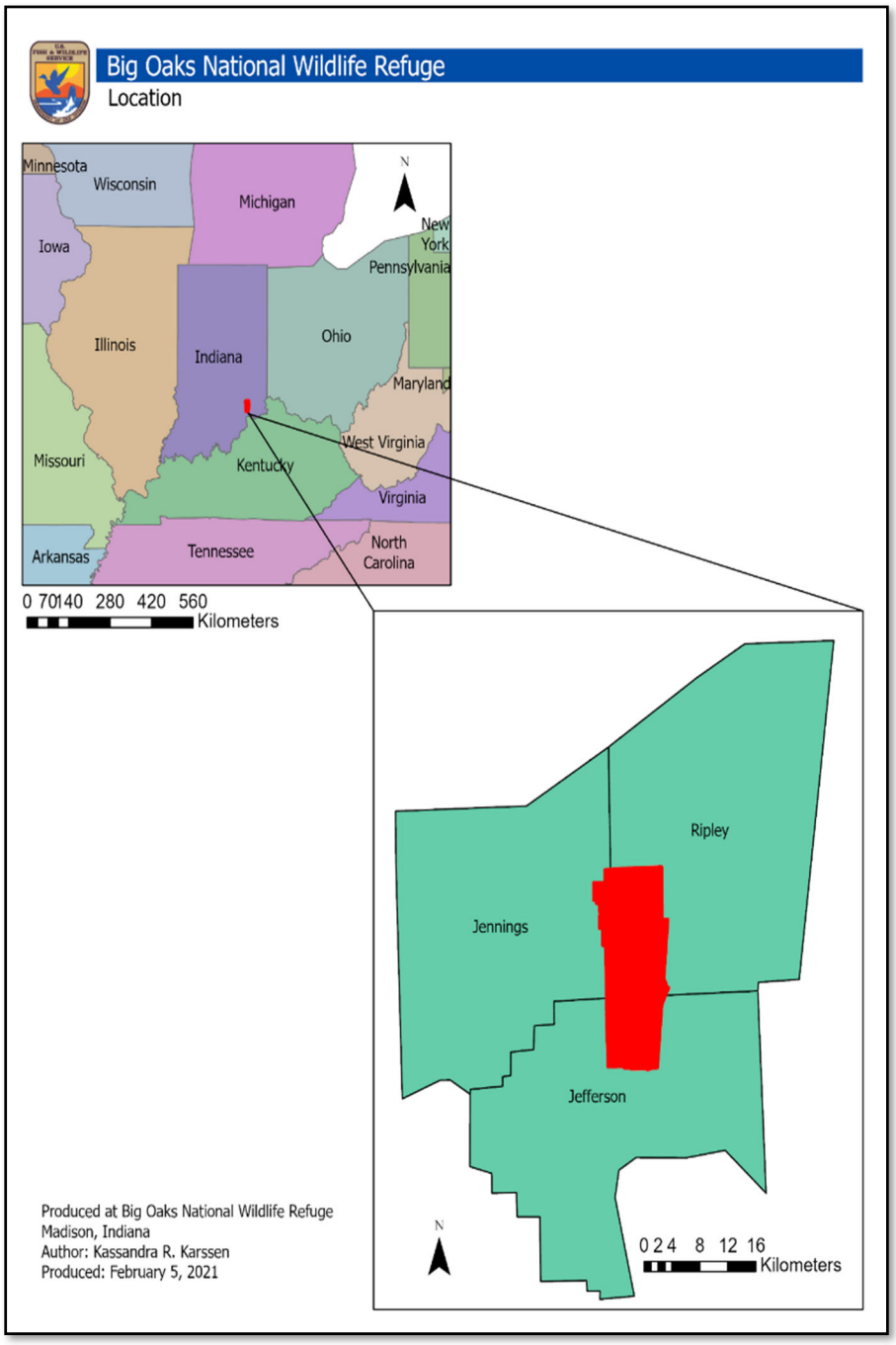

Figure 1. Location of Big Oaks National Wildlife Refuge in Jefferson, Jennings, and Ripley Counties, southeastern Indiana, along US HWY 421 and Old Michigan Rd between Versailles and Madison, IN (1661 W JPG Niblo Rd, Madison, IN 47250). The refuge is indicated with red on both the regional and county-level maps in this figure.

Purpose and Need for the Proposed Action

The purpose of the proposed action is to control, prevent, and limit the spread of invasive species and other undesirable vegetation within all Big Oaks NWR habitat management units and for use on or around refuge facilities. The rapid growth of invasive species and other undesirable vegetation can displace native plants and significantly alter fish and wildlife habitats. This directly affects the refuge's biological integrity, diversity, wildfire risk, and environmental health. Undesirable vegetation can impact refuge facilities and degrade roads, trails, dams, buildings, kiosks and other improvements.

The need for this proposed action is to meet Service priorities and mandates as outlined by the NWRSAA including "*Provide for the conservation of fish, wildlife, and plants, and their habitats within the NWRS*" and "*Ensure that the biological integrity, diversity, and environmental health of the NWRS are maintained for the benefit of present and future generations of Americans*" (16 U.S.C. 668dd(a)(4)). The threats posed by invasive species and other undesirable vegetation have increased because of range expansions and changing environmental conditions associated with climate change. The use of herbicides is the most efficient and safest way to control, prevent, and limit the spread of invasive and other undesirable plant species across Big Oaks NWR. The prevalence of UXO on most of the refuge's management units means aerial herbicide application is often the only safe management option.

Alternatives

Alternative A – Continued Herbicide Use– No Action and Proposed Alternative

Under the No Action and Proposed Alternative, the refuge would continue using herbicides to control invasive species and other undesirable vegetation. Herbicide application is needed to effectively control and reduce the overall presence of invasive species and other undesirable vegetation. Ground herbicide applications on Big Oaks NWR would be done with tractors, ATV/UTVs, specialized trucks, and by hand (e.g., cut stump, basal bark, hack and squirt, backpack sprayers, etc.). Aerial applications would be done with fixed-wing aircraft, rotary-winged aircraft, and unmanned aerial vehicles (UAVs). Under the No Action and Proposed Alternative, herbicide applications would continue to be integrated with non-herbicide control methods including mowing, prescribed fire, hand-pulling and biological control when possible. Treatments in closed areas with UXO would be limited to roadside and aerial herbicide applications, prescribed fire and biological control methods.

The USFWS's Integrated Pest Management (IPM) Policy (569 FW 1) requires a sustainable approach to managing pests that uses the following kinds of tools to minimize health, environmental, and economic risks: (1) **Biological** (e.g., predators, parasites, and pathogens),

(2) **Cultural** (e.g., crop rotation, alterations in planting dates, and sanitation), (3) **Physical** (e.g., barriers, traps, hand-pulling, hoeing, mowing, and tilling), and (4) **Chemical** (e.g., pesticides, such as herbicides, insecticides, or fungicides). The IPM Policy also requires review and approval of a pesticide use proposal (PUP) prior to all herbicide applications. All PUPs require a site-specific Endangered Species Act (Section 7) consultation. All herbicide applications on Big Oaks NWR are required to follow product label restrictions (see below) and regionally approved best management practices (BMPs). The BMPs are designed to minimize environmental and safety risks and include:

- **Slopes** - Do not apply pesticides to slopes greater than 5% if significant rainfall is predicted within 24 hours.
- **Wind speed** - Do not apply pesticides when wind velocity exceeds 7 miles per hour or when inversion conditions exist.
- **Buffers** - Use a minimum 25-foot vegetated treatment buffer around all surface water resources.
- **Air temperature** - Do not spray pesticide containing 2,4-D when air temperatures exceed 85°F.
- **Droplet size** - Select nozzles and operate application equipment with boom pressures such that spray droplets produced medium (236 - 340 microns) or coarser (341 - 403 microns) sized droplets.
- **Boom Height** - Do not allow boom height to exceed 20 inches above target canopy.
- **Dye** -Where possible, use a dye for non-crop spot treatment to indicate treated areas.

The Federal Insecticide, Fungicide, and Rodenticide Act [7 U.S.C. §136 et seq. (1996)] requires all herbicide applications follow product label restrictions. These restrictions detail measures to minimize the potential for contamination and non-target effects. The Environmental Protection Agency is the lead agency for approving herbicide product labels (40 CFR; 156) and this process includes NEPA analysis and Endangered Species Act (Section 7) consultations with the USFWS. Therefore, all ground and aerial herbicide applications included in this alternative have received prior environmental analysis and review via the NEPA and Endangered Species Act consultation processes.

Alternative B – Discontinue Herbicide Use

Under this Alternative, the Big Oaks NWR would limit management of invasive species and other undesirable vegetation to non-herbicide methods including prescribed fire, mowing, other cultural/mechanical disturbance methods, hand-pulling, and biological control.

Vegetation management with these methods often requires more frequent treatments than is feasible with current resources. On Big Oaks NWR, the only areas deemed safe by U.S. Army for access by vehicles, and thus available for mowing and other cultural/mechanical disturbance methods, are roads, the perimeter road rights-of-way, one area adjacent to the south perimeter fence, and two grassland units along the east perimeter (Figure 2). Under this Alternative, prescribed fire and biological control would be the only management tools available to control or reduce invasive species and other undesirable vegetation on most of Big Oaks NWR.

Affected Environment and Environmental Consequences

This section is organized by affected resource categories and for each affected resource discusses both (1) the existing environmental baseline in the action area for each resource and (2) the effects and impacts of the proposed action and any alternatives on each resource. The effects and impacts of the proposed action considered here are changes to the human environment, whether adverse or beneficial, that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives. This EA 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." Any resources that will not be more than negligibly impacted by the action have been dismissed from further analyses.

Direct, indirect, and cumulative impacts are evaluated in this environmental assessment. Direct effects are those which are caused by the action and occur at the same time and place. Indirect effects are those which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions.

Big Oaks NWR consists of approximately 50,000 acres in Jefferson, Jennings, and Ripley Counties of southeastern Indiana (Figure 1). The refuge is a critical property within the *Southern Indiana Sentinel Landscape*. Sentinel landscapes are areas in which natural and working lands are well suited to protect defense facilities from land use that is incompatible with the military's mission. The program is administered by the U.S. Department of Agriculture, Department of Defense, and Department of the Interior. The importance of wildlife habitat within Big Oaks NWR has also been recognized at both the state and national levels and the refuge was named a *Globally Important Bird Area* by the National Audubon Society. Many invasive plants already

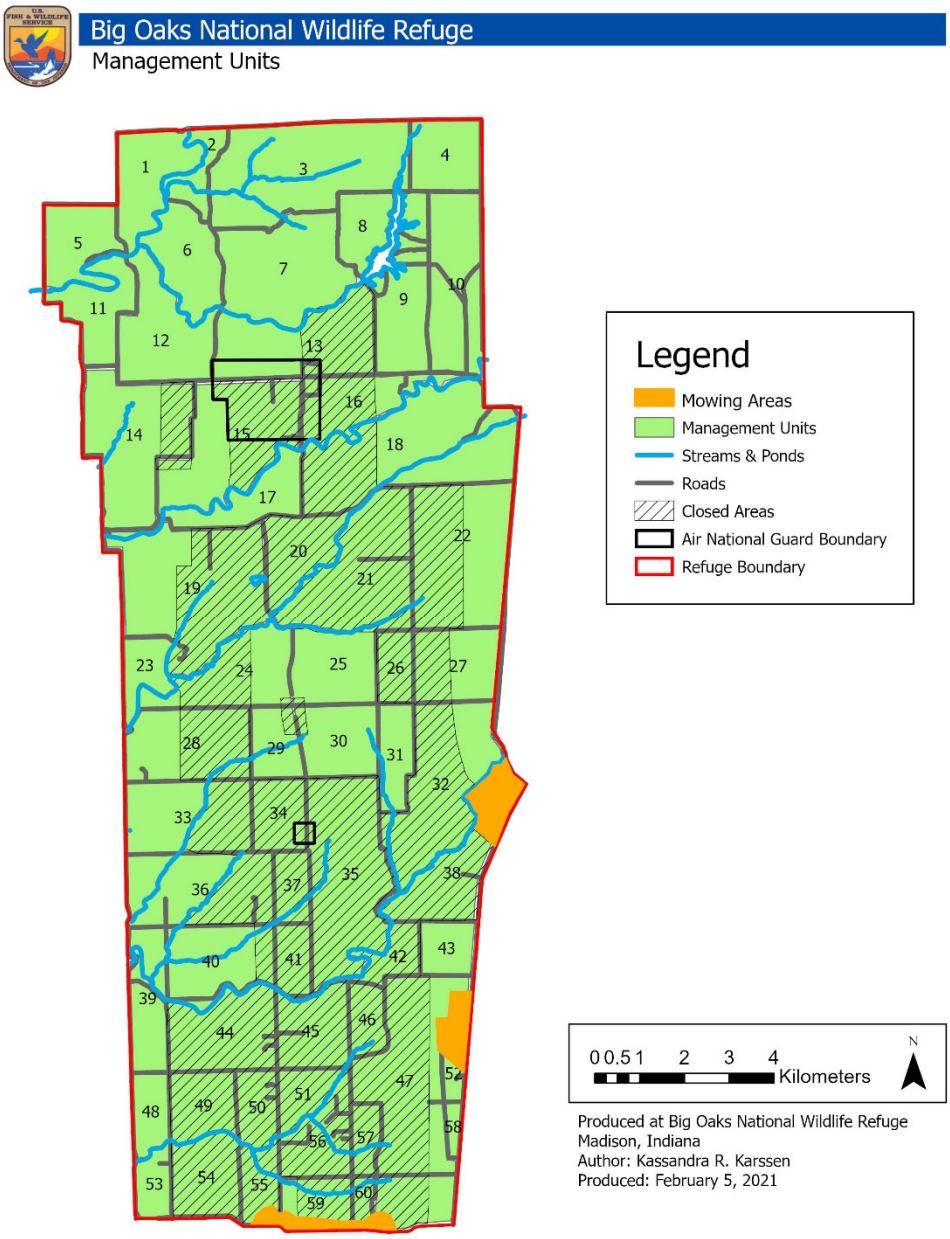

Figure 2. Map of Big Oaks National Wildlife Refuge management units. Portions of 3 management units (indicated with orange as "Mowing Areas") have been approved for tractor access. Vehicular access beyond roads into units (highlighted with green) is restricted because of safety concerns associated with unexploded ordnance. Hatched areas are closed to entry by foot beyond roads.

occur on Big Oaks NWR (detailed below) and are ranked among Indiana's highest priority invasive species (Keller 2020).

The refuge contains some of the largest tracts of contiguous forest communities as well as some of the largest grassland and shrubland communities in southeastern Indiana. Forests comprise about 60% of the refuge, followed by grasslands and shrublands (30%), and wetlands (10%). Large wetlands have been created by beaver (*Castor canadensis*) activity and several small ephemeral wetlands have been created from ordnance testing and restoration of northern crawfish frog (*Lithobates aerolatus*) breeding habitat. Many of the forested ephemeral wetlands are flatwoods that contain a clay soil layer (i.e., fragipans) restricting water percolation.

The proposed action would take place across any of these habitat areas as needed to control, contain, or eradicate invasive plants and other undesirable vegetation known for their ability to survive in nutrient poor soils, produce new stems via root suckers and re-sprouting, and their capacity for voluminous seed production and dispersal. Historically, vegetation management occurred at Jefferson Proving Ground by annual fire resulting from ordnance testing or prescribed fire as well as herbicide and mechanical control using U.S. Army armored equipment. Upon the cessation of ordnance testing, fire frequencies were reduced, and the armored equipment were relocated to active ordnance testing locations. As a result, invasive plants expanded, forming dense monocultures eliminating open landscapes and outcompeting plant species typical of grassland habitats. Most of the grassland management units are inaccessible to people and equipment due to the continued presence of UXO in former testing areas. Also, invasive species have spread into forested areas and reduce the diversity in these habitats. Invasive and undesirable vegetation grow in refuge roads and trails and on refuge buildings and other facilities.

Wildlife habitat throughout the refuge is being degraded due to the rapid expansion of invasive plants and other undesirable vegetation; primarily Japanese stiltgrass (*Microstegium vimineum*), garlic mustard (*Alliaria petiolata*) privets (*Ligustrum* spp.), bush honeysuckles, burning bush (*Euonymus alatus*), multiflora rose (*Rosa multiflora*), Callery pear (*Pyrus calleryana*) and autumn olive (*Elaegnus umbellata*). Non-native, invasive vines are also increasing across the refuge; primarily winter creeper (*Euonymus fortunei*), periwinkle (*Vinca minor*), Japanese honeysuckle (*Lonicera japonica*), Chinese wisteria (*Wisteria sinensis)* and oriental bittersweet (*Celastrus orbiculatus*). Invasive plant species result in a reduction of the floristic diversity of forests, grasslands, and wetlands and reduces habitat availability for many species of rapidly declining bird and bat species. Vegetation management is also needed around buildings, roadsides, and other facilities (e.g., parking areas), safety signs and for road maintenance. Habitat restoration (e.g., pollinator habitat) often uses herbicide application to

remove existing undesirable vegetation to release desirable vegetation or before seeding with native plants.

The following resources either (1) do not exist with the project area or (2) would either not be affected or only negligibly affected by the proposed action: air quality, wilderness, floodplains, cultural resources, socioeconomics, and environmental justice.

Natural Resources

Terrestrial Wildlife and Aquatic Species

Affected Environment

Description of Affected Environment for the Affected Resource

Big Oaks NWR is very important for migratory birds, during both the nesting season and migration. More than 120 species of birds have been recorded breeding and nesting at the refuge and over 200 species of birds use the refuge during migration. Point count surveys conducted between 2001 and 2007 (Avian Knowledge Network 2021) indicated the Henslow's sparrow (*Centronyx henslowii*), cerulean warbler (*Setophaga cerulea*), Kentucky warbler (*Geothlypis formosa*), prairie warbler (*Setophaga discolor*), red-headed woodpecker (*Melanerpes erythrocephalus*), wood thrush (*Hylocichla mustelina*), and black-billed cuckoo (*Coccyzus erythropthalmus*) use Big Oaks NWR during the nesting season. All these species are on the *Partners in Flight* Watch list, which lists species with the highest conservation concern at the continental scale (Rosenberg et al. 2016). The refuge is recognized as a *Globally Important Bird Area* by the National Audubon Society for its outstanding value to wild birds and their habitats and specifically for the refuge's relatively large numbers of nesting Henslow's sparrows (Cooper 2012, Crimmins et al. 2016) and cerulean warblers (Varble 2006, Buehler et al. 2008, Roth and Islam 2008).

Forty-nine species of mammals have been documented on the refuge. A few of the more charismatic species include white-tailed deer (*Odocoileus virginianus*), beaver, bobcat (*Lynx rufus*), and river otter (*Lontra canadensis*). Beavers are a keystone species on Big Oaks NWR creating the largest wetland communities scattered throughout the refuge. The contiguous, mature forest communities provide critical habitat for maternity colonies of Indiana (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*)(see https://ecos.fws.gov/ServCat/DownloadFile/219845). Acoustic surveys conducted from 2012 to 2021 indicated an additional seven bat species occur on the refuge during breeding. This included the big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), eastern small-

footed bat (*Myotis leibii*), evening bat (*Nycticeius humeralis*), hoary bat (*Lasiurus cinereus*), little brown bat (*Myotis lucifugus*), and tricolored bat (*Perimyotis subflavus*) (see https://ecos.fws.gov/ServCat/DownloadFile/206888). Additional species migrate through or occur occasionally on the refuge including the silver-haired bat (*Lasionycteris noctivagans*) and seminole bat (*Lasiurus seminolus*)(Big Oaks NWR, unpublished data).

The refuge has diverse herpetofauna containing thirty-three species of amphibians and twenty species of reptiles. These include the state endangered northern crawfish frog and Kirtland's snake (*Clonophis kirtlandii),* as well as several state species of concern including the eastern box turtle (*Terrapene carolina*), common mudpuppy (*Necturus maculosus*), four-toed salamander (*Hemidactylium scutatum*), and streamside salamander (*Ambystoma laterale*). Some of the small wetlands throughout the refuge are intensively managed to provide breeding habitat for northern crawfish frogs. The population of northern crawfish frogs on Big Oaks NWR represents the eastern most population of the species in North America.

Big Oaks NWR has approximately fifty-eight species of fish and twenty-six species of freshwater mussels. Old Timbers Lake contains recreationally important game fish, including largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), and white crappie (*Pomoxis annularis*).

Invertebrates are abundant throughout the refuge. Seventy-three butterfly species have been documented on the refuge during annual North American Butterfly Association Surveys. The many caves, seeps, and springs on the refuge are unique for their invertebrate fauna. Seventy-one subterranean species of invertebrates have been identified on the refuge (Lewis and Rafail 2002), four of which are on the Indiana State Watch List, and one listed as State Rare.

Numerous rare plants are also found, or presumed to occur, on Big Oaks NWR. This includes the state endangered northern bog clubmoss (*Lycopodiella inundata*), American climbing fern (*Lygodium palmatum*), broom panic grass (*Dichanthelium scoparium*), narrow-leaved sunflower (*Helianthus angustifolius*), swamp smartweed (*Persicaria setacea*), clasping-leaved St. John's-wort (*Hypericum gymnanthum*), elliptical rushfoil (*Croton michauxii* var. *elliptica*) and eastern grey beardtongue (*Penstemon canescens*), and the state threatened Maryland meadow beauty (*Rhexia mariana*), barren strawberry (*Geum fragarioides*), small sundrops (*Oenothera perennis*), thread-like naiad *(Najas gracillima*) and wallrue spleenwort (*Asplenium ruta-muraria*).

Description of Environmental Trends and Planned Actions

The effects of invasive species and other undesirable vegetation are expected to be amplified in the future because of shifting precipitation patterns, altered disturbance regimes, and increased frequency of late-growing-season moisture stress, which are all associated with a changing climate (Angel et al.2018). Population growth and urbanization around the refuge and southern Indiana in general will likely increase anthropogenic threats to the refuge. This

almost guarantees a continual source of new invasive species and other undesirable vegetation for the foreseeable future. Japanese stiltgrass is thought to have been introduced from China and was first found in Indiana in 1994. By 2008 it spread to 21 counties (Indiana Invasive Species Task Force 2008); it affects refuge road maintenance because of its affinity to roadsides and roads which from it spreads into forested habitats. Access limitations associated with UXO at Big Oaks NWR is not expected to change and will severally limit the refuge's options for managing invasive species and other undesirable vegetation for many decades.

Impacts on Affected Resource

Alternative A

Under the No Action and Proposed Alternative herbicide applications would continue. Invasive species and other undesirable vegetation would be treated with herbicide and non-herbicide methods where possible. Treatments in closed areas with UXO would be limited to aerial herbicide methods, biological control and prescribed fire. Invasive species and other undesirable vegetation would be controlled throughout the refuge to the extent possible. This would accelerate the refuge's ability to control and prevent the expansion of invasive species and other undesirable vegetation promoting not only suitable, but desirable habitat for wildlife species. Increasing the quality of habitat across the refuge would lead to increased wildlife use and abundance.

This alternative would result in the direct effect of wildlife disturbance during herbicide applications. Because aerial treatments can cover much larger treatment areas, they could result in more wildlife disturbances, however the disturbance duration would most likely be shorter as compared to ground application methods. Timing of aerial applications within the target plant's susceptibility window could also be modified to reduce disturbance issues. Disturbances associated with ground treatments would be limited to the perimeter areas of the refuge that have been deemed safe for vehicular entry. Additionally, wildlife disturbance associated with ground herbicide application would include traveling to and from application sites. Wildlife disturbance would be temporary, lasting approximately the amount of time it would take to treat the desired site.

Ground herbicide applications would result in the direct effect of disturbance to vegetation such as trampling. These effects are expected to be short-term as vegetation is expected to quickly recover from this disturbance. The effects of continued herbicide use would indirectly benefit wildlife. The desired habitat diversity and structural conditions detailed above would be maximized under this alternative because invasive species and other undesirable vegetation would not be allowed to alter them.

Under the No Change and Proposed Alternative, herbicide applications would be combined with non-herbicide methods like prescribed fire and could have cumulative effects. Following

combined treatments, a reduction in plant and invertebrate abundance and diversity could occur. Such reductions would be localized but could alter the food and cover requirements for wildlife and result in displacement as organisms move to other areas on the refuge to locate necessary habitat requirements. Such cumulative effects are expected to be temporary, lasting no more than one year as the habitat recovers from unaffected perennial root stock, seed bank resources, and immigration from surrounding untreated sites. Cumulative impacts can be negated through timing of management options, amount, and location of treatments to minimize or eliminate the compounding influence of multiple management programs. For example, tall fescue (*Festuca arundinacea*) regrows following a fall burn while native vegetation remains dormant until the next spring. Herbicide treatment of tall fescue following prescribed fire has been shown to significantly reduce tall fescue abundance (Rhoades et al. 2002, Washburn et al. 2002). The reduction in sod forming tall fescue increases floristic and invertebrate diversity and abundance the following year.

Maintaining the refuge's plant and structural diversity maintains its resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of continued herbicide use. Indirectly, maximizing habitat diversity on the refuge maximizes insect diversity including pollinators. Improved pollination directly benefits plants and increased insect diversity has trophic level, cumulative benefits. Continued herbicide use has the potential of contributing to herbicide resistance of target plants. This indirect effect can be minimized using herbicides with different modes of action and/or using tank mixes of different herbicides.

Alternative B

Under this alternative herbicide applications would be discontinued. Invasive species and other undesirable vegetation would be treated with non-herbicide methods where possible. Invasive species and other undesirable vegetation would be expected to expand across the entire refuge. Initially, the effects would be most pronounced in areas where ground access is prohibited (closed areas due to UXO), but eventually habitat across the entire refuge would be degraded and converted by invasive species and other undesirable vegetation.

Grassland habitat would be converted to shrubs and eventually succeed to forest. This would affect grassland nesting birds like the Henslow's sparrow (James 1971, Herkert 2002) and bat species (Tibbels and Kurta 2003, Morris et al. 2010) that feed on insects in openings. Nesting habitat for the prairie warbler would temporarily increase as grasslands converted to shrubs but eventually would be lost as the areas succeeded to forest. Invasive species and other undesirable vegetation would degrade forest habitats by altering forest structure. This would affect birds (e.g., cerulean warbler) and bats that require forest openings (e.g., Perkins and Wood 2014, King et al. 2019), and those like the red-headed woodpecker (King et al. 2007) that

require an open understory. Eventually, degraded stands of even-aged invasive trees and vines would reduce light to the forest floor thus reducing dense stands of shrubs and herbaceous plants required by ground nesting birds (e.g., Kentucky warbler) (Dunn and Garrett 1997, McDonald 1998).

The effects of discontinuing herbicide use on the refuge for wildlife would be mostly indirect. The habitat structural changes and conversions detailed above would be caused by uncontrolled succession, which would be an indirect effect of discontinuing herbicide use. Conversion of habitats to stands dominated and degraded by invasive species would greatly reduce the refuge's diversity, which would be a direct effect of discontinuing herbicide applications. The loss of plant and structural diversity would reduce Big Oaks NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of discontinued herbicide use.

Threatened and Endangered Species, and Other Special Status Species

Affected Environment

Description of Affected Environment for the Affected Resource

Currently there is one federally listed endangered species (FE), one federally listed threatened species (FT), one candidate species, and one recovered species that occurs on the refuge, including:

- Indiana Bat (FE)
- Northern Long-eared Bat (FT)
- Monarch Butterfly, *Danaus plexippus* (Candidate)
- Bald Eagle (*Haliaeetus leucocephalus*) (Recovered)

Using acoustic surveys and capturing individuals with mist nets, both Indiana and northern long-eared bats have been detected on Big Oaks NWR (USFWS 2021). Both species hibernate in caves off the refuge, and it is in caves that they are most vulnerable. This vulnerability includes human disturbance and white-nose syndrome (USFWS 2006 & 2015). Indiana and northern long-eared bats primarily use Big Oaks NWR as feeding, roosting and maternity habitat when not hibernating. This means ensuring the refuge has diverse forests with a continual supply of tree species with loose bark (e.g., shagbark hickory, *Carya ovata*) and dead and dying trees. This is because both the Indiana bat and northern long-eared bats roost under loose bark found on these type of trees. Openings within and around forests and along stream corridors may provide feeding locations for both species.

Monarch butterfly numbers have been declining across North America over the past two decades. An extensive status assessment was completed by the USFWS in 2020 which determined that listing the monarch under the Endangered Species Act was warranted but precluded by higher priorities at that time. Widespread habitat loss and fragmentation is believed to be among the contributing factors to the species' decline (Thogmartin et al. 2017). Monarchs rely on milkweed plant species (*Asclepias* spp.) as their obligate host plant. Big Oaks NWR contains large areas of milkweed and nectar plants. Monarchs have been documented throughout the refuge during mid-summer butterfly counts (see https://ecos.fws.gov/ServCat/DownloadFile/219846).

The bald eagle was removed from the endangered species list in 2007 (USFWS 2021). This species' recovery was largely the result of removal of the insecticide DDT from the environment and efforts to restore bald eagles to their former range. Illegal shooting of bald eagles led Congress to pass the Bald Eagle Protection Act in 1940, which prohibited killing, selling, or possessing the species. In 1962 the Act was amended to include the golden eagle, and the law became the Bald and Golden Eagle Protection Act. Although no longer included as a threatened or endangered species, the bald eagle maintains protection under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Bald eagles utilize the refuge year-round. There is one known bald eagle nest that is used annually on Old Timbers Lake in the northeast portion of the refuge.

Description of Environmental Trends and Planned Actions

The decline and vulnerability of the Indiana bat and northern long-eared bat are largely related to disturbance and white-nose syndrome vulnerabilities at their hibernation sites of which Big Oaks NWR has none. The refuge's large, forested tracks provide roosting and feeding habitat for both species. The monarch is susceptible to loss of milkweed through indiscriminate herbicide use in agriculture and loss of habitat (Thogmartin et al. 2017). Invasive non-native plants could cause declines in insect abundance which could affect local food availability for bats (Tallamy et al. 2020).

Big Oaks NWR's proposal to continue herbicide use to reduce invasive species and to maintain large blocks of diverse and healthy grasslands, wetlands, and forests would directly benefit the Indiana bat, northern long-eared bat, and monarch. Off-refuge threats and pressures including disturbances and diseases at bat hibernacula and habitat development and fragmentation resulting from urbanization will make habitat management at the refuge even more important in the future. This importance would be accentuated by changes associated with climate change.

Impacts on Affected Resource

Alternative A

Under the No Action and Proposed Alternative invasive species and other undesirable vegetation would be treated with herbicide and non-herbicide methods where possible. Treatments in closed areas with UXO would be limited to aerial herbicide methods, biological control and prescribed fire. This alternative would maximize the refuge's ability to control and prevent the expansion of invasive plants and other undesirable vegetation promoting not only suitable, but desirable habitat for threatened and endangered species. This alternative would be expected to benefit Indiana bats, northern long-eared bats, and monarch butterflies as it would help maintain large blocks of diverse and healthy forest and grassland habitats needed by these species (USFWS 2022c, see https://ecos.fws.gov/ServCat/DownloadFile/219872.

The widespread use of pesticides is thought to have contributed to the decline of monarch butterflies in North America; however, this typically occurs when insecticides are used for agricultural practices. The loss of milkweed in agricultural fields through herbicide application has also reduced host plant availability (Thogmartin et al. 2017). There is no agricultural land on Big Oaks NWR and no recent history of insecticide use on lands managed as Big Oaks NWR. Potential impacts on the monarch would therefore be indirect and include herbicide inadvertently being applied to milkweed plants and nectar plants while treating invasive species and other undesirable vegetation. Herbicide is used to remove non-native sod forming grasses to restore pollinator habitat, including milkweeds which directly benefit monarchs (Rhoades et al. 2002, Washburn et al. 2002).

As noted above, this potential non-target effect has been analyzed (NEPA) as part of the labeling process for all herbicides and measures to minimize those effects, including restrictions, are listed on the product label. Also as noted above, each pesticide application is individually reviewed and approved prior to treatment as part of the PUP process. This includes regionally approved BMPs. Because all label restrictions and regionally approved BMPs must be followed and because each herbicide application is reviewed and approved, the potential for indirect negative effects on the monarch are expected to be very minimal. Indirectly, herbicide applications through improved habitat diversity and health are expected to benefit the monarch (USFWS 2022c, see https://ecos.fws.gov/ServCat/DownloadFile/219872).

As noted above, this alternative would result in the direct effect of wildlife disturbance (including listed species) and ground disturbance during herbicide applications and in both cases are expected to be short-term effects. The desired habitat diversity and structural conditions detailed above would be maximized for threatened and endangered species under this alternative because invasive species and other undesirable vegetation would not be allowed to alter those conditions. Following the National Bald Eagle Management Guidelines

(USFWS 2007), aerial herbicide applications in the area surrounding bald eagle nests would only be made during the fall to not disrupt or otherwise disturb nesting eagles.

Under the No Change and Proposed Alternative, herbicide applications would be combined with non-herbicide methods like prescribed fire and could have cumulative effects. Following combined treatments, a reduction in plant and invertebrate abundance and diversity could occur. Such reductions would be localized but could alter the food and cover requirements for threatened and endangered species and result in displacement as organisms move to other areas on the refuge to locate necessary habitat requirements. Such cumulative effects are expected to be temporary, lasting no more than one year as the habitat recovers from unaffected perennial root stock, seed bank resources, and immigration from surrounding untreated sites. As noted above, cumulative impacts can be negated through timing of management options, amount, and location of treatments to minimize or eliminate the compounding influence of multiple management programs.

Maintaining the refuge's plant and structural diversity maintains its resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of continued herbicide use. Indirectly, maximizing habitat diversity on the refuge maximizes insect diversity including pollinators. Improved pollination directly benefits plants and increased insect diversity has trophic level, cumulative benefits. Continued herbicide use has the potential of contributing to herbicide resistance of target plants. This indirect effect can be minimized using herbicides with different modes of action and/or using tank mixes of different herbicides.

Alternative B

Under this alternative, herbicide use would be discontinued, and management of invasive plants and other undesirable vegetation would be limited to non-herbicide tools. This could only occur in accessible areas. Most of the refuge is not accessible as result of UXO and in those areas, prescribed fire and biological control would be the only management tools for invasive plants and other undesirable vegetation.

Under this alternative, forest understory encroachment of invasive shrubs would likely result in a reduction in forest plant diversity, and a subsequent decrease in aerial invertebrate abundance. Aerial invertebrates are the primary food source for northern long-eared and Indiana bats. Furthermore, a forest understory with dense invasive shrubs reduces the foraging abilities of bats by creating impenetrable barriers for forage flights.

Grassland communities on Big Oaks NWR would experience advancing successional stages under this alternative. This would reduce breeding and foraging monarch habitat. Furthermore,

monocultures resulting from invasive plants on the grasslands would reduce plant diversity, forever altering breeding and foraging plant diversity.

The effects of discontinuing herbicide use on threatened and endangered species would be mostly indirect. The habitat structural changes and conversions detailed above would be caused by uncontrolled succession, which would be an indirect effect of discontinuing herbicide use. Conversion of habitats to monotypic stands of invasive species would greatly reduce the refuge's diversity. This includes insect diversity as a food for bats. The loss of plant and structural diversity would reduce Big Oaks NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of discontinued herbicide use (USFWS 2022c, see https://ecos.fws.gov/ServCat/DownloadFile/219872) .

Habitat and Vegetation (including vegetation of special management concern)

Affected Environment

Description of Affected Environment for the Affected Resource

Big Oaks NWR lies within the Pre-Wisconsinan Drift Plains Ecoregion. This ecoregion is located within southwest Ohio and southeastern Indiana and was previously glaciated, but not during the most recent, Wisconsinan glaciation. Wood et al. (1998) provides the following description for the Pre-Wisconsinan Drift Plains Ecoregion:

> *"This area is covered in pre-Wisconsinan glacial till, which has been extensively leached and is thus acidic and nutrient poor. There are also thin loess deposits. The region is underlain by older carbonates. The area is deeply dissected…ranging from 50-500 feet. The climate is borderline between the colder end of a humid subtropical climate and the warmer end of a humid continental climate. Precipitation peaks in May and is slightly lower September-February. The frost-free growing season ranges from 165-195 days…"*

Big Oaks NWR lies within the Central Hardwoods Ecosystem, which is characterized by large tracts of contiguous forests of oak (*Quercus* spp.) and hickory (*Carya* spp.). Fire is integral to the maintenance of oak-hickory forest communities on the refuge. The refuge has approximately 4,200 acres of oak-hickory forest (Hoy et al. 2020). This forest type may also include contain beech (*Fagus* spp.), maple (*Acer* spp.), ash (*Fraxinus* spp.), tulip tree (*Liriodendron tulipifera*), and other deciduous tree species.

Flatwoods are a unique forest type also found on Big Oaks NWR. They occur where clay soils

create fragipans restricting water percolation and typically contain vegetation communities that are unique compared to the surrounding forest matrix. Flatwoods on Big Oaks NWR contain sweetgum (*Liquidambar styraciflua*), American beech (*Fagus grandifolia*), swamp chestnut oak (*Quercus michauxii*), swamp white oak (*Quercus bicolor*), pin oak (*Quercus palustris*), red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), northern spicebush (*Lindera benzoin*), and a variety of forbs, sedges, grasses and ferns. Hoy et al. (2020) estimated the refuge contains more than 12,000 acres of flatwoods.

Grasslands at Big Oaks NWR are dominated by medium height grasses and contain forbs as well as several low shrub species typical of grassland communities within the Central Hardwoods Ecosystem. Hoy et al. (2020) indicated the refuge contained more than 4,000 acres of grassland. Basey and Badger (2004) surveyed fire-managed grasslands on the refuge and found the understory contain 16 shrub species while the ground layer contained 54 unique plant species with three fire-tolerant species being the most common [e.g., broomsedge bluestem (*Andropogon virginicus*), poverty oatgrass (*Danthonia spicata*), and early goldenrod (*Solidago juncea*)].

Invasive and aggressive shrub and tree species such as autumn olive, bush honeysuckle (*Lonicera* sp.) sweetgum, sericea lespedeza (*Lespedeza cuneata*) and eastern red cedar (Juniperus virginiana) are threatening Big Oaks NWR's grasslands. Hoy et al. (2020) classified former grasslands that are now invaded with shrubs as early successional habitats or "old fields" and estimated the Big Oaks NWR contained more than 24,000 acres of these habitat types.

According to the USFWS's National Wetlands Inventory (USFWS 2022a), Big Oaks NWR has five wetland types. Among the wetland types, freshwater forested/shrub wetland (7,672 acres) is the most common followed by riverine (1,486 acres), freshwater emergent wetland (392 acres), lake (138 acres), and freshwater pond (82 acres) (USFWS 2022a). Wetlands created by beavers can be found within both forested and grassland communities throughout the refuge. Ephemeral wetlands are found throughout the refuge in both forest and grassland communities. Forested ephemeral wetlands are associated with flatwoods that contain a clay soil layer (i.e., fragipans) restricting water percolation. A few constructed wetlands with water control structures have been established to provide additional breeding habitat for northern crawfish frogs in grasslands where refuge biologists can study their natural history.

Description of Environmental Trends and Planned Actions

Wood et al. (2008) summarized results of a state-wide forest inventory. Survey results indicated Indiana forests have been increasing since the 1960s and the state now has more than 4.5 million acres of forest. The vast majority (95%) of those forests are classified as hardwood forests, but as oak and hickory forests are aging, they are being replaced with shade-tolerant species; sugar maple is by far Indiana's most common tree species. Nearly all the plots used to

inventory Indiana's forest contained at least one invasive species with multiflora rose, non-native bush honeysuckles, Japanese honeysuckle, and garlic mustard (*Alliaria petiolata*) being most common.

Indiana has lost nearly 100% of its historic grasslands (Samson and Knopf 1994). Big Oaks NWR is part of Indiana's Drift Plains Area. The greatest threats to grasslands in this area include conversion to agriculture and invasive species (Indiana Department of Natural Resources 2015). Similarly, Belesky and Malinowski (2016) found future grassland loss in the area may be influenced more by agricultural programs than climate change.

Indiana has lost 85% of its historic wetlands. This ranks it near the top of proportional wetland loss among the 50 states (Dahl 1990). Indiana's wetlands are currently impacted by agricultural activities, commercial and residential development, road building, water development projects, groundwater withdrawal, loss of instream flows, water pollution, and vegetation removal (Indiana DNR 1996).

Impacts on Affected Resource

Alternative A

Under the No Action and Proposed Alternative invasive species and other undesirable vegetation would be treated with herbicide and non-herbicide methods where possible. Treatments in areas with UXO would be limited to aerial herbicide methods, biological treatments and prescribed fire. This alternative would maximize the refuge's ability to control and prevent the expansion of invasive plants and other undesirable vegetation promoting not only suitable, but desirable habitat for wildlife species. This alternative would be expected to directly benefit refuge forests, grasslands, and wetlands.

Potential negative effects of herbicide treatments would be indirect and include herbicide inadvertently being applied to non-target plants while treating invasive species and other undesirable vegetation. The greatest potential for non-target effects occurs when herbicides are applied aerially. This is because the potential for drift is much higher for aerial herbicide applications. Aerial applications would be used in areas that would limit the potential for non-target drift.

The potential for non-target effects can be minimized using plant phenology. Many invasive species begin actively growing before native species in the spring and continue active growth after native species have gone dormant in the fall allowing minimal, if any, non-target treatment damage to native plants. For example, aerial applications of herbicide in forested units to treat invasive plants can be accomplished from late October through mid-November with reduced impact to native vegetation. Ground herbicide applications would be used in areas that are not logistically feasible for aerial application, such as with tractors along

perimeter roads, and areas safe for access. Spot treatment of undesirable plants by foot using backpack sprayers and cut stump treatments would be used in areas that are safe for foot entry.

The refuge has a long and diverse history of herbicide use with non-target impacts limited in scale and duration. Big Oaks NWR has been using herbicide to control invasive species since 2004, this includes applications with a variety of herbicides including aerial applications beginning in 2005 (Figures 3 and 4).

Figure 3. Image of Big Oaks National Wildlife Refuge staff member surrounded by dense blazing star (*Liatris spicata*) in a field approximately 2 years after aerial herbicide application to control woody vegetation within a grassland matrix near Madison, IN. Dead trees can be seen in the treatment area.

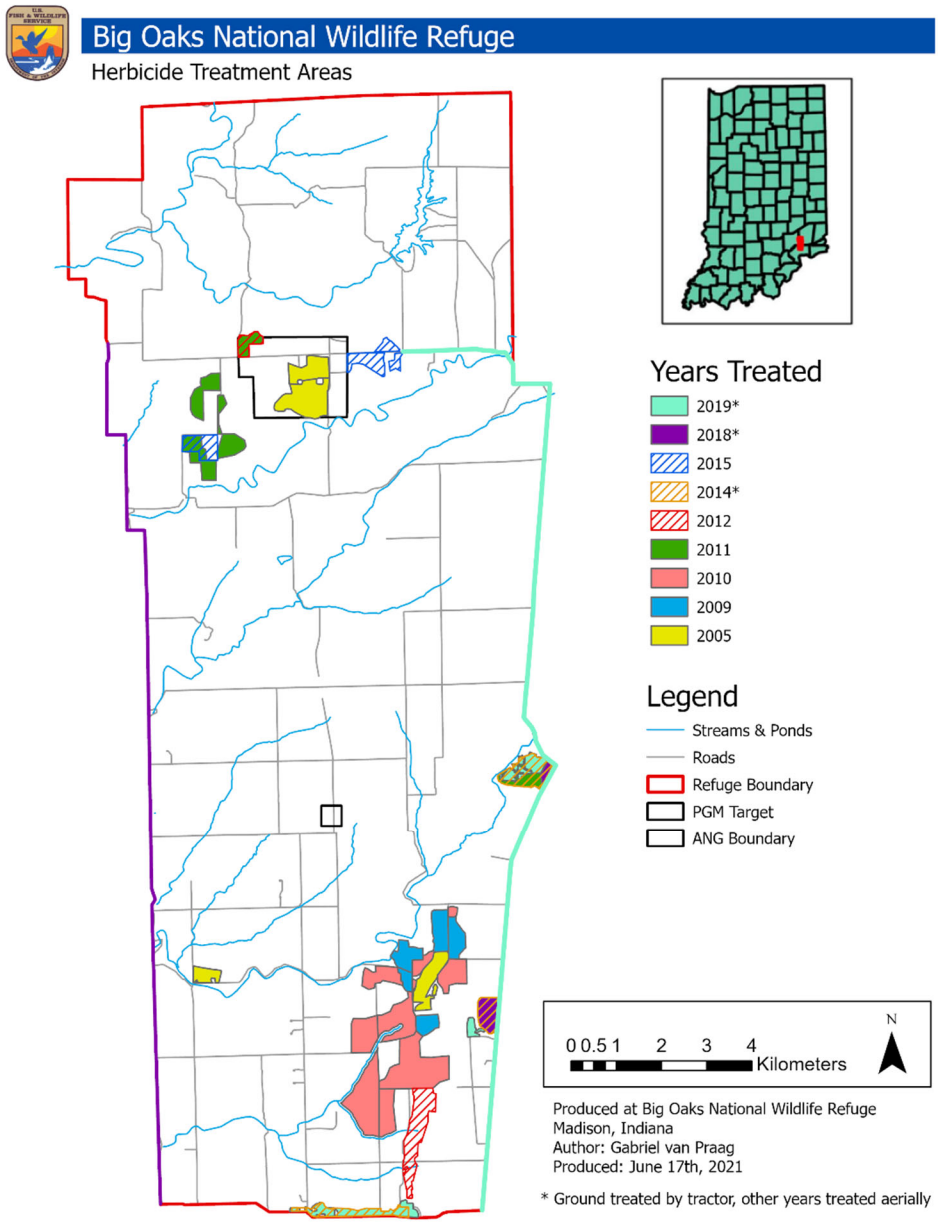

Figure 4. Map of Big Oaks National Wildlife Refuge showing the location of roadside and aerial herbicide applications dating back to 2005. Different color polygons indicate large areas previously treated by herbicides to restore habitat for wildlife. Perimeter roads were treated to remove sod forming fescue to restore pollinator habitat.

As noted above, the potential for non-target effect has been analyzed (NEPA) as part of the labeling process for all herbicides and measures to minimize those effects, including restrictions, are included in the product label. Because the label is the law, the potential for indirect negative effects on forests, grasslands, and wetlands are expected to be very minimal. This potential negative affect is further minimized by the refuge following regionally approved BMPs and all PUPs being reviewed and approved as detailed above. The indirect benefits of herbicide applications through improved habitat diversity and health are expected to benefit forests, grasslands, and wetlands.

This alternative would result in the direct effect of ground disturbance during ground herbicide applications and is expected to be short-term effects. The desired habitat diversity and structural conditions detailed above would maximize the benefits for forests, grasslands, and wetlands under this alternative because invasive species and other undesirable vegetation would not be allowed to alter those conditions.

Under the No Change and Proposed Alternative, herbicide applications would be combined with non-herbicide methods like prescribed fire and could have cumulative effects. Following combined treatments, a reduction in plant abundance and diversity could occur. Such reductions would be localized but could result in a reduction in habitat quality. Such cumulative effects are expected to be temporary, lasting no more than one year as the habitat recovers from unaffected perennial root stock, seed bank resources, and immigration from surrounding untreated sites. As noted above, cumulative impacts can be negated through timing of management options, amount, and location of treatments to minimize or eliminate the compounding influence of multiple management programs.

Maintaining the refuge's forest, grassland, and wetland health and diversity maintains its resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of continued herbicide use. Continued herbicide use has the potential of contributing to herbicide resistance of target plants. This indirect effect can be minimized by using herbicides with different modes of action and/or using tank mixes of different herbicides.

Alternative B

Under this alternative, herbicide use would be discontinued, and invasive plants and other undesirable vegetation management would be limited to non-herbicide tools. This could only occur in accessible areas. Most of the refuge is not accessible as result of UXO and in those areas, prescribed fire and biological controls would be the only management tools for invasive plants and other undesirable vegetation.

Under this alternative, encroachment of invasive plants and other undesirable vegetation would likely result in a reduction in forest, grassland, and wetland plant diversity. The effects of

discontinuing herbicide use on refuge habitats would be mostly indirect with invasive species and other undesirable vegetation out-competing desirable vegetation. Conversion of habitats to monotypic stands of invasive species would greatly reduce the refuge's diversity, which would be a direct effect of discontinuing herbicide applications. The loss of plant diversity would reduce Big Oaks NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of discontinued herbicide use.

Geology and Soils

Affected Environment

Description of Affected Environment for the Affected Resource

Big Oaks NWR contains a wide variety of soil types, but just five soil types cover the majority (81.5%) of the refuge. Those soil types include Cobbsfork silt loam (29%), Avonburg silt loam (20.5%), Cincinnati silt loam (13.5%), Nabb silt loam (13.1%), and Grayford silt loam (4.5%). All five of these soil types are very slowly permeable to moderately permeable with clay content ranging from 10-80%. No other soil type found on the refuge covers more than 2.5% of the area (Natural Resources Conservation Service 2022).

Because the refuge limits soil compaction/disturbance and manages habitats to maximize diversity, soil health on the refuge is expected to be very good. This combined with the soil characteristics noted above, indicates herbicide absorption and decomposition on the refuge should be very good.

Description of Environmental Trends and Planned Actions

The soils and geology of Big Oaks NWR is not expected to change in the future.

Impacts on Affected Resource

Alternative A

Under the No Action and Proposed Alternative invasive species and other undesirable vegetation would be treated with herbicide and non-herbicide methods where possible. Treatments in areas with UXO would be limited to aerial herbicide methods, biological control and prescribed fire. This alternative would maximize the refuge's ability to control and prevent the expansion of invasive plants and other undesirable vegetation. This alternative would be expected to maximize soil health on the refuge. This would be an indirect effect of maximizing plant diversity within forests, grasslands, and wetlands on the refuge. Additionally, invasive plants can have direct negative effects on soil health (Weidenhamer et al. 2010, 2017, Gibbons et al. 2017, Teixeira et al. 2020) so efforts to control them would indirectly benefit soils.

Herbicides have the potential to negatively affect the health and diversity of microorganisms, which is directly related to soil health. The effects of pesticides on soil health have been poorly studied and those used for agriculture have received the most study (Gunstone et al. 2021). Although results appear highly variable, depending on the chemical and soil characteristics, what is consistent is healthy soils help with absorption and breakdown of pesticides. Best management practices aimed at minimizing herbicide contact with soil is likely the best tool to mitigate any threats to soil health and include minimizing soil compaction/disturbance, maximizing plant diversity, and maintaining permanent plant cover. As noted above, the potential for soil effects is minimized because of soil characteristics on the refuge and the refuge's habitat management goal of maximizing diversity in forests, grasslands, and wetlands.

This alternative would result in the direct effect of ground disturbance during ground herbicide applications and is expected to be a short-term effect. The desired habitat diversity and health would be maximized under this alternative because invasive species and other undesirable vegetation would not be allowed to alter those conditions.

Under the No Change and Proposed Alternative, herbicide applications would be combined with non-herbicide methods like prescribed fire and could have cumulative effects. Following combined treatments, a reduction in plant abundance and diversity could occur. Such reductions would be localized but could result in a reduction in habitat quality. Such cumulative effects are expected to be temporary, lasting no more than one year as the habitat recovers from unaffected perennial root stock, seed bank resources, and immigration from surrounding untreated sites. The cumulative effect of fire and herbicide to control invasive plants has been shown to increase soil nitrogen and net nitrogen transformation rates, which improves native plant performance and diversity (Rhoades et al. 2002). As noted above, cumulative impacts can be negated through timing of management options, amount, and location of treatments to minimize or eliminate the compounding influence of multiple management programs.

Maintaining the refuge's soil health maintains its resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of continued herbicide use. Continued herbicide use has the potential of contributing to herbicide resistance of target plants. This indirect effect can be minimized using herbicides with different modes of action and/or using tank mixes of different herbicides.

Alternative B

Under this alternative, herbicide use would be discontinued, and management of invasive plants and other undesirable vegetation would be limited to non-herbicide tools. This could only occur in accessible areas. Most of the refuge is not accessible as result of UXO and in those

areas, prescribe fire and biological control would be the only management tools available for invasive plants and other undesirable vegetation.

Under this alternative, encroachment of invasive plants and other undesirable vegetation would likely result in a reduction of soil health. Invasive plants alter soil chemistry, microbial, and mycorrhizal fungal communities increasing the difficulty of restoration activities with native plant species (McNeish and McEwan 2016, Rai 2022). Invasive plants tend to have less robust root systems resulting in an increase in soil erosion in areas with heavy infestations (Rai 2022). The effects of discontinuing herbicide use on refuge habitats would be mostly indirect with invasive species and other undesirable vegetation altering soil health. The loss of plant and diversity would reduce Big Oaks NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of discontinued herbicide use.

Water Quality

Affected Environment

Description of Affected Environment for the Affected Resource

Big Oaks NWR lies within the Muscatatuck Plateau of the Indiana's Southern Hills and Lowlands physiographic region. Bedrock consists of Silurian and Ordovician shale and limestone. Limestone outcrops are common along creeks and drainage areas throughout the refuge. Karst development of the carbonate limestone occurs throughout the refuge; however, it is limited to narrow areas of exposed bedrock along creeks and drainages. The most common karst features on the refuge are caves. Thirty-two known caves have been identified with 52 entrances, and range in length from 26.1 to 1,507.5 feet (Sheldon 1997). Sinkholes are also present throughout the refuge along creeks and drainages; however, they are not pervasive, and the numbers are unknown.

Soil types are primarily silt loams with a silty clay loam to clay loam B horizon and range from well drained to poorly drained depending on the topography. Fragipans are present in most soil types and range from eight to greater than eighty inches. The presence of shallow fragipans is most evident in flatwoods, creating ephemeral wetlands. Depth to the water table is seasonally variable from six to greater than eighty inches.

Big Oaks NWR lies within the Muscatatuck River watershed, a tributary of the White River which flows into the Ohio River. There are five third order, permanent streams that run through the refuge, Otter Creek, Graham Creek, Little Graham Creek, Marble Creek, and Big Creek. Of these, Otter, Graham, and Big Creeks have been designated as Outstanding Rivers by the Indiana Department of Natural Resources for their environmental and aesthetic values. Flash

flooding is one of the main issues affecting refuge habitats as well as the neighboring region. Flash floods occur most often during the spring months but can occur anytime during heavy rain events.

The refuge includes four main man-made impoundments: Old Timbers Lake (164 acres), Hyde's Pond (0.5 acres), Gate 3 Pond (.10 acres) and Gate 8 Pond (.25 acres). Old Timbers Lake is in the northeast corner of the refuge. The watershed of Old Timbers Lake is forested except for some agricultural land north of the refuge.

Description of Environmental Trends and Planned Actions

Factors related to water quality are not expected to change in the future. This includes geology (e.g., karst features), depth to groundwater, location of river, streams, ponds and impoundments, soil characteristics (e.g., fragipans), and the influx of agricultural chemicals from offsite agricultural lands.

Impacts on Affected Resource

Alternative A

Under the No Action and Proposed Alternative invasive species and other undesirable vegetation would be treated with herbicide and non-herbicide methods where possible. Treatments in areas with UXO would be limited to aerial herbicide methods, biological control, and prescribed fire. This alternative would maximize the refuge's ability to control and prevent the expansion of invasive plants and other undesirable vegetation.

Potential negative effects of herbicide treatments would be indirect and include herbicide inadvertently dripping off target plants and leaching through the soil into groundwater and/or running off into nearby surface waters. Impacts of herbicides on water quality can be easily mitigated by applying only those herbicides approved for specific sites. Impacts can be further mitigated by timing of herbicide application. For example, most herbicide applications near ephemeral wetlands would be made from late summer to early fall when the wetlands are dry. When herbicide applications must be made near or over water, herbicide use would be restricted to those approved for use over or near water. The refuge has a long and diverse history of herbicide use and no groundwater or surface water contamination has been observed. Dating back to 2004, this includes applications with a variety of herbicides including aerial applications.

As noted above, the potential for groundwater and surface water contamination has been analyzed (NEPA) as part of the labeling process for all herbicides and measures to minimize those effects, including restrictions, are included in the product label. Because the label is the law, the potential for groundwater or surface water contamination is expected to be very minimal. Additionally, the refuge has healthy soils to absorb and decompose herbicides and does not generally have a shallow depth to groundwater.

This alternative would result in the direct effect of ground disturbance during herbicide applications and is expected to be short-term effects. The desired habitat diversity and structural conditions detailed above would be maximized under this alternative because invasive species and other undesirable vegetation would not be allowed to alter those conditions. Maintaining healthy diverse ground cover indirectly benefits water quality because that vegetation filters water before it gets to surface water and/or groundwater.

Under the No Change and Proposed Alternative, herbicide applications would be combined with non-herbicide methods like prescribed fire and could have cumulative effects. Following combined treatments, a reduction in plant abundance and diversity could occur. Such reductions would be localized but could result in a reduction in habitat quality. Prescribed fire often removes protective vegetation from the soil surface, thus resulting in a potential for increased siltation of water resources. The cumulative effect of using herbicides with prescribed fire could potentially increase both siltation and chemical contamination of water resource. Timing the use of fire to minimize root damage to native vegetation would assure minimal siltation. Furthermore, following herbicide label instruction accordingly would ensure undesirable vegetation control can be achieved through minimal runoff into water resources. Such cumulative effects are expected to be temporary, lasting no more than one year as the habitat recovers from unaffected perennial root stock, seed bank resources, and immigration from surrounding untreated sites. As noted above, cumulative impacts can be negated through timing of management options, amount, and location of treatments to minimize or eliminate the compounding influence of multiple management programs.

Maintaining the refuge's health and diversity of its habitats helps maintain its resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of continued herbicide use. Continued herbicide use has the potential of contributing to herbicide resistance of target plants. This indirect effect can be minimized using herbicides with different modes of action and/or using tank mixes of different herbicides.

Alternative B

Under this alternative, herbicide use would be discontinued, and invasive plants and other undesirable vegetation management would be limited to non-herbicide tools. Most of the refuge is not accessible as result of UXO and in those areas, prescribe fire and biological control would be the only tools available for invasive plants and other undesirable vegetation.

Under this alternative, encroachment of invasive plants and other undesirable vegetation would likely result in a reduction in plant diversity. The effect of discontinuing herbicide could result in conversion of habitats to monotypic stands of invasive species, and this could affect water quality through diminished water filtration. The loss of plant diversity would reduce Big

Oaks NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of discontinued herbicide use.

Visitor Use and Experience (including facilities needed for visitor use)

Affected Environment

Description of Affected Environment for the Affected Resource

Big Oaks NWR is open to wildlife observation, photography, hunting, and environmental education and interpretation. Currently, wildlife observation and photography occur within the 5000-acre public use area in the northeast corner of the refuge on designated public use days. Public-use days are Mondays and Fridays, and the second and fourth Saturday of each month from mid-April through mid-November. Public-use day hours are 7:00 am to 4:30 pm. All visitors are required to watch a safety briefing and sign an acknowledgement of danger waiver annually as per U.S. Army regulations.

Fishing is allowed on Old Timbers Lake in the public-use area. The lake is limited to no more than 30 boats at one time and are restricted to electric motors or paddle conveyance. Managed hunting for white-tailed deer, wild turkey (*Meleagris gallopavo*), and tree squirrels (*Sciurus* spp.) is permitted in designated units around the refuge but only during public use days and within state-designated hunting seasons. Big Oaks NWR hosts two of the largest youth hunting opportunities in the country, one during the white-tailed deer season and another during the spring wild turkey season. The refuge also allows mushroom and berry gathering with restrictions like those used to manage hunting.

Description of Environmental Trends and Planned Actions

Wildlife dependent recreation is expected to increase on Big Oak NWR in the future. This trend is not unique to the refuge and is a result of increasing population density and urban development.

Impacts on Affected Resource

Alternative A

Under the No Action and Proposed Alternative invasive species and other undesirable vegetation would be treated with herbicide and non-herbicide methods where possible. This would include refuge facilities required for visitor use. Treatments in areas with UXO would be limited to aerial herbicide methods and prescribed fire. This alternative would maximize the refuge's ability to control and prevent the expansion of invasive plants and other undesirable vegetation.

A direct negative effect of herbicide is a temporary closure of treatment areas when that area would otherwise be open for public use. The length of closure is dependent on the herbicide being applied and is detailed as the "*Restricted Entry Interval*" on the product label. Because the restricted entry interval is detailed in the product label, it is a requirement. The restricted entry interval for most herbicides is "Until Dry," but some are as restrictive as 48 hours. Public use areas would be closed where needed at least 24 hours prior to treatment and remain closed for the restricted entry interval. Most of the refuge is closed to the public during the time frame herbicide applications would take place. In areas open to public use, impacts can be minimized by applying herbicides on days when the refuge is closed to public use. All closures would be posted with signs indicating ongoing herbicide treatment. Invasive plants and other undesirable vegetation near facilities and roads could be adequately treated with ground application of herbicides when visitors are not present.

Under the No Change and Proposed Alternative, herbicide applications would be combined with non-herbicide methods like prescribed fire and could have cumulative effects. Following combined treatments, a reduction in plant abundance and diversity could occur. Such reductions would be localized and could result in a reduction of screening cover for hunters and wildlife watchers. Such cumulative effects are expected to be temporary, lasting no more than one year as the habitat recovers from unaffected perennial root stock, seed bank resources, and immigration from surrounding untreated sites. As noted above, cumulative impacts can be negated through timing of management options, amount, and location of treatments to minimize or eliminate the compounding influence of multiple management programs.

The cumulative effects would likely only impact hunters through the reduction in screening areas within hunting units. Hunters could potentially find fewer locations in which to hide, especially early in the spring wild turkey hunting season. Such exposure for turkey hunters would be short lived as dormant native vegetation not impacted by spring fire and herbicide applications would quickly provide screening cover for hunters as the growing season progresses.

This alternative would result in the desired habitat diversity and structural conditions detailed above, which would improve conditions for wildlife and therefore wildlife-dependent recreation. Maintaining the refuge's health and diversity of its habitats helps maintain its resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of continued herbicide use. Continued herbicide use has the potential of contributing to herbicide resistance of target plants. This indirect effect can be minimized using herbicides with different modes of action and/or using tank mixes of different herbicides.

Alternative B

Under this alternative, herbicide use would be discontinued, and invasive plants and other undesirable vegetation management would be limited to non-herbicide tools. This could only occur in accessible areas. Most of the refuge is not accessible as result of UXO and in those areas, management of invasive plants and other undesirable vegetation would be limited to prescribed fire.

Under this alternative, encroachment of invasive plants and other undesirable vegetation would likely result in a reduction in plant diversity. The effects of discontinuing herbicide use on refuge habitats would be mostly indirect with invasive species and other undesirable vegetation out-competing desirable vegetation. Conversion of habitats to monotypic stands of invasive species would greatly reduce the refuge's diversity, which would be a direct effect of discontinuing herbicide applications. The loss of plant and diversity would lead to a reduction in wildlife diversity and wildlife-dependent recreation. The loss of diversity would also reduce Big Oak NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks. This would directly affect the refuge's environmental health and would be a cumulative effect of discontinued herbicide use.

Monitoring

The USFWS, Midwest Region, requires all herbicide applications are recorded via the *R3 Management Actions Chemical Plant Map* (USFWS 2022b). The recorded information includes the treatment area and amount of applied herbicide. The refuge monitors vegetation response to herbicides with visual observations.

Areas that have experienced widespread invasions of trees and shrubs have experienced documented impacts and declines in crawfish frogs (Wiliams et al. 2012) and Henslow's sparrows (Herkert 2002). The refuge currently monitors populations of Henslow's sparrows, northern crawfish frogs, and monarchs throughout the refuge grasslands. Continued population monitoring of these species using established protocols would document success in these species' ability to reestablish populations in the reclaimed management units.

Summary of Analysis

Alternative A – Continued Herbicide Use– No Action and Proposed Alternative:

As described above, under the No Action and Proposed Alternative the refuge would continue using herbicide methods along with non-herbicide methods to control invasive plants and other undesirable vegetation. This alternative provides flexibility in selecting the appropriate application method and timing for the safest and most effective herbicide treatment. Timing of

herbicide applications would typically take place when target plants are most susceptible to herbicide control. In addition to ground and aerial herbicide application, the refuge would continue with an integrated management approach using other control methods, including prescribed fire and mechanical control, when feasible.

One of the main concerns for environmental impact under this alternative is the application of herbicides and their associated risks. However, several measures are in place to mitigate the minimal negative impacts of herbicide use to control invasive plants and other undesirable vegetation on Big Oaks NWR. All herbicides are applied following product label restrictions, which have received environmental review (NEPA) and Endangered Species Act (Section 7) consultation. All herbicide applications on Big Oaks NWR are reviewed and approved at the appropriate level using the Pesticide Use Proposal System. This includes site-specific Endangered Species Act (Section 7) consultation. All herbicide application on Big Oaks NWR must also follow standard USFWS BMPs.

Visitor use and experience would be minimally impacted because most herbicide applications would occur out of public use areas. When herbicide application must occur within the public use area of the refuge, applications can be mostly achieved when those areas are closed for public use. Refuge visitor exposure to herbicides would be avoided by following restricted entry interval detailed on the product labels.

This alternative fulfills the Service's mandate under the NWRSAA. This alternative also fulfills Big Oaks NWR's purpose and mission and the mission of the NWRS.

Alternative B – Discontinued Herbicide Application:

Under this alternative, the refuge would limit management of invasive species and other undesirable vegetation to non-herbicide methods including prescribed fire, mowing, hand-pulling, and biological control. Vegetation management with these methods often requires more frequent treatments than is feasible with current resources. Non-herbicide methods would be restricted to management units and facilities that are accessible to entry (i.e., not closed due to UXO restrictions) or physical barrier for equipment, such as trees. On Big Oaks NWR, the only areas deemed safe by U.S. Army for access by vehicles, and thus available for mowing and other mechanical disturbance methods, are roads, the perimeter road rights-of-way, one area adjacent to the south perimeter fence, and two grassland units along the east perimeter (Figure 2). Under this Alternative, prescribed fire and biological control would be the only tools available to control or reduce invasive species and other undesirable vegetation on most of Big Oaks NWR.

With this alternative the refuge would not be expected to meet its purpose or mission as all habitats and facilities would eventually be degraded with invasive species and other

undesirable vegetation. This would negatively affect refuge resources like migratory birds, resident wildlife, and threatened and endangered species. The loss of habitat diversity would negatively affect wildlife-dependent recreation and the refuge's environmental health. This would then limit Big Oak NWR's resilience in the face of stressors like climate change, new invasive species introductions, and disease outbreaks.

List of Sources, Agencies and Persons Consulted

Tribes, other federal agencies, state, county, and local agencies, non-governmental organizations, and other Service personnel have been invited to review the draft for this EA. Their comments will be included when provided.

List of Preparers

Robert Chapman, Biological Science Technician, Big Oaks National Wildlife Refuge

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Public Outreach

This draft Environmental Assessment will be available for public review and comment for 15 days from July 20 to August 4, 2022. The draft document will be available at the refuge office (1661 West JPG Niblo Road, Madison, IN 47250), via email (BigOaks@fws.gov), and can be downloaded from the refuge website (https://www.fws.gov/refuge/big_oaks/). Comments can be sent by email to BigOaks@fws.gov or to the refuge office.

Determination

This section will be filled out upon completion of any public comment period and at the time of finalization of the Environmental Assessment.

- ☐ The Service's action will not result in a significant impact on the quality of the human environment. See the attached **"Finding of No Significant Impact."**
- ☐ The Service's action **may significantly affect** the quality of the human environment and the Service will prepare an Environmental Impact Statement.

Signatures

Submitted By:

Project Leader Signature

Date:

Concurrence:

Regional Historic Preservation Officer Signature

Date:

Concurrence:

Refuge Supervisor Signature

Date:

Approved:

Regional Chief, National Wildlife Refuge System Signature

Date:

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