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Memorandum

Date: August 16, 2016

To: Assistant Regional Director, Ecological Services, Bloomington, MN

From: Field Supervisor, Bloomington Field Office, Bloomington, IN

Subject: Biological Opinion for the Issuance of an Incidental Take Permit for the Federally Endangered Indiana Bat *(Myotis sodalis)* and Federally Threatened Northern Long-eared Bat (*Myotis septentrionalis*) for the Wildcat Wind Farm, Madison and Tipton Counties, Indiana

The attached document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion based on our review of the "Indiana Bat and Northern Long-eared Bat Habitat Conservation Plan, Wildcat Wind Farm Phase 1 Tipton and Madison Counties, Indiana" (HCP). The HCP was submitted by Wildcat Wind Farm I, LLC as part of their application for a permit for incidental take of Indiana and northern long-eared bats resulting from actions associated with the Wildcat Wind Farm. This Biological Opinion is prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)

For further discussion, please contact me at (812) 334-4261 ext. 1214 or Scott_Pruitt@fws.gov.

BIOLOGICAL OPINION

and

INCIDENTAL TAKE STATEMENT

for the

APPLICATION FOR AN INCIDENTAL TAKE PERMIT FOR THE FEDERALLY LISTED INDIANA BAT (*Myotis sodalis*) AND NORTHERN LONG-EARED BAT (*Myotis septentrionalis*) FOR WILDCAT WIND FARM I, MADISON AND TIPTON COUNTIES, INDIANA

Prepared by:
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August 16, 2016

Contents

Introduction

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion based on our review of the Indiana Bat and Northern Long-Eared Bat Habitat Conservation Plan (hereafter referred to as the HCP) submitted by Wildcat Wind Farm, LLC (hereafter referred to as WWF or the Applicant). The HCP was submitted by the Applicant as part of their application for a permit for incidental take of Indiana bats (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*) resulting from actions associated with Wildcat Wind Farm I (hereafter referred to as the Project). This Biological Opinion is prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

This Biological Opinion is the culmination of formal section 7 consultation under the Act. The purpose of formal section 7 consultation is to insure that any action authorized, funded, or carried out by the Federal government is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat of the species. This Biological Opinion evaluates the Service's issuance of an Incidental Take Permit pursuant to section 10 of the Act, as the issuance of this permit is a federal action requiring consultation under section 7 of the Act.

This Biological Opinion is primarily based on the information provided from the following sources:

1) the Applicant's HCP,
2) the Environmental Assessment (EA) for the Proposed Habitat Conservation Plan and Incidental Take Permit,
3) Reports and scientific literature on Indiana bats, northern long-eared bats and similar bat species', and
4) meetings, phone calls, site visits, and written correspondence with the Applicant and their consultants (see CONSULTATION HISTORY below).

Consultation History

February 23, 2010 – Early coordination initiated by ARCADIS for the proposed Wildcat Wind Farm in Grant, Howard, Madison and Tipton Counties, Indiana.

July 12, 2011 – Stantec Consulting Services requests site-specific authorization for mist net surveys at Wildcat Wind Farm. USFWS emails concurrence with survey request.

October 5, 2011 – USFWS receives mist net survey report from Stantec for bat surveys completed in Summer 2011.

June 8, 2012 – E.ON Climate and Renewables requests technical assistance from the Service concerning Wildcat Wind Farm's (Phases I and II) effects on Endangered Species Act-listed species.

Jun 18, 2012 – USFWS issues a Technical Assistance Letter to E.ON Climate and Renewables for Wildcat Wind Farm (Phases I and II).

May 21, 2013 – Stantec Consulting Services requests site-specific authorization for mist net surveys at Wildcat Wind Farm. Service emails concurrence with survey request.

December 20, 2013 – USFWS and WWF enter into a Reimbursable Agreement for the Wildcat Wind Farm HCP Project (Enhanced Permitting and Review Services).

July 15, 2014 – Meeting at the U.S. Fish and Wildlife Service Bloomington, Indiana Field Office (BFO) to discuss Evidence of Absence monitoring protocols, mitigation, spring take, take estimate.

November 12, 2014 – Meeting at the BFO to discuss spring take coverage, monitoring and adaptive management.

December 17, 2015 – Meeting at the BFO to discuss adaptive management and mitigation.

May 12, 2016 – Wildcat Wind Farm submits a valid application for an Incidental Take Permit for the operation of the wind farm, along with a Habitat Conservation Plan for the Indiana and northern long-eared bats that included all required elements.

June 25, 2015 – E.ON Climate and Renewables requests technical assistance from the Service concerning Wildcat Wind Farm's effects on Endangered Species Act-listed species

July 2, 2015 – USFWS issues Technical Assistance Letter incorporating spring take concerns

June 16, 2016 – USFWS published the Draft EA and Draft HCP in the Federal Register (FWS–R3–ES–2016–N089) for a 45-day public comment period.

August 4, 2016 – Public comment period on Draft EA and Draft HCP closes.

Biological Opinion

Description of Proposed Action

Project Description

The Federal action being evaluated in this Biological Opinion is the Service's issuance of a section 10(a)(1)(B) Incidental Take Permit (ITP) to Wildcat Wind Farm, LLC (WWF), a wholly owned subsidiary of E.ON Climate & Renewables, North America (E.ON), for the incidental take of Indiana bats (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*) associated with the operation, maintenance, decommissioning, monitoring and mitigation activities of Wildcat Wind Farm I (the Project). As part of the requirements for obtaining an ITP, the Applicant has prepared an HCP (WWF 2016) in coordination with the Service. The 28-year ITP term will cover the 27-year operational life of the Project plus a decommissioning phase. The Project is described in the HCP and EA; a summary of the action as described in these two documents follows.

Wildcat Wind Farm I is a 200 megawatt (MW) wind-energy facility, which currently consists of 125 wind turbine generators and associated access roads, electrical collection system, operations and maintenance facility, and substation. The Project is located in Madison and Tipton Counties on 24,434 acres of private land shown in Figure 1 leased from landowners whose primarily agricultural use of the land will not change due to the project (the Project Area).

The Project includes 125 GE 1.6 MW wind turbines, each composed of three major components: the tower, the nacelle, and the rotor. The Project includes towers of two different heights from foundation to top of tower ("hub height"): 76 towers of approximately 328 ft (100 m) and 49 towers of approximately 315 ft (96 m). The nacelle sits atop the tower, and the rotor hub is mounted to the front of the nacelle. Each rotor consists of three composite blades that are approximately 161 ft (49 m) in length (total rotor diameter of 328 ft [100 m]). The total turbine height (i.e., height at the highest blade tip position) is approximately 492 ft (150 m) for the 100 m towers and approximately 479 ft (146 m) for the 96 m towers.

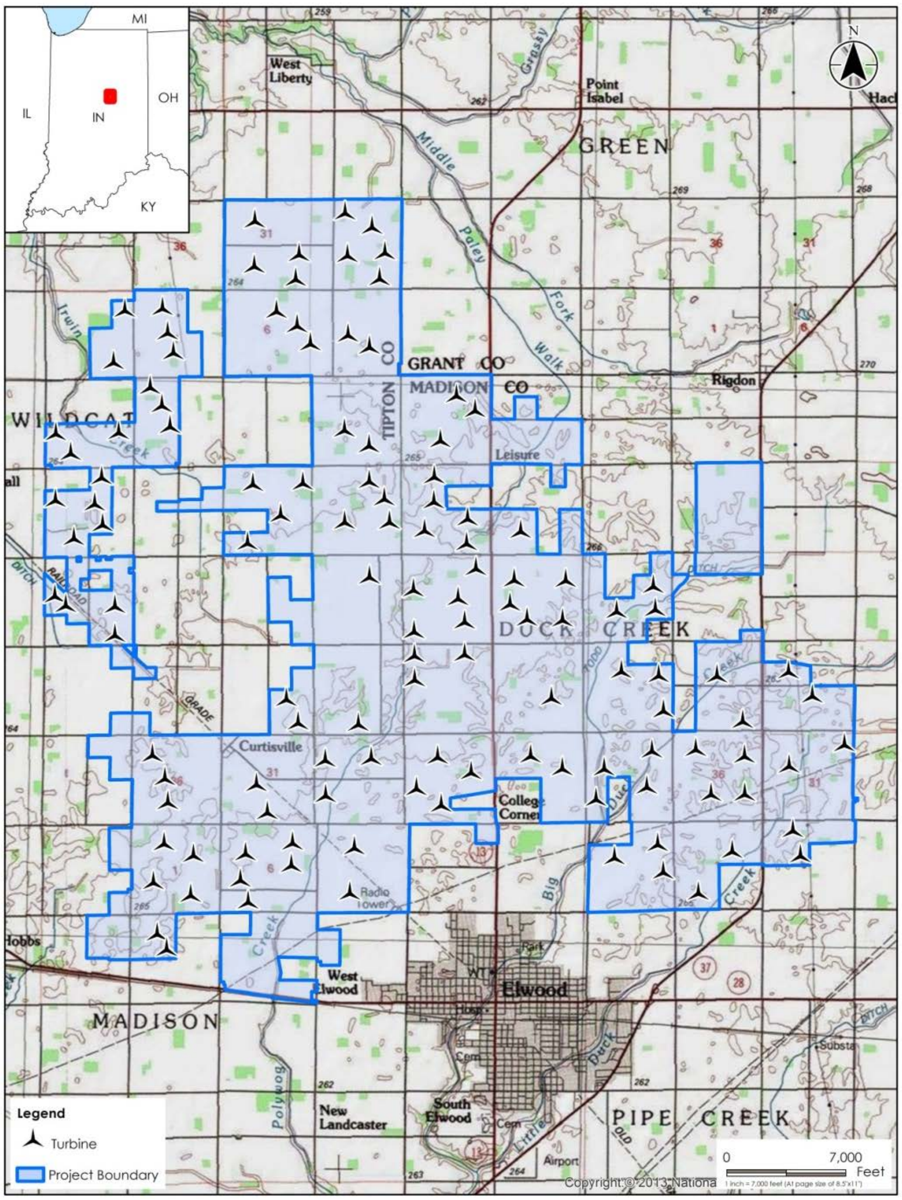

FIGURE 1. PROJECT ACTION AREA, WILDCAT WIND FARM, TIPTON AND MADISON COUNTIES, INDIANA.

Action Area

The Project Action Area is defined as "all areas to be affected directly or indirectly by the Federal action" (50 CFR §402.02). Therefore, the Project Action Area includes the Project footprint and the geographic extent of the area that could be affected by construction or operational activities either directly, indirectly, or through interrelated or interdependent actions.

For purposes of this Biological Opinion, the Action Area includes all lands leased by the Permittee for the operation of the Project (Figure 1). The Action Area encompasses 24,434 acres (9,888 hectares) of private land leased in Tipton and Madison Counties, located in central Indiana. Based on the National Land Cover Database (2011), land cover within Madison and Tipton Counties is dominated by agriculture (ranging from 74% in Madison County to 90% in Tipton County), mostly row crops of corn, soybeans, and wheat. Cultivated crops comprise 93.4% of the land use within the Project Area (Table 1). Developed open space (5.1%), deciduous forest (0.5%), grassland/herbaceous cover (0.5%), pasture/hay (0.2%), and low intensity development (0.2%) cover nearly all of the remaining land within the Project Area. Forested tracts are fragmented and scattered across the landscape. Table 1 shows the distribution of land cover within the Project Area.

TABLE 1. NATIONAL LAND COVER DATABASE LAND COVER TYPES AND EXTENTS WITHIN THE WILDCAT WIND PROJECT BOUNDARY (TIPTON AND MADISON COUNTIES, INDIANA)

Land Cover Type	Acres (hectares)	Approximate Percent Composition
Developed, Open Space	1,203.1 (486.9)	4.9%
Developed, Low Intensity	79.6 (32.2)	0.3%
Developed, Medium Intensity	11.6 (4.7)	<0.1%
Developed, High Intensity	2.0 (0.8)	<0.1%
Deciduous Forest	117.7 (47.6)	0.5%
Shrub/Scrub	10.5 (4.3)	<0.1%
Grassland/Herbaceous	109.4 (44.3)	0.4%
Pasture Hay	47.7 (19.3)	0.2%
Cultivated Crops	22,849.6 (9,246.9)	93.5%
Emergent Herbaceous Wetlands	2.5 (1.0)	<0.1%
Total	24,433.6 (9,887.9)	100%

Although individual listed bats that are impacted by the Project originate from a broader source population (e.g., a non-local migratory population), we do not anticipate that the Project's related effects (e.g., collision/barotrauma, habitat alteration, noise, lighting, etc.) will extend outside the Project footprint. Therefore, the maternity colonies and hibernaculum of these individually impacted bats are not included in the Action Area.

Conservation Measures

The Applicant has incorporated conservation measures into the HCP designed to avoid, minimize, and mitigate impacts of the proposed action on Indiana bats and northern long-eared bats. The Service has analyzed the effects of the proposed action based on the assumption that all conservation measures will be implemented. A summary of the conservation measures follows, and a more detailed description of the Project's conservation measures can be found in the HCP (see Chapter 5 – Conservation Plan).

1. Avoidance Measures:
    a. The Project was sited in an area with no suitable Indiana bat or northern long-eared bat habitat. Neither bat species uses this area in the summer and the nearest hibernaculum for both Indiana and northern long-eared bats is 121 km (75 mi) away from the Project Area.
2. Minimization Measures:
    a. From August 1 – October 15, turbines will cut-in at wind speeds of 5.0 meters per second (m/s) at night (sunset to sunrise). Below the 5.0 m/s cut-in speed, turbine blades will be "feathered" (i.e., turbine blades will be pitched into the wind to minimize spinning to less than 2 rotations per minute). The only exception to turbine operational adjustments will be on nights when temperatures are below 50˚ F (10°C) from August 1 to October 15. Turbines will be allowed to operate at full capacity below these temperatures.
    b. From October 16 – July 31, turbines will operate at the manufacturer's rated cut-in speed of 3.5 m/s at night (sunset to sunrise). Below the 3.5 m/s cut-in speed, turbine blades will be "feathered".
3. Mitigation Measures:
    a. Preserve and permanently protect at least 253 acres (102 hectares) of summer maternity habitat in the Middle Wabash-Little Vermillion watershed in northern Indiana. Only lands within the home range of both Indiana and northern long-eared bat maternity colonies will be considered for summer habitat mitigation. See details of the mitigation measures in HCP Section 5.2.2 Mitigation for Impact of the Taking.
4. Monitoring, Reporting and Adaptive Management Measures
    a. Post-construction mortality monitoring will be conducted throughout the lifetime of the project.
        i. Intensive baseline monitoring during the spring migration period (April 1 – May 15) will be conducted annually for the first 2 years. If no Indiana bat or northern long-eared bat carcass is found during the first two spring migration seasons under the HCP, then spring monitoring will be discontinued. If any Indiana bat or northern long-eared bat carcass is found during the first two spring migration seasons under the HCP, road and pad only monitoring will be conducted in subsequent years. Monitoring will include carcass searches and corrections for scavenger removal, searcher efficiency and searchable area. For details see HCP Section 5.3.4 Monitoring Protocols.
        ii. Intensive baseline monitoring during the fall migration period (August 1 – October 15) will be conducted annually for the first 3 years. Road and pad only monitoring will be conducted in subsequent years. Monitoring will include carcass searches and corrections for scavenger removal, searcher efficiency and searchable area. For details see HCP Section 5.3.4 Monitoring Protocols.

b. Adaptive management will be implemented to maintain take numbers within the limits of the permit through adjustments to turbine cut-in speeds and feathering regimes or increased monitoring efforts, based on the results of post-construction mortality monitoring. For a detailed discussion of adaptive management see HCP Section 5.4.1 Evidence of Absence Framework.
c. The Applicant will prepare an annual report describing methods and results of take compliance monitoring following completion of the field surveys and data analysis for each year of monitoring. The annual report will be submitted to the Service by January 31st following completion of the field surveys.

Status of the Species and Critical Habitat

Indiana Bat

Species Listing and Critical Habitat

The Indiana bat was listed as an endangered species on March 11, 1967 (Federal Register 32[48]:4001), under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U.S.C. 668aa[c]). In 1973, the Endangered Species Preservation Act was subsumed by the Endangered Species Act and the Indiana bat was extended full protection under this law. Critical habitat was designated for the species on September 24, 1976 (41 FR 14914). Thirteen hibernacula, including 11 caves and two mines in six states, were listed as critical habitat.

Indiana Bat Life History

The Indiana bat is a temperate, insectivorous, migratory bat that hibernates in caves and mines in the winter, and spends the summer in wooded areas. A description of the species physical appearance and a discussion of taxonomy can be found in the Indiana Bat Draft Recovery Plan: First Revision (USFWS 2007).

The Indiana Bat Draft Recovery Plan: First Revision (USFWS 2007) provides a comprehensive discussion of Indiana bat life history. A summary of the life history follows (citation for information in the summary is USFWS 2007 unless otherwise noted).

Annual Chronology

A generalized chronology of the annual cycle in Indiana bats is found in Figure 2. Note that this figure depicts peaks for each phase of annual chronology, but does not capture outliers.

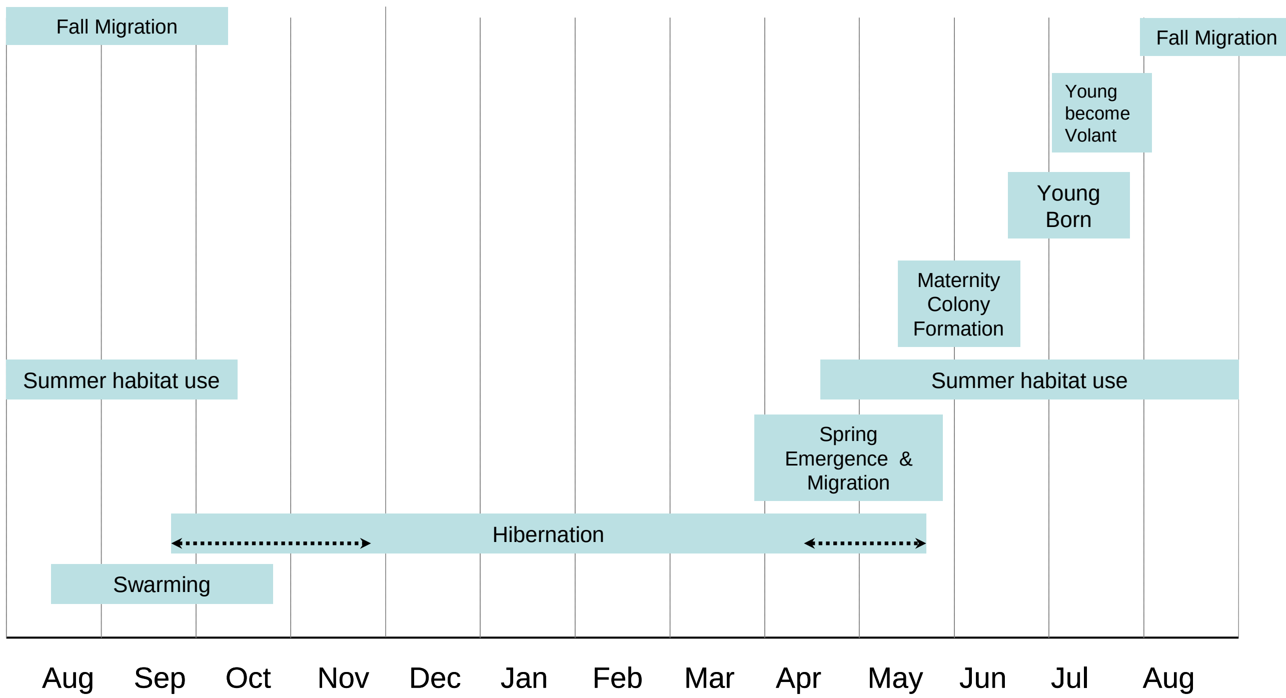

FIGURE 2. GENERALIZED INDIANA BAT ANNUAL CHRONOLOGY.

In winter Indiana bats hibernate in caves or mines, often with other species. The period of hibernation varies across the range of the species, among years, and among individuals. On a rangewide basis, the months of October through April capture the hibernation period of most individuals.

In spring, Indiana bats emerge from hibernation. Female Indiana bats emerge first, generally late March and through April, and most males emerge later. The timing of annual emergence varies, depending in part on latitude and annual weather conditions. Shortly after emerging from hibernation, females become pregnant via delayed fertilization from the sperm that has been stored in their reproductive tracts through the winter. Most reproductive females appear to initiate migration to their summer habitat quickly after emerging from hibernation. Females migrate to their traditional roost sites, where they find other members of their maternity colony. Members of the same maternity colony may come from many different hibernacula. Most documented maternity colonies have 50 to 100 adult female bats; average colony size of 80 adult females (Whitaker and Brack 2002) is a widely used estimate.

Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas; that is, they return to the same summer range annually to bear their young. Female Indiana bats form maternity colonies in forested areas where they bear and raise their pups. Maternity colony habitats include riparian forests, bottomland and floodplain habitats, wooded wetlands, and upland forest communities. Maternity roost sites are most often under the exfoliating bark of dead trees that retain peeling bark. Live trees, especially shagbark hickory, are also used if they have flaking bark under which the bats can roost. Primary roosts, those used frequently by large numbers of female bats and their young, are usually large diameter snags (dead trees). Roost trees are often in mature mostly closed-canopy forests, but in trees with solar exposure (i.e., sunlight on the roost area for at least part of the day) – these may be in canopy gaps in the forest, in a fenceline, or along a wooded edge. Indiana bats typically forage in forested habitats, forest edges, and riparian areas.

Fecundity is low with female Indiana bats producing only one pup per year in late June to early July. Young bats can fly at about four weeks of age. Cohesiveness of maternity colonies begins to decline after young bats become volant. That is, the bats tend to roost together in the same roosts less frequently and at lower densities. A few bats from maternity colonies may commence fall migration in August, although at many sites some bats remain in their maternity colony area through September and even into October. Members of a maternity colony do not necessarily hibernate in the same hibernacula, and may migrate to hibernacula that are over 300 km (190 mi) apart (Kurta and Murray 2002, Winhold and Kurta 2006).

Indiana bats arrive at their hibernacula in preparation for mating and hibernation as early as late July; usually adult males or nonreproductive females make up most of the early arrivals (Brack 1983). The number of Indiana bats active at hibernacula increases through August and peaks in September and early October (Cope and Humphrey 1977, Hawkins and Brack 2004, Hawkins et al. 2005). Return to the hibernacula begins for some males as early as July, but most females arrive later. After fall migration, females typically do not remain active outside the hibernaculum as long as males. Males may continue swarming through October in what is believed to be an attempt to breed with late arriving females. Swarming is a critical part of the life cycle when Indiana bats converge at hibernacula, mate, and forage until sufficient fat reserves have been deposited to sustain them through the winter (Hall 1962). Swarming behavior typically involves large numbers of bats flying in and out of cave entrances throughout the night, while most of the bats continue to roost in trees during the day.

Swarming continues for several weeks and mating may occur on cave ceilings or near the cave entrance during the latter part of the period. Limited mating activity occurs throughout the winter and in spring before the bats leave hibernation (Hall 1962). Adult females store sperm through the winter and become pregnant via delayed fertilization soon after emergence from hibernation. Young female bats can mate in their first autumn and have offspring the following year (although how many actually do so is variable), whereas males may not mature until the second year.

Migration in Indiana Bats

Indiana bat migration has not been extensively studied and is poorly understood; further, little information is available to determine habitat use and needs for Indiana bats during migration.
We are including a discussion of migration in Indiana bats in this Biological Opinion because bats, generally, and Indiana bats, specifically, appear to be most susceptible to strikes with wind turbines during fall migration. Therefore, understanding migration is relevant to assessing how Indiana bats will be impacted by wind turbines.

Reproductive female Indiana bats may migrate long distances between hibernacula and summer habitat; the longest documented migration is 575 km (357 mi) (Winhold and Kurta 2006). However, most females migrate shorter distances. For example, we calculated the average migration distance of 27 female Indiana bats banded during summer at multiple locations in Indiana that were subsequently observed (i.e., banded bat spotted and identified) in hibernacula. For these bats, the distance between summer capture to the hibernacula ranged from 8 to 209 km (5 to 130 mi); the average distance was 84 km (52 mi) (USFWS 2007). Migration is sex-biased, with females being more likely to migrate than males. Males and some nonreproductive females may migrate, but many stay close to their hibernacula. Spring migration is thought to be stressful for the Indiana bats; fat reserves and food supplies are low. Females, which are likely to migrate further, also have the added energy demands of pregnancy. Most females appear to make the trip from hibernaculum to summer habitat quickly during the spring, many making the trip in one or two nights (although those moving long distances likely take longer).

Little information is available to determine habitat use and needs for Indiana bats during migration. Further, the nature of migration in Indiana bats is poorly understood. We do not know if Indiana bats migrate singly or in groups, what routes Indiana bats follow during migration, or at what height Indiana bats fly while migrating. Further, we do not know if the natures of spring and fall migration are similar (e.g. does an individual simply reverse the spring migration route during the fall). All of this information would be of value in informing management decisions, especially relative to avoiding the mortality of Indiana bats at wind energy facilities. Most of the migration studies conducted to date have involved radio-tagging Indiana bats (mostly females) during spring emergence and tracking those bats en route to summer habitat. To date, there has only been one similar study of fall migrating Indiana bats (Roby 2012).

The extent to which Indiana bats require stopover habitat (i.e., areas to rest and possibly forage) during migration is not known. Several studies suggest that Indiana bats move relatively quickly during spring migration (from hibernacula to summering areas). Evidence from spring radio-tracking studies in New York and Pennsylvania indicate that Indiana bats are capable of migrating at least 48 km (30 mi) in one night (USFWS 2011 and references therein). In studies in Northeastern states, most Indiana bats completed their spring migration in one to two nights (see Turner 2006 for an exception). Similarly, Roby (2012) found that a female Indiana bat migrating from summer maternity habitat in Kentucky to her hibernaculum in southern Indiana (i.e., fall migration) traveled the 47.5 km (29.5 mi) in one night. As previously discussed, some Indiana bats migrate long distances (up to 575 km, as discussed above). We do not know how long bats take to migrate this distance, but we presume that bats moving these distances must require some stopover sites during migration. Further, we presume that Indiana bats would use forested habitats, similar to habitats used in summer, for these stopovers. [Although Belwood (2002) observed that some Indiana bats may roost in manmade structures during spring migration]. Hicks et al. (2012) conducted a large-scale study of Indiana bats during spring migration from a hibernaculum in Illinois. They reported that Indiana bats appeared to take routes associated with wooded cover during spring migration and that “all roosting bats were associated with wooded cover, and all roosts that were specifically located were in trees.” Limited data from other spring migration studies also support that spring migration stopover habitats are similar to those used in summer (Butchkoski and Turner 2006, 2007; Turner 2006).

We can infer from our knowledge of the segregation of female and male bats during summer that the sexes do not generally migrate together. We know that females and juveniles do not usually congregate with males during the summer; many males are solitary or may congregate in small groups during the summer, often near their hibernacula. (However, some males are found in the vicinity of maternity colonies). For those males that remain near their hibernacula, migration is short in both distance and duration and not done in the company of reproductive female or juvenile bats. Arrival times of males and females at hibernacula (in fall) also suggest that male and female bats generally do not all migrate together; males arrive first followed by females (Cope and Humphrey 1977, LaVal and LaVal 1980, Brack 1983, Brack et al. 2005). It is further known that not all females depart from a given maternity colony at the same time and that females from the same maternity colony do not all hibernate in the same hibernacula, although some do (Kurta and Murray 2002, Winhold and Kurta 2006). This information suggests at least some females migrate independently. However, we cannot discount the possibility that some females and/or young may migrate together. Indiana bats are likely cued by the same stimuli (possibly including temperature, day length, and other environmental cues) with regard to the trigger for fall migration. So, it is reasonable that there may be migratory pulses moving through areas en route to hibernacula. Thus, many Indiana bats are likely migrating simultaneously, though perhaps independently. Spring migration studies to date do not suggest that females migrate to maternity colonies in groups (Butchkoski and Turner 2007, Gumbert and Roby 2011), although we cannot rule out the possibility that some do.

The path of migration in Indiana bats is also poorly understood. Generally, migrations in the Midwest are from hibernation sites that are south of summer maternity areas (i.e., spring migrating bats are generally moving north from hibernacula to summering areas); the routes in the Northeast and the Appalachians tend to be multi-directional (i.e., hibernation sites are not consistently located south of summering sites) (USFWS 2011). We do not know if Indiana bats consistently follow a specific route (i.e., does the same bat take the same route each year), or whether routes tend to be through forested landscapes or to follow linear landscape features (e.g., streams or rivers). Spring tracking studies in the Northeast suggest that Indiana bats may follow topographic features, including stream corridors and tree lines, during much of their spring migration (Turner 2006, USFWS 2011). Gumbert and Roby (2011) found that female Indiana bats tracked from Tennessee caves after spring emergence flew relatively straight paths, but would change course to take advantage of mountain passes or to follow rivers or other linear features. Based on extensive spring tracking of female Indiana bats in New York, Hicks and Herzog (2006) also concluded that reproductive female Indiana bats “follow a more or less direct route from the hibernacula to their summer range,” although they noted that bats avoided a large urban area (choosing to fly around rather than maintain their course). Butchkoski and Turner (2007) also noted a spring migrating Indiana bat detour around an urban area in Pennsylvania.

During spring tracking of Indiana bats in Illinois, Hicks et al. (2012) observed that migrating Indiana bats in a primarily agricultural landscape made use of wooded cover. They concluded that “the presence of forest cover is an important consideration in their selection of migratory routes." However, recent mortality of fall migrating Indiana bats at Fowler Ridge Wind Farm in northwest Indiana (Johnson et al. 2010a, Good et al. 2011), in a flat and almost exclusively agricultural area, indicated that Indiana bats will migrate through non-forested areas (where there are no apparent linear features to follow), at least during fall migration. Whether or not Indiana bats also pass through this area during spring migration is not known.

It is unknown how bats find their way during migration, but some combination of navigational cues, likely including the earth's magnetic field (Holland et al. 2006, Wang et al. 2007), are probably involved. Research suggests that bats do not consistently (or even usually) echolocate during migration (Griffin 1970, Barclay et al. 2007). Vision plays a role in Indiana bat migration (Davis and Barbour 1965, Barbour et al. 1966), and is likely more important to migrating bats than echolocation (Eklöf 2003).

Data regarding the height at which Indiana bats migrate are severely lacking. Most of the migration data to date have been collected by radio-tagging bats (mostly females) during spring emergence and tracking those bats en route to summer habitat. Data from these studies suggest that spring migrating Indiana bats fly at canopy level or lower (Turner 2006, USFWS 2011). These studies have been conducted in the northeast portion of the bat's range. It is uncertain if these flight heights would be similar in central and western portions of the range, particularly in areas with little tree cover. Further, it is unknown whether flight heights during spring and fall migration are similar; the natures of spring and fall migration may be very different (USFWS 2011).

There are no data available on flight height of radio-tagged Indiana bats during fall migration. However, there has been mortality of Indiana bats at wind facilities during fall migration (Pruitt and Okajima 2014) and mortality of other Myotids (bats from the genus Myotis, the same genus as Indiana bats) at wind facilities primarily during late summer and fall (Arnett et al. 2008, Gruver et al. 2009). These data demonstrate that at least a portion of Myotid bats, and specifically some Indiana bats, are flying at rotor-swept height, which is well above the tree canopy, during fall migration.

Range and Distribution

Indiana bats are found over most of the eastern half of the United States (current range is depicted by the outer red line in Figure 3). The recovery program for the Indiana bat delineates four Recovery Units (RUs): the Ozark-Central, Midwest, Appalachian Mountains, and Northeast RUs (Figure 3; see USFWS 2007 for explanation of RU boundaries). The proposed project would be constructed within the Midwest RU, and we assume that bats killed at WWF will be from the Midwest RU.

In 2015, approximately 35% of Indiana bats (185,720 of 523,636) hibernated in caves in southern Indiana. Other states which supported populations of over 50,000 hibernating Indiana bats included Illinois, Missouri, and Kentucky. Other states within the current winter range of the Indiana bat include Alabama, Arkansas, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. Approximately 50% of the population hibernated in the Midwest

Recovery Unit (Table 2). The 2015 population estimate (523,636) is almost 400,000 bats less than when the species was listed as endangered in 1967 (approximately 900,000).

The known summer distribution of the Indiana bat covers a broader geographic area than its winter distribution. For more detailed information on current summer distribution reference Appendix 2 in the Indiana Bat Draft Recovery Plan: First Revision (USFWS 2007); Appendix 2 details the distribution of approximately 270 known Indiana bat maternity colonies. Based on an estimated total Indiana bat population of 523,636 in 2015 and an average maternity colony size of 80 adult females, we estimate that there are about 3,275 maternity colonies of Indiana bats. As of 2007, we know the location of approximately 270 colonies, which is less than 10% of the colonies we assume to be present.

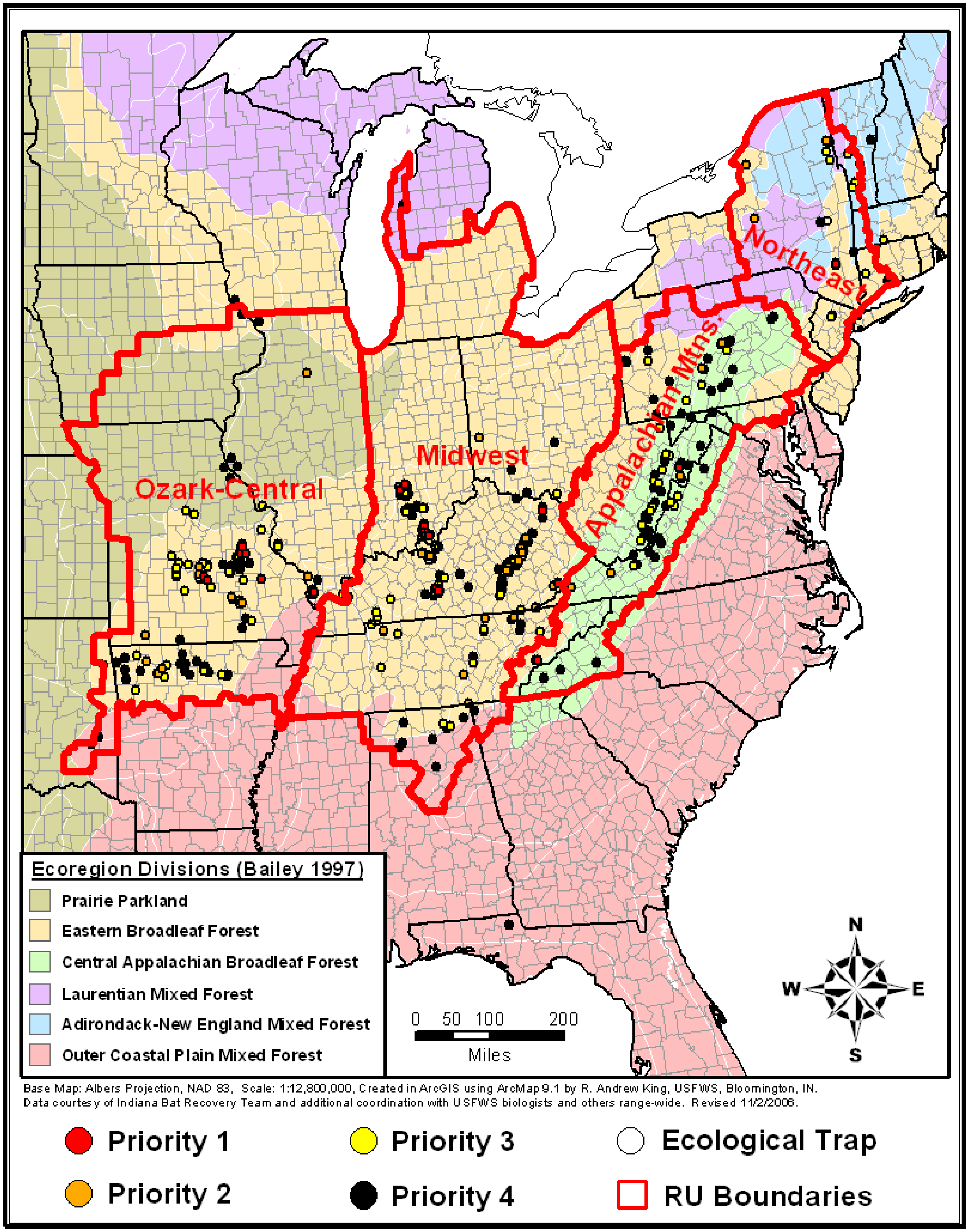

FIGURE 3. INDIANA BAT CURRENT RANGE (DELINEATED BY OUTER RED LINE) AND RECOVERY UNITS.

TABLE 2. POPULATION ESTIMATES FOR THE INDIANA BAT BY RECOVERY UNIT

IBat Recovery Unit	State	2007	2009	2011	2013	2015	% Change from 2013	% of 2015 Total
Ozark-Central	Illinois	53,824	53,342	61,239	58,840	56,055	-4.7%	10.7%
	Missouri	183,304	181,097	182,852	184,245	185,693	0.8%	35.5%
	Arkansas	1,821	1,480	1,206	856	1,389	62.3%	0.3%
	Oklahoma	0	0	13	5	5	0.0%	0.0%
	Total	**238,949**	**235,919**	**245,310**	**243,946**	**243,142**	**-0.3%**	**46.4%**
Midwest	Indiana	238,068	213,244	225,477	226,572	185,720	-18.0%	35.5%
	Kentucky	71,250	57,325	70,598	62,233	66,024	6.1%	12.6%
	Ohio	7,629	9,261	9,870	9,259	4,809	-48.1%	0.9%
	Tennessee	2,929	1,657	1,791	2,369	2,551	7.7%	0.5%
	Alabama	258	253	261	247	247	0.0%	0.0%
	SW Virginia	188	217	307	214	137	-36.0%	0.0%
	Michigan	20	20	20	20	20	0.0%	0.0%
	Total	**320,342**	**281,977**	**308,324**	**300,914**	**259,508**	**-13.8%**	**49.6%**
Appalachia	West Virginia	14,745	17,965	20,296	3,845	2,373	-38.3%	0.5%
	E Tennessee	5,977	11,058	11,096	13,200	2,401	-81.8%	0.5%
	Pennsylvania	1,038	1,035	516	120	24	-80.0%	0.0%
	Virginia	535	514	556	418	460	10.0%	0.1%
	North Carolina	0	1	1	1	0	-100.0%	0.0%
	Total	**22,295**	**30,573**	**32,465**	**17,584**	**5,258**	**-70.1%**	**1.0%**
Northeast	New York	52,779	33,172	15,654	17,772	15,564	-12.4%	3.0%
	New Jersey	659	619	409	448	111	-75.2%	0.0%
	Vermont	325	64	61	53	53	0.0%	0.0%
	Total	**53,763**	**33,855**	**16,124**	**18,273**	**15,728**	**-13.9%**	**3.0%**
Rangewide Total:		**635,349**	**582,324**	**602,223**	**580,717**	**523,636**	**-9.8%**	**100%**

Population Status and Threats

This section will include a discussion of status of the Indiana bat and threats to the species rangewide. Within this rangewide context, we will also comment on the status and threats in the Midwest Recovery Unit, which is where this project will take place.

Population Status

The 2015 rangewide population estimate of Indiana bats was 523,636 individuals, based on winter hibernacula survey information compiled by the Service (Table 2). Figure 4 provides the rangewide Indiana bat population estimates from 1981-2015.

Generally, the Indiana bat population (rangewide) decreased from the time of listing through the 1990s. From 2001 through 2007 the population increased, but has declined since. The population in the Midwest Recovery Unit has followed the same trend.

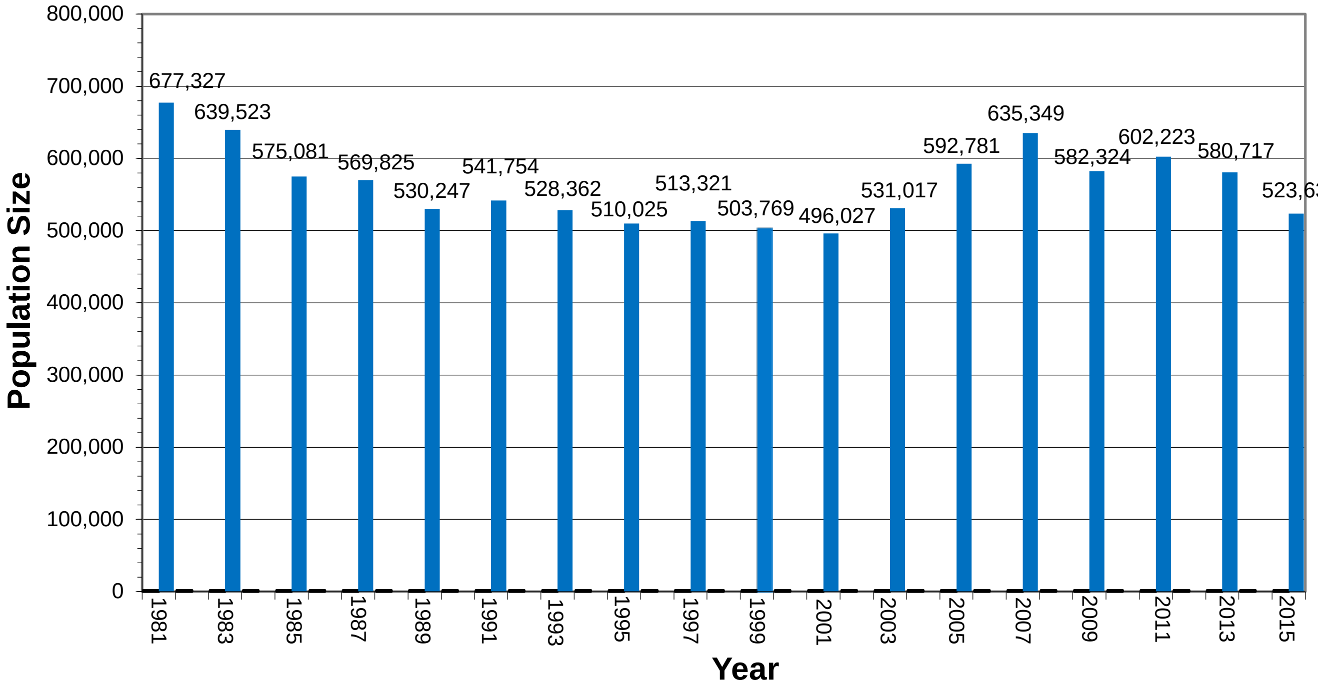

FIGURE 4. RANGEWIDE INDIANA BAT POPULATION ESTIMATES 1981-2015.

Threats

We categorize threats based on these five factors, consistent with current listing and recovery analyses under the Endangered Species Act:

A. The present or threatened destruction, modification, or curtailment of its habitat or range.
B. Overutilization for commercial, recreational, scientific, or educational purposes.
C. Disease or predation.
D. The inadequacy of existing regulatory mechanisms.
E. Other natural or man-made factors affecting its continued existence.

The draft revised Recovery Plan (USFWS 2007) includes a detailed discussion of threats. The following summary is based primarily on that document, with emphasis on the Midwest Recovery Unit. This summary also includes information that was not available at the time the draft revised plan was completed.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Destruction/Degradation of Hibernation Habitat

There are well-documented examples of modifications to Indiana bat hibernation caves that affected the thermal regime of the cave, and thus the ability of the cave to support hibernating Indiana bats, as summarized in the draft revised Recovery Plan (USFWS 2007). Generally, threats to the integrity of hibernacula have decreased since the time that Indiana bats were listed as endangered. Increasing awareness of the importance of cave microclimates to hibernating bats and regulatory authorities under the Endangered Species Act have lessened, but not eliminated, this threat. In addition to purposeful modifications, the threat of collapse in mines where Indiana bats hibernate, and the threat of inadvertent modifications to caves or natural catastrophes that can impact hibernacula remain.

Loss/Degradation of Summer Habitat, Migration Habitat, and Swarming Habitat

As discussed in the Recovery Plan (USFWS 2007), the Indiana bat requires forested areas for foraging and roosting. Loss of forest cover and degradation of forested habitats have been cited as contributing to the decline of Indiana bats (USFWS 1983, Gardner et al.1990, Garner and Gardner 1992, Drobney and Clawson 1995, Whitaker and Brack 2002). However, at a landscape level Indiana bat maternity colonies occupy habitats ranging from completely forested to areas of highly fragmented forest. Attempts to correlate forest cover with the presence of Indiana bats (typically maternity colonies) have generally not been successful. Clearly, forest cover is not a completely reliable predictor of where Indiana bat maternity colonies will be found on the landscape (Farmer et al. 2002). Nonetheless, trends in forest cover are of interest relative to Indiana bat, with increasing forest cover suggesting at least the potential for improved habitat conditions, as the species does rely on forested areas for both roosting and foraging outside the hibernation period. Conversely, in areas where almost all forest land has been lost, the absence of woodlands on the landscape certainly equates to less habitat than in prehistoric and early historic periods.

Throughout the range of the Indiana bat, there is less forest land now than there was prior to European settlement (Smith et al. 2003), particularly within the core of the species' range in the Midwest.

Conversion to agriculture has been the largest single cause of forest loss. The conversion of floodplain and bottomland forests, recognized as high quality habitats for Indiana bats, has been a particular cause of concern (Humphrey 1978). More recently, since the 1950s, some marginal farmlands have been abandoned and allowed to revert to forest and there has been a net increase in forest land within the range of the Indiana bat, particularly in the Northeast (Smith et al. 2003). Forest cover has also increased within the Midwest Recovery Unit (Smith et al. 2003). Not only has the amount of forest cover increased since the 1950s, but also the average diameter of trees has increased (Smith et al. 2003), which may equate to an increased supply of suitable roost trees for Indiana bats.

Currently, the greatest single cause of conversion of forests within the range of the Indiana bat is urbanization and development (Wear and Greis 2002; U.S. Forest Service 2005, 2006), which results in permanent conversion to land uses generally unsuitable for Indiana bats. Indiana bats are known to use forest-agricultural interfaces for foraging. In contrast, Indiana bats appear to avoid foraging in highly developed areas. At a study site in central Indiana, Indiana bats avoided foraging in a high-density residential area (Sparks et al. 2005), although maternity roosts have been found in low-density residential areas (Belwood 2002). Duchamp (2006) found that greater amounts of urban land use was negatively related to bat species diversity in north-central Indiana; several bat species, including the Indiana bat, were less likely to occur in landscapes with greater amounts of urban and suburban development. Development directly destroys habitat and fragments remaining habitat.

In summary, the relationship between forest cover at the landscape scale and Indiana bat populations is complex. Current trends toward increasing amounts of forest cover suggest that potential habitat for the Indiana bat may also be increasing. However, further study and monitoring will be required to determine if this potential habitat will be used and ultimately affect an increase in survival or productivity of Indiana bats.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

DISTURBANCE OF HIBERNATING BATS

The original recovery plan for the species stated that human disturbance of hibernating Indiana bats was one of the primary threats to the species (USFWS 1983). The primary forms of human disturbance to hibernating bats result from cave commercialization (cave tours and other commercial uses of caves), recreational caving, vandalism, and research-related activities.

Progress has been made in reducing the number of caves in which disturbance threatens hibernating Indiana bats, but the threat has not been eliminated. Biologists throughout the range of the Indiana bat were asked to identify the primary threat at specific hibernacula "Human disturbance" was identified as the primary threat at 41 percent of Priority 1, 2 and 3 hibernacula combined (Table 3). Note that the category "None Identified" includes responses of "Unknown," as well as no response to the question regarding "primary threat." (Definitions for hibernacula priority numbers: Priority 1 - current and/or historically observed winter population ≥ 10,000 Indiana bats; Priority 2 - current or observed historic population of 1,000 or greater but fewer than 10,000; Priority 3 - current or observed historic populations of 50-1,000 Indiana bats; Priority 4 - current or observed historic populations of fewer than 50 Indiana bats. See USFWS 2007 for additional information on hibernacula priority numbers.)

TABLE 3. PRIMARY THREATS AT PRIORITY 1, 2, AND 3 INDIANA BAT HIBERNACULA RANGEWIDE (USFWS UNPUBLISHED DATA 2011).

Hibernacula by Priority (N=number of hibernacula)	Primary Threat							
	Human Disturbance % (N)	Collapse % (N)	Unsuitable Temperature % (N)	Encroaching Development % (N)	Flooding % (N)	Freezing % (N)	Predation % (N)	None Identified % (N)
Priority 1 (N=24)	38% (9)	8% (2)	13% (3)	0	8% (2)	0	0	33% (8)
Priority 2 (N=54)	41% (22)	4% (2)	6% (3)	4% (2)	6% (3)	0	0	41% (22)
Priority 3 (N=155)	41% (64)	5% (7)	3% (5)	3% (4)	3% (5)	<1% (1)	<1% (1)	44% (68)
Priority 1, 2, 3 combined (N=233)	41% (95)	5% (11)	5% (11)	3% (6)	4% (10)	<1% (1)	<1% (1)	42% (98)

When only hibernacula in the Midwest Recovery Unit were considered, the proportion of sites where "human disturbance" was considered the primary threat was lower compared to rangewide (Table 4), although it was still the primary threat that has been identified for Priority 1, 2, and 3 hibernacula combined. So, while it appears that the threat of human disturbance at hibernacula is less in the Midwest Recovery Unit compared to the rangewide threat, it remains a primary issue to be addressed in some important hibernacula.

TABLE 4. PRIMARY THREATS AT PRIORITY 1, 2, AND 3 INDIANA BAT HIBERNACULA IN THE MIDWEST RECOVERY UNIT (USFWS UNPUBLISHED DATA 2011).

Hibernacula by Priority (N=number of hibernacula)	Primary Threat							
	Human Disturbance % (N)	Collapse % (N)	Unsuitable Temperature % (N)	Encroaching Development % (N)	Flooding % (N)	Freezing % (N)	Predation % (N)	None Identified % (N)
Priority 1 (N=12)	17% (2)	0	8% (1)	0	17% (2)	0	0	58% (7)
Priority 2 (N=27)	15% (4)	0	0	4% (1)	11% (3)	0	0	70% (19)
Priority 3 (N=74)	26% (19)	0	0	0	3% (2)	0	0	72% (53)
Priority 1, 2, 3 combined (N=113)	22% (25)	0	1% (1)	1% (1)	6% (7)	0	0	70% (79)

Disturbance of Summering Bats

There are far fewer documented examples of disturbance of Indiana bats in summer due to "overutilization for commercial, recreational, scientific, or educational purposes," compared with impacts to hibernating bats. However, research-related disturbance of summering Indiana bats has been observed (USFWS 2007).

As of December 2007, there were approximately 30 active section 10(a)(1)(A) permits (research permits) for Indiana bats in Region 3 of the Service (which includes most of the Midwest Recovery Unit). As of January 2014, there are approximately 80 permits that are active (or in the process of renewal). Generally, there is more mist netting being conducted for Indiana bat surveys in the Midwest Recovery Unit (as well as other parts of the range) than at any time in the past. Much of this increase is associated with surveys to determine if Indiana bats are present at locations associated with proposed wind energy developments (see discussion below under Other Natural or Man-made Factors affecting Its Continued Existence), as well as other development projects. Mortality associated with mist netting and associated handling of bats has been observed. However, insuring that only qualified, permitted researchers conduct this work and follow proper holding and marking techniques minimizes potential for research-related mortality.

In addition to research, mortality of summering Indiana bats resulting from the felling of roost trees has been documented (USFWS 2007). Roost abandonment has been documented when heavy equipment was operated in the vicinity of roosts (Callahan 1993, Timpone 2004). Minimizing disturbance in the vicinity of known roost sites, and checking suitable sites prior to disturbance to determine if they are occupied, can help to avoid disturbance-related mortality.

Factor C. Disease or Predation

In the past, disease and predation have generally not been considered major threats to bat populations in general, or Indiana bats specifically (USFWS 2007). The emergence of white-nose syndrome (WNS) has changed that. WNS has caused recent catastrophic declines among multiple species of bats in eastern North America (Lorch et al. 2011, Cryan et al. 2013a) including large declines in Indiana bat populations (Turner et al. 2011). WNS is now recognized as the most significant threat to the Indiana bat.

Dead bats were first documented at four sites in eastern New York in the winter of 2006-2007. At the time, the cause of mortality was unknown but white fungus was observed on muzzles of many of the dead bats and the term "white-nose syndrome" was coined. WNS has since caused the death of an estimated 5.7 – 6.7 million bats of seven species, including the Indiana bat, across the eastern North America. Bat population declines due to WNS are one of the fastest declines of wild mammal populations ever observed (Cryan et al. 2010; Frick et al. 2010). Associated with the fungus *Pseudogymnoascus destructans* (Minnis and Linder 2013), the disease is named after the most obvious visible symptom of WNS which is the presence of a white fungus on the face, wing, or tail membranes of some affected animals (some do not exhibit visible fungus). [Note that when first identified the fungus was named *Geomyces destructans* (Gargas et al. 2009), but more recent phylogenetic analyses have demonstrated that the WNS fungus should be placed in the genus *Pseudogymnoascus* (Minnis and Linder 2013) and it has been reclassified].

WNS may affect behavioral changes in infected individuals. For example, at some WNS-affected sites a shift of hibernating bats from traditional winter roosts to roosts unusually close to hibernacula entrances has been observed. Bats have also been observed flying outside of hibernacula during winter (often during the day) at some affected sites. At some sites, bat carcasses (particularly of *Myotis lucifugus*, the little brown bat) have been found outside affected hibernacula. Many infected bats do not survive the winter. The exact processes by which the fungal skin infection lead to death are not known, but depleted fat reserves (i.e., starvation) contribute to mortality (Reeder et al. 2012, Warnecke et al. 2012) and dehydration may also have a role (Willis et al. 2011, Cryan et al. 2013b, Ehlman et al. 2013). It is also suspected that some of the affected bats that survive hibernation emerge in such poor condition that they do not survive the summer. Among those bats that do survive, it appears that productivity of female survivors may be negatively affected (Francl et al. 2012).

At the end of the 2014-2015 hibernating season, bats with WNS were confirmed in 29 states and five Canadian provinces (see http://www.whitenosesyndrome.org/ for most recent information). Turner et al. (2011) summarized mortality rates from WNS for six species of bats for five states (NY, PA, VT, VA, WV) at sites where WNS had been present for at least two years. They summarized data from 42 sites and saw an overall decline of 88% in the number of hibernating bats at WNS-affected sites, from a total of 412,340 bats (pre-WNS) to 49,579. Mortality varies among sites and among species (Turner et al. 2011). If current trends for spread and mortality at affected sites continue, WNS will drastically reduce the abundance of many species of hibernating bats in much of North America.

The little brown bat, which was the most abundant cave-hibernating bat species in the Northeast prior to WNS, has declined by 91% in affected sites (Turner et al. 2011). Population modeling suggests a 99% chance of regional extirpation of the little brown bat in the Northeast within 16 years due to WNS (Frick et al. 2010).

Impacts of WNS on Indiana Bats

The Indiana bat, which is closely-related to the little brown bat, has also declined due to WNS. Turner et al. (2011) summarized data from 15 Indiana bat hibernation sites in five states (NY, PA, VT, VA, WV) (11 of the sites were in New York) where WNS had been present for at least two years. They documented an overall decline of 72% in the number of hibernating Indiana bats at those sites.

Impacts to Indiana bats have been variable among affected hibernacula. The following is an example of population counts in New York (at the sites with largest Indiana bat populations) when comparing the most recent counts to the last count conducted prior to signs of WNS at any given site, generally 2005 or 2007 counts (USFWS 2013):

- Haile's Cave 100% decline from 685 bats in 2005 to 0 in 2015
- Williams Preserve Mine 98.5% decline from 13,014 in 2007 to 191 in 2015

- Williams Lake Mine 99.9% decline from 1,003 in 2007 to 1 in 2015
- Glen Park 87.6% decline from 1,928 in 2007 to 239 in 2015
- Williams Hotel Mine 96.2% decline from 24,317 in 2007 to 918 in 2015
- Jamesville 98.6% decline from 2,932 in 2007 to 40 in 2015
- Barton Hill Mine 49.3% increase from 9,393 in 2007 to 14,023 in 2015

The Northeast Recovery Unit, where WNS was first observed in the winter of 2006-2007, lost almost 71% of its Indiana bats between 2007 and 2015 (Table 2). At the time dead bats were first observed in the winter of 2006-2007, we do not know how long the (previously unidentified) fungus, *Pseudogymnoascus destructans,* had been present in affected sites. Based on subsequent observations as WNS spread, it appears that the arrival of the fungus in an area may precede large-scale fatality of bats by several years. Between 2011 and 2015 the Appalachian Recovery Unit, where WNS was confirmed in the winter of 2008-2009, declined by 84%. The Midwest Recovery Unit, where WNS was confirmed in the winter of 2010-2011, declined by 16%. The Ozark-Central Recovery Unit, where WNS as confirmed in the winter of 2011-2012, had not yet experienced declines by 2015.

Thogmartin et al.'s (2013) model of the impacts of WNS on Indiana bat populations suggested that WNS will cause local and regional extirpation of some wintering populations of Indiana bats, and overall population declines exceeding 86%. However, they note a number of important limitations and sources of uncertainty that could result in actual declines being less or more severe compared to projections. One uncertainty is whether or not Indiana bats will develop any degree of immunity, genetic resistance, or behavioral tolerance to WNS.

Langwig et al. (2012) found that in Indiana bats and little brown bats, species that cluster in tight aggregations during hibernation, the declines due to WNS were equally severe across a large range of colony sizes, suggesting that WNS transmission is not density-dependent in these species. In little brown bats, after populations had declined they found an increase in the proportion of little brown bats that were roosting individually. This change in behavior could potentially reduce transmission of WNS among surviving little brown bats. Changes in sociality (i.e., clustering behavior) were less apparent in Indiana bats, possibly putting this species at higher continued risk of WNS transmission (i.e., impacts of WNS may be less likely to abate over time).

WNS now has been confirmed in all Indiana bat RUs and we anticipate that WNS will continue to radiate out to new sites within the more recently affected RUs, eventually reaching all major hibernacula for the species. Based on observations in the Northeast, the area that has been affected the longest and has the best data on mortality, we anticipate that all RUs may eventually experience the level of decline that has been documented in the Northeast.

Ultimately, how WNS will impact Indiana bat populations in the long term is not known, although current data suggest that those impacts will be severe. The impacts of WNS in the Northeast and models of spread and impacts (e.g. Thogmartin et al 2012a, 2012b, 2013) suggest that local and regional extirpations of some populations of Indiana bats should be expected. However, Thogmartin et al. (2012a) noted that the causative processes associated with WNS spread and associated impacts are not well understood. WNS may not cause the same consequences on wintering bat populations (e.g., mortality may be less) as the disease moves west and south. Ehlman et al. (2013) suggested that bat populations experiencing shorter southern winters could persist longer than their northern counterparts when faced with WNS; modeling by Flory et al. (2012) also suggested that mortality may be lower in some areas due to different environmental conditions. It has been documented that bats held in captivity and given supportive care can recover from the wing damage caused by *P. destructans* (Meteyer et al. 2011). Healing of wing membranes has also been observed in free-ranging bats caught during the active season (following WNS infection during hibernation) (Dobony et al. 2011, Fuller et al. 2011). However, the recovery process is physiologically challenging (Cryan et al. 2013a). Current thinking is that it is likely that *P. destructans*, the fungus that causes WNS, was accidentally translocated from Europe to the U.S. (Blehert 2012). Although the fungus is widespread among bats in Europe, bat mortality events similar to those in North America have not been observed in Europe (Wibbelt et al. 2010). Researchers hypothesize that bats in Europe may be more immunologically or behaviorally resistant to the fungus than their congeners in North America because they potentially coevolved with the fungus. Whether or not European bats have immunological resistance to WNS has not been determined. Likewise it is unknown if North American bats will develop resistance, although immunologically resistant individuals have not been detected to date (Moore et al. 2013).

Factor D. The Inadequacy of Existing Regulatory Mechanisms

Listing of the Indiana bat in 1967 under the Endangered Species Preservation Act brought attention to the dramatic declines in the species' populations and led to regulatory and voluntary measures to alleviate disturbance of hibernating bats (Greenhall 1973). Subsequent listing under the Endangered Species Act (ESA) in 1973 led to further protection of hibernacula. The Federal Cave Resources Protection Act of 1988 (18 U.S.C. 4301-4309; 102 Stat. 4546) was passed to "secure, protect, and preserve significant caves on Federal land" and to "foster increased cooperation and exchange of information between governmental authorities and those who utilize caves located on Federal lands for scientific, educational, or recreational purposes." This law provides additional protections for hibernacula located on Federal lands. At the time of listing, summer habitat requirements of the Indiana bat were virtually unknown, so listing had minimal impact on protection of summer habitat. Discovery of the first maternity colony under the bark of a dead tree in Indiana was made in 1971 (Cope et al. 1974). Since the advent of transmitters small enough to attach to bats in the late 1980s, summer habitat has been extensively studied and increasingly is the subject of consultation under the ESA.

State endangered species laws also afford protection to the Indiana bat; in most states protection is limited to prohibitions against direct take and does not extend to protection of habitat. The Indiana bat is state listed in 19 of 22 states where it currently occurs including Alabama, Arkansas, Connecticut, Georgia, Illinois, Indiana, Iowa, Kentucky, Ohio, Oklahoma, Maryland, Michigan, Missouri, New Jersey, New York, Pennsylvania, Tennessee, Vermont, and Virginia. The Indiana bat is listed in all states that make up the Midwest RU. State recognition of the need for protection of endangered species, including the Indiana bat, has increased dramatically. When listed under the ESA, the Indiana bat was only listed by two states (Martin 1973). Local laws, particularly ordinances that regulate development in karst areas, also help to protect areas surrounding caves and other karst features from inappropriate development, although local karst protection ordinances are not common within the species' range (Richardson 2003).

Generally, existing regulatory mechanisms are more effective at protecting Indiana bat hibernacula than summer habitat. Hibernacula are discrete and easily identified on the landscape, whereas summer habitat is more diffuse. Even in situations where we know a maternity colony is present, we seldom know the extent of the range of the colony. Further, the conservation value of protecting a hibernaculum is easier to demonstrate and quantify compared with the value of protecting summer habitat. Therefore, application of regulatory mechanisms at hibernacula is more easily justified.

Ownership of Indiana bat habitat is probably the primary factor that limits effectiveness of existing regulatory mechanisms. Of 78 Priority 1 and 2 hibernacula, 16 (21 percent) are federally owned, 19 (24 percent) are state owned, 42 (54 percent) are privately owned, and 1 has ownership recorded as "unknown" (USFWS, unpublished data, 2011). ESA protection extends to hibernacula that are privately owned, but in some cases recovery options may be limited on private lands.

We suspect that the majority of summer habitat also occurs on private land, although this is difficult to document. The location of most Indiana bat maternity colonies is not known, so we cannot assess ownership of summer habitat, as we did for hibernacula. However, in every state within the range of the Indiana bat, the majority of the forest land is privately owned (Smith et al. 2003), particularly in the core maternity range of the species in the Midwest (e.g., percentage of forest land privately owned is 84 percent in Illinois, 83 percent in Indiana, 88 percent in Iowa, 83 percent in Missouri, and 91 percent in Ohio). Krusac and Mighton (2002) and Kurta et al. (2002) noted that opportunities for managing for Indiana bat maternity habitat on public lands are limited and suggested that strategies for engaging private landowners in management are needed.

Factor E. Other Natural or Man-made Factors affecting Its Continued Existence

NATURAL FACTORS

Natural catastrophes in hibernacula, particularly flooding and freezing, have the potential to kill large numbers of Indiana bats (USFWS 2007). Anthropogenic factors on the landscape (e.g., siltation in caves as result of agriculture in surrounding area) can cause or exacerbate some of these events. Generally, awareness of the Indiana bat hibernation needs and active management of hibernacula to meet these needs (e.g., removal of debris in caves prone to flooding) have alleviated the threat of these natural catastrophes at most important hibernacula. However, this remains a threat to some localized populations.

ANTHROPOGENIC FACTORS

Environmental Contaminants: With the restrictions on the use of organochlorine pesticides in the 1970s, this significant threat to Indiana bats was reduced. However, cholinesterase inhibiting insecticides, organophosphates, and carbamates have now become the most widely used insecticides

(Grue et al. 1997), and the impact of these chemicals on Indiana bats is not known. Because of the unique physiology of bats in relation to reproduction, high energy demands and sophisticated thermoregulatory abilities, much more research needs to be done with these pesticides and their effects on bats. These and other contaminants likely remain a significant and poorly understood threat to Indiana bats. The Draft Revised Indiana Bat Recovery Plan (USFWS 2007) summarizes known and suspected contaminant threats to bats.

Climate Change: The capacity of climate change to result in changes in the range and distribution of wildlife species is recognized, but detailed assessments of how climate change may affect specific species, including Indiana bats, are limited. During winter, only a small proportion of caves provide the right conditions for hibernating Indiana bats because of the species' very specific temperature requirements. Surface temperature is directly related to cave temperature, so climate change will inevitably affect the suitability of hibernacula. Impacts on the availability or timing of emergence of insect prey are also likely. Loeb and Winters (2013) modeled potential changes in Indiana bat summer maternity range within the United States; in their model, the area suitable for summer maternity colonies of Indiana bats was forecasted to decline significantly.

Collisions with Man-made Objects: Collisions of bats with man-made objects have not been fully evaluated, but concern for bat mortality related to such collisions is growing, specifically with reference to collisions with turbines at wind energy facilities. The primary emphasis of wildlife research related to wind energy development has been how these facilities have impacted birds, and to a lesser extent bats, although the focus on bats has increased recently. The results of studies to date indicate that impacts on bat populations may be more severe than the impacts on bird populations (Kuvlesky et al. 2007). Hayes (2013) concluded that "in 2012, over 600,000 bats are likely to have died as a result of interactions with wind turbines." Smallwood (2013) estimated 888,000 bat fatalities per year at 51,630 megawatts (MW) of installed wind-energy capacity in the United States in 2012. (See Smallwood 2013 for a discussion of sources of bias in fatality estimates, including that fatality reports for many facilities are kept confidential). He further noted that thousands of additional MW of capacity were planned or under construction in 2012, meaning that the annual toll on bats will increase. There is growing concern regarding bat kills given the rapid proliferation of wind energy and the large-scale mortality that has occurred at some facilities, as well as the finding that turbines have been consistently associated with fatalities of some species of bats in many different areas of the continent (Kunz et al. 2007a, Arnett et al. 2008).

Johnson (2005), Kunz et al. (2007a), and Arnett et al. (2008) synthesized information on bat mortality due to collisions with turbines at wind energy facilities in the United States (Arnett et al. 2008 included three Canadian studies). Kunz et al. (2007a) reported that of the 45 species of bats that are found in North America, 11 had been recorded among the mortalities at wind energy facilities; migratory tree-roosting bats within the genera *Lasiurus* and *Lasionycteris*, especially hoary bats (*Lasiurus cinereus*) and eastern red bats (*L. borealis*), form a large proportion of the bats killed. At least two additional species – Indiana bat (Pruitt and Okajima 2014) and evening bat (Good et al. 2012) – have now been documented. Most bat fatalities at turbines occur during late summer and autumn (Johnson 2005, Kunz et al. 2007a, Arnett et al. 2008) suggesting that bats may be particularly susceptible during fall migration. Generally, limited knowledge of the migratory behavior of bats limits our ability to understand and evaluate why bats are susceptible to striking wind turbines (Larkin 2006).

The first known fatality of an Indiana bat at a wind facility occurred in northern Indiana in September 2009, and a second fatality was documented at the same site in September 2010. Since that time, there have been six additional known fatalities of Indiana bats at wind facilities throughout the range of the species (Pruitt and Okajima 2014). To put these fatalities in context, it is important to understand that monitoring of bat fatalities at wind facilities is difficult and expensive. Not all facilities conduct fatality monitoring, and even when monitoring is conducted only a small proportion of dead bats are found. It is likely that additional Indiana bat mortality has occurred at these facilities and at other wind facilities throughout the range of the species. Investigations suggest that bats, generally, are particularly susceptible to fatality at turbines during fall migration. The Indiana bat fatalities to date suggest that this is also the most vulnerable time for this species (Pruitt and Okajima 2014). Four of the five known fatalities to date appear to be associated with fall migration, while one occurred in July. In addition to fall migration, Indiana bats may be susceptible to wind turbine fatalities while on summer range and/or during spring migration.

While post-construction fatality monitoring is shedding light on bat mortality at wind turbines, sublethal interactions (i.e., a bat is injured but does not die) are poorly documented. There is also potential for delayed lethal effects after nonlethal contact with wind turbines (i.e., bats sustain injuries and die sometime later). As noted by Grodsky et al. (2011): "Delayed lethal effects after nonlethal contact with wind turbines are poorly understood and difficult to quantify by mortality searches alone but can result in underestimating bat mortality caused by wind energy facilities."

One potential injury that may not result in immediate death is damage to the ear, resulting in impairment of hearing and echolocation abilities. The tympana (ear drums) are sensitive to barotrauma, a phenomenon in which abrupt air pressure changes cause tissue damage to air-containing structures. The tympana of bats could potentially be affected by air pressure changes when bats fly in the near vicinity of wind turbine blades. The auditory system in bats has a major role in echolocation, which is critical to a bat's ability to find prey and to navigate while flying. Any significant impairment of hearing would have the potential to affect survival. Both Rollins et al. (2012) and Grodsky et al. (2011) examined the ears of bats killed at wind turbines, and both noted damage to the ears in some of the bats, although both noted difficulty in distinguishing damage caused by traumatic injuries (i.e., blunt force trauma caused by a turbine blade) versus barotrauma. So, while some bats that die at wind farms have injuries to the ear, it is not known to what extent there are also bats that fly near the blades and suffer damage, but are able to fly away. Such bats would not be detected during mortality searches.

Investigations of interactions between wind turbines and bats are relatively recent, but some research results are beginning to provide insights into why bats are killed and/or potential approaches to minimizing or avoiding fatalities, such as acoustic deterrents, operational changes, or other mitigation strategies. Horn et al. (2008) studied the behavioral response of bats to operating wind turbines using thermal infrared cameras and observed that bats actively foraged near and investigated operating turbines, rather than simply passing through the airspace around the turbines. Further, they documented that blade rotational speed was a negative predictor of collisions; other researchers have also observed that most bat fatalities occurred at times of low wind speeds (Kunz et al. 2007b, Arnett et al. 2008). Barclay et al. (2007) reported that bat fatalities increased with turbine height, with turbine towers 65 m or taller having the highest fatality rates. Cryan and Brown (2007) and Cryan (2008) hypothesized that tree roosting bats may collide with wind turbines while engaged in flocking or mating activities, but it is unknown if this might also apply to Myotid species. Baerwald et al. (2008) reported on evidence that some bats were killed by barotrauma to the lungs caused by rapid air pressure reduction near moving turbine blades. However, data from forensic investigation of bats killed at wind farms strongly suggests that traumatic injury (e.g., blunt force trauma from a collision with a turbine blade), not barotrauma, is the major cause of bat mortality at wind farms (Rollins et al. 2012). Although these and other studies yielded valuable insights into bat fatalities, much additional research is needed. Kunz et al. (2007a) proposed 11 hypotheses to evaluate why insectivorous bats are killed at wind energy facilities, and urged the testing of these as well as additional hypotheses.

Wind energy developments, particularly near hibernacula or other areas where large numbers of Indiana bats may aggregate (e.g. maternity colonies), should be evaluated as a potential threat. In addition, migratory Indiana bats are at risk throughout the species range. Wind energy development is rapidly expanding throughout the U.S., including within the range of the Indiana bat. Within the states in the Midwest Recovery Unit, there was 3,899 megawatts of operational wind generating capacity at the end of first quarter 2016 (AWEA 2016). Given that the Midwest RU also has the most Indiana bats (50% of the rangewide population in 2015 – see Table 2) wind energy development in the Midwest RU potentially puts a relatively large proportion of the population at risk. Impacts of wind energy development on bats are not limited to mortality of bats caused by collisions with turbines, but include indirect impacts resulting from habitat alteration that may disrupt foraging, breeding, and other behaviors (Kunz et al. 2007b, Kuvlesky et al. 2007).

In addition to wind turbines, much lower rates of bat collision mortalities have been associated with communication towers and other man-made structures (Johnson 2005), including strikes with planes (Peurach et al. 2009). Like collisions with wind turbines, these strikes occur most often during the fall migration. Mortality from collision with a vehicle has also been documented (Russell et al. 2002). While there is no implication to date that Indiana bats are particularly susceptible to such collisions, vehicle traffic may represent a threat to local populations under certain conditions.

Northern Long-Eared Bat

This section is a discussion of the range-wide status of the northern long-eared bat and presents biological and ecological information relevant to formulating the biological opinion. It includes information on the species' life history, its habitat and distribution, and the effects of past human and natural factors that have led to the current status of the species.

Species Listing and Critical Habitat

The northern long-eared bat was listed as a threatened species on 2 April 2015 (federal Register 80[63]:17974; USFWS 2015), under the ESA (became effective on 4 May 2015). The USFWS also established a final rule under the authority of section 4(d) of the ESA that prohibits purposeful take of northern long-eared bats throughout the species' range, except in instances of removal of northern long-eared bats from human structures, defense of human life, or removal of hazardous trees for the protection of human life and property. In areas not yet affected by white-nose syndrome (WNS), all incidental take resulting from any otherwise lawful activity is excepted from prohibition. In areas currently known to be affected by WNS, incidental take is prohibited under the following circumstances:

- If it occurs within a hibernaculum,
- If it results from tree removal activities and
  - The activity occurs within 0.25 miles of a known hibernaculum; or
  - The activity cuts or destroys a known, occupied maternity roost tree or other trees within a 150 ft radius from the maternity roost tree during the pup season from June 1 – July 31.

The final 4(d) rule went into effect on 16 February 2016. No critical habitat has been proposed for the species.

Northern Long-Eared Bat Life History

The northern long-eared bat is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. The key stages in its annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy/weaning, fall migration and swarming. northern long-eared bat generally hibernate between mid-fall through mid-spring each year. Spring migration period likely runs from mid-March to mid-May each year, as females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. One pup is born per adult female between mid-June and early July, with nursing continuing until weaning, which is shortly after young become volant in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

Annual Chronology

In winter, northern long-eared bat tend to roost singly or in small groups (USFWS 2015), with hibernating population sizes ranging from a just few individuals to around 1,000 (USFWS, unpublished data). northern long-eared bat display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940a-b; Whitaker and Rissler 1992; Caceres and Barclay 2000). northern long-eared bat have shown a high degree of philopatry to the hibernacula used, returning to the same hibernacula annually.

Suitable winter habitat (hibernacula) includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by northern long-eared bat during the winter that have yet to be documented. Generally, northern long-eared bat hibernate from October to April depending on local climate (November-December to March in southern areas and as late as mid-May in some northern areas). Hibernacula for northern long-eared bat typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

In spring, after hibernation ends in late March or early April (as late as May in some northern areas), most northern long-eared bat migrate to summer roosts. Females emerge from hibernation prior to males. Reproductively active females store sperm from autumn copulations through winter. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as “staging,” a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

northern long-eared bat is not considered to be a long distance migrant (typically 40-50 miles). Migration is an energetically demanding behavior for the northern long-eared bat, particularly in the spring when their fat reserves and food supplies are low and females are pregnant.

Upon emergence from the hibernacula in the spring, females seek suitable habitat and actively form maternity colonies in the summer (Foster and Kurta 1999). Suitable summer habitat for northern long-eared bat consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

northern long-eared bat roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches dbh). northern long-eared bat are known to use a wide variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. northern long-eared bat have also been occasionally found roosting in structures like barns and sheds (particularly when suitable tree roosts are unavailable).

northern long-eared bat maternity colonies exhibit fission-fusion behavior (Garroway and Broders 2007), where members frequently coalesce to form a group (fusion), but composition of the group is in flux, with individuals frequently departing to be solitary or to form smaller groups (fission) before returning to the main unit (Barclay and Kurta 2007). As part of this behavior, northern long-eared bats switch tree roosts often (Sasse and Pekins 1996), typically every 2 to 3 days (Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). northern long-eared bat maternity colonies range widely in size, although 30-60 may be most common (USFWS 2015). northern long-eared bat show some degree of interannual fidelity to single roost trees and/or maternity areas. Male northern long-eared bat are routinely found with females in maternity colonies. northern long-eared bat use networks of roost trees often centered around one or more central-node roost trees (Johnson et al. 2012). northern long-eared bat roost networks also include multiple alternate roost trees and male and non-reproductive female northern long-eared bat may also roost in cooler places, like caves and mines (Barbour and Davis 1969; Amelon and Burhans 2006).

Many species of bats, including the northern long-eared bat, consistently avoid foraging in or crossing large open areas, choosing instead to forage in more densely forested areas and to use tree-lined pathways or small openings (Patriquin and Barclay 2003, Yates and Muzika 2006). Further, wing morphology of the species suggests that they are adapted to moving in cluttered habitats. Thus, relatively small and highly isolated patches of forest may not be suitable for foraging or roosting unless the patches are connected by a wooded corridor.

northern long-eared bat are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant (able to fly) between early July and early August.

Upon arrival at hibernacula in mid-August to mid-November, northern long-eared bat “swarm,” a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum as they had been mating at. A majority of bats of both sexes hibernate by the end of November (by mid-October in northern areas).

Range and Distribution

The northern long-eared bat ranges across much of the eastern and north central United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Nagorsen and Brigham 1993; Caceres and Pybus 1997; Environment Yukon 2011). In the United States, the species’ range reaches from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east through the Gulf States to the Atlantic Coast (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006). The species’ range includes the following 37 States (plus the District of Columbia): Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Historically, the species has been most frequently observed in the northeastern United States and in Canadian Provinces, Quebec and Ontario, with sightings increasing during swarming and hibernation (Caceres and Barclay 2000). However, throughout the majority of the species’ range it is patchily distributed, and historically was less common in the southern and western portions of the range than in the northern portion of the range (Amelon and Burhans 2006).

Although they are typically found in low numbers in inconspicuous roosts, most records of northern long-eared bat are from winter hibernacula surveys (Caceres and Pybus 1997). More than 780 hibernacula have been identified throughout the species' range in the United States, although many hibernacula contain only a few (1 to 3) individuals (Whitaker and Hamilton 1998). Known hibernacula (sites with one or more winter records of northern long-eared bats) include: Alabama (2), Arkansas (41), Connecticut (8), Delaware (2), Georgia (3), Illinois (21), Indiana (63), Kentucky (119), Maine (3), Maryland (8), Massachusetts (7), Michigan (103), Minnesota (11), Missouri (more than 269), Nebraska (2), New Hampshire (11), New Jersey (8), New York (90), North Carolina (22), Oklahoma (9), Ohio (7), Pennsylvania (112), South Carolina (2), South Dakota (21), Tennessee (58), Vermont (16), Virginia (8), West Virginia (104), and Wisconsin (67). northern long-eared bat are documented in hibernacula in 29 of the 37 States in the species' range. Other States within the species' range have no known hibernacula (due to no suitable hibernacula present, lack of survey effort, or existence of unknown retreats).

The current range and distribution of northern long-eared bat must be described and understood within the context of the impacts of WNS. Prior to the onset of WNS, the best available information on northern long-eared bat came primarily from summer surveys (primarily focused on Indiana bat or other bat species) and some targeted research projects. In these efforts, northern long-eared bat was very frequently encountered and was considered the most common myotid bat in many areas. Overall, the species was considered to be widespread and abundant throughout its historic range (Caceres and Barclay 2000).

WNS has been particularly devastating for northern long-eared bat in the Northeast, where the species was believed to be the most abundant. Similarly, there are data supporting substantial declines in northern long-eared bat populations in portions of the Midwest due to WNS. In addition, WNS has been documented at more than 100 northern long-eared bat hibernacula in the Southeast, with apparent population declines at most sites. WNS has not been found in any of the western states to date and the species is considered rarer in the western extremes of its range. We expect further declines as the disease continues to spread across the species' range.

Population Status and Threats

No other threat is as severe and immediate for the northern long-eared bat as the disease white-nose syndrome (WNS). It is highly unlikely that northern long-eared bat populations would be declining so dramatically without the impact of WNS. Since the disease was first observed in New York in 2007 (later biologists found evidence from 2006 photographs), WNS has spread rapidly in bat populations from the Northeast to the Midwest and the Southeast. Population numbers of northern long-eared bat have declined by 99 percent in the Northeast, which along with Canada, has been considered the core of the species' range. Although there is uncertainty about how quickly WNS will spread through the remaining portions of this species' range, it is expected to spread throughout the entire range. In general, the Service believes that WNS has significantly reduced the redundancy and resiliency of the northern long-eared bat.

Although significant northern long-eared bat population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines. Specifically, declines due to WNS have significantly reduced the number and size of northern long-eared bat winter populations in some areas of its range. This has reduced these populations to the extent that they may be increasingly vulnerable to other stressors that they may have previously had the ability to withstand. These impacts could potentially be seen on two levels. First, individual northern long-eared bat sickened or struggling with infection by WNS may be less able to survive other stressors. Second, local northern long-eared bat populations impacted by WNS, with smaller numbers and reduced fitness among individuals, may be less likely to rebound from stochastic events and thus more prone to extirpation over time. The status and potential for these impacts will vary across the range of the species.

Bats adversely affected but not killed by WNS during hibernation may be weakened by the effects of the disease and may have extremely reduced fat reserves and damaged wing membranes. These effects may reduce their capability to fly efficiently or to survive long-distance spring migrations to summer roosting or maternity areas.

In areas where WNS is present, there are additional energetic demands for northern long-eared bats. For example, WNS-affected bats have less fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2013) and have wing damage (Meteyer et al. 2012; Reichard and Kunz 2009) that makes migration and foraging more challenging. Females that survive the migration to their summer habitat must partition energy resources between foraging, keeping warm, successful pregnancy/pup-rearing and healing and may experience reduced reproductive success.

Over the long-term, sustainable forestry benefits northern long-eared bat by maintaining suitable habitat across a mosaic of forest treatments. However, some forest practices can have a variety of impacts on the northern long-eared bat depending on the quality, amount, and location of the lost habitat, and the time of year of clearing. Depending on their characteristics and location, forested areas can function as summer maternity habitat, staging and swarming habitat, migration or foraging habitat, or sometimes, combinations of more than one habitat type. Impacts from tree removal to individuals or colonies would be expected to range from indirect impacts (e.g., minor amounts of forest removal in areas outside northern long-eared bat summer home ranges or away from hibernacula) to minor (e.g., small changes in largely forested landscapes with robust northern long-eared bat populations) to significant impacts (e.g., removal of a large percentage of summer home range particularly in parts of the range with highly fragmented landscapes with WNS-impacted northern long-eared bat populations).

Lastly, there is growing concern that bats, including the northern long-eared bat (and other bat species) may be threatened by the recent surge in construction and operation of wind turbines across the species' range. Mortality of northern long-eared bat has been documented at multiple operating wind turbines/farms. The Service is actively working with wind farm operators to avoid, minimize, and mitigate incidental take of bats.

Environmental Baseline

Under section 7(a)(2) of the ESA, when considering the "effects of the action" on federally listed species, the Service is required to take into consideration the environmental baseline. The environmental baseline includes past and ongoing natural factors and the past and present impacts of all Federal, State, or private actions and other activities in the action area (50 CFR 402.02), including Federal actions in the area that have already undergone section 7 consultation, and the impacts of State or private actions that are contemporaneous with the consultation in process. As such, the environmental baseline is "an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including critical habitat), and ecosystem, within the action area" (USFWS and NMFS 1998, page 4-22).

Status of the Species and Critical Habitat in the Action Area

Currently, the Action Area does not support wintering or summering habitat for the Indiana or northern long-eared bat. There are no caves or mines suitable for use as hibernacula; the nearest known wintering populations of Indiana or northern long-eared bats are located in a hibernacula approximately 121 km (75 mi) away in Preble County, Ohio (USFWS 2007).

The area does not have sufficient forest cover to be suitable as summer habitat. Landuse in the Action Area is almost entirely agricultural; less than 1 percent is forested. In the Action Area, neither the amount of forested habitat nor the connectivity of remaining patches is sufficient to provide habitat for summering Indiana or northern long-eared bats.

It appears that habitats used during migratory stopovers are similar to summer habitat. Based on our knowledge of stopover habitat, we do not believe that the Action Area is suitable. However, pre-construction acoustic monitoring indicates bat activity in the Action Area during the spring and fall migration periods. During the 2010 activity season, bat activity at stationary acoustic detectors was lowest during spring (83; mean 1.4 passes/detector/night) and highest during fall (771; mean 3.5 passes/detector/night). Four confirmed *Myotis* calls were recorded, representing only 0.4% of the identifiable calls. A single call was recorded on 24 July, 27 July, 28 July and 5 August. Likewise, during the 2011 activity season, bat activity was lowest during spring (98, mean 1.3 passes/detector/night) and highest during fall (996, mean 4.9 passes/detector/night). *Myotis* calls represented 0.0% (0 calls) of the identifiable calls recorded during the spring, 0.4% (1 call) of the identifiable calls recorded during the summer, and 0.3% (2 calls) of the identifiable calls recorded during the fall during the 2011 stationary acoustic survey. Although no Indiana or northern long-eared bat calls were confirmed, it is highly likely that listed bats fly through the airspace at the Project during migration. Based on these data, we assume that risk to Indiana and northern long-eared bats from collision with wind turbines is greater in the fall than in the spring.

Currently the area supports no Indiana or northern long-eared bat habitat. Based on information available we presume that the only Indiana and northern long-eared bat use of the Action Area is migratory bats flying through the air space above the Action Area. We are unaware of any activities in the Action Area, other than the proposed project, which will impact the Indiana or northern long-eared bat use of the airspace over the area.

Factors Affecting Indiana and Northern Long-Eared Bat Environment within the Action Area

This analysis describes factors affecting the environment of the Indiana and northern long-eared bat in the Action Area. (Note that if critical habitat occurred in the Action Area or was affected by the action that would also be described here, but there is no critical habitat to discuss in this case). The baseline includes the past, present and future impacts from federal, state, tribal, local, and private actions that have occurred or are presently occurring. This section of a Biological Opinion also incorporates impacts from future federal actions in the Action Area that have undergone section 7 consultation; in this case there are none.

The factors affecting Indiana and northern long-eared bats in the Action Area are a subset of the threats affecting the species rangewide and in the Midwest Recovery Unit. There is no Indiana or northern long-eared bat habitat in the Action Area; therefore, impacts to habitat are not relevant to this discussion. However, listed bats utilize the airspace above the Project during migration, making them susceptible to turbine strikes. Those bats are migrating between maternity colonies and wintering colonies. Thus, to characterize the environmental baseline for these bats we must consider the other stressors to these same bats that pass through the Action Area. With reference to the bats that pass through the Project, the main threats are disease (specifically WNS) and collisions with wind turbines.

White-Nose Syndrome

As discussed previously, WNS is a devastating disease affecting many eastern U.S. bats including both Indiana and northern long-eared bats.

For Indiana bats, the disease was first documented in the Midwest RU in 2011 and by the end of the 2015 hibernating season had spread to multiple hibernacula in all states in the RU. For northern long-eared bats, the disease was also first documented in Indiana in 2011. The nearest known hibernaculum to the Action Area is a hibernacula located approximately 121 km (75 mi) away in Preble County, Ohio (USFWS 2007); WNS was confirmed at this site in 2011.
(See http://www.whitenosesyndrome.org/about/where-is-it-now for a current map of where WNS has been found).

There has been no WNS surveillance conducted in the Action Area, but given the location it is almost certain that bats en route to affected hibernacula pass through this area during fall migration. We do not know how WNS is currently affecting the Indiana and northern long-eared bats that pass through the Action Area (i.e., we do not know if the populations in maternity colonies and hibernacula to which these bats belong have declined).

As noted previously, according to 2015 rangewide population estimates, the Midwest Recovery Unit has lost approximately 16% of its Indiana bats since the onset of WNS. Northern long-eared bat populations in the northeast have experiences a 99% drop in populations. As previously discussed, we expect declines to continue in the coming years. So in assessing the effects of incidental take at the Project, we will have to make assumptions regarding the impacts of WNS on listed bats that pass through the Action Area.

Collisions with Wind Turbines

As discussed previously in this document, mortality of bats is an unintended byproduct of wind energy development. The U.S. wind industry installed 520 megawatts (MW) during the first quarter of 2016 bringing the total U.S. wind power capacity installations to 74,512 MW (AWEA 2016). There are now more than 48,800 wind turbines installed across the U.S.

To what extent other wind installations are affecting the same bats that pass through the Project during migration is not known, but given the widespread distribution of wind energy facilities it is likely that other individuals originating from the same maternity colonies as the Project's bats are at potential risk from a wind facility somewhere along their migratory route. The same is true of hibernating colonies; bats that migrate through the Project likely hibernate with bats that are at risk from collision at other wind facilities. This take of listed bats that is already occurring at existing wind facilities is reflected in the baseline population estimates generated from biennial winter surveys of hibernacula for Indiana bats, and population estimates of northern long-eared bats derived from occupancy and capture rates.

Take of listed bats that occurs in the future at facilities yet to be built may be addressed under future HCPs (just as the WWF HCP is being analyzed in this Biological Opinion) or possibly through some other take permitting process. Within the Service's Region 3, a multi-state, multi-species HCP planning effort is underway to cumulatively address a large proportion of future wind projects. Take of Indiana and northern long-eared bats from wind projects that are addressed under other HCPs (either individual HCPs or the Region 3 HCP) will be subjected to effects analyses and jeopardy analyses in biological opinions such as this one, to ensure that take associated with the projects does not jeopardize the continued existence of the species. Alternatively, rather than developing an HCP some facilities may operate their wind turbines to avoid take of listed bats (e.g., by not operating turbines at times when bats are at risk or reducing operation of turbines such that bats are not at risk).

In addition to facilities that operate under an HCP and those that operate turbines to avoid take, the Service acknowledges that some wind farms within the range of the Indiana or northern long-eared bat do not seek incidental take authorization and do not adjust turbine operation to avoid take, although presumably take is occurring. Those projects that do not obtain incidental take authorization put the Indiana and northern long-eared bats at risk because the Service cannot fully quantify and consider this future take in evaluating the environmental baseline for projects that are subjected to Biological Opinions (and the associated analyses). Further, those facilities are not mitigating for the take that does occur. Conceivably, this take, or unanticipated mortality from other sources (e.g., if impacts of WNS on populations are worse than predicted), could result in worse impacts to populations than anticipated in this Biological Opinion. The Service is conducting the analysis in this Biological Opinion using the best information available, and will continue to incorporate new information that becomes available in further evaluations of this and other projects.

Effects of the Action

This section includes an analysis of the direct and indirect effects of the proposed action, and interrelated and interdependent activities, on the Indiana and northern long-eared bats and/or critical habitat. For the proposed Project, effects will be analyzed for listed bats that migrate through the

Action Area. There is no Indiana or northern long-eared bat habitat in the Action Area; we assume that the only use of the area is bats flying through the airspace above the Project during migration. Effects of proposed mitigation, which has been incorporated into the Applicant's project, will also be assessed.

For the Indiana bat, the Action Area and all proposed mitigation sites are within the Midwest Recovery Unit. All effects will be evaluated as they pertain to the Indiana bat population within the Midwest RU and local populations (summering or wintering populations to which impacted bats belong) within that RU. Note that there is no designated critical habitat for the Indiana bat in or near the Action Area. There is no potential for the Project to affect critical habitat.

Since there are no established recovery units for the northern long-eared bat, all effects will be evaluated as they pertain to the northern long-eared bat population within the state of Indiana. Note that there is no designated critical habitat for the northern long-eared bat.

Indiana Bat Response to the proposed action

Framework for Analysis

The intent of our analyses is to evaluate the response of Indiana bats to the proposed action, and ultimately to ensure that the proposed action is not likely to appreciably reduce the likelihood of both survival and recovery of the Indiana bat by reducing its reproduction, numbers, or distribution in the wild. That is, to ensure that proposed action is not likely to jeopardize the continued existence of the species.

Step 1- Effects to individuals

In this step, we evaluate the likelihood that the proposed action will adversely affect the fitness of individual Indiana bats. This analysis involves an evaluation of the likelihood that individual Indiana bats will be exposed to proposed action-related stressors. If exposure is likely, we then evaluate how the exposed individuals are likely to respond.

Step 2- Effects to population(s)

In step 2, we evaluate whether the aggregated effect of the proposed action on individual Indiana bats is likely to cause appreciable reductions to the fitness of the population to which these individuals belong. We assess the impact of the anticipated take of individual Indiana bats at 2 population levels: 1) maternity colony level; and, 2) winter colony level.

Step 3- Effects to the Recovery Unit

In this step, we evaluate whether the anticipated reductions in population fitness are likely to cause appreciable reductions in the likelihood of survival and recovery of Indiana bats within the Recovery Unit where the populations occur. This analysis entails evaluating how the population-level consequences will affect reproduction, numbers, or distribution of Indiana bats in the RU.

Step 4- Effects to the species

In this step, we evaluate whether the anticipated reductions in the likelihood of survival and recovery at the RU level are likely to cause appreciable reductions in the likelihood of survival and recovery of the Indiana bat rangewide. This final step entails describing why appreciable reductions in the likelihood of both survival and recovery at the RU level leads to appreciable reductions in the likelihood of both survival and recovery of the Indiana bat rangewide. As explained in the 2007 draft recovery plan (USFWS 2007), the RUs were designed to preserve sufficient representation, redundancy, and resiliency to ensure the long-term viability of the Indiana bat. Thus, an appreciable reduction in the likelihood of both survival and recovery of Indiana bats in any RU will concomitantly reduce the representation, redundancy, and resiliency of the species rangewide, and thereby, will cause an appreciable reduction in the likelihood of survival and recovery of the Indiana bat rangewide.

Analysis

Step 1- Effects to individuals

There are four Project Components that will be evaluated, in terms of impacts to Indiana bats, in this section. The components and, generally, the type of impact expected to Indiana bats are:

1. Operations and Maintenance of WWF – mortality of migrating Indiana bats is expected.
2. Decommissioning of WWF – not expected to adversely affect Indiana bats.
3. Mitigation activities proposed by the Applicant – beneficial effects to Indiana bats are expected.

Each of these components and effects are discussed below.

Operations and Maintenance of WWF

It is expected that Indiana bats will die at WWF as the result of collision with wind turbines during migration.

Annual take was estimated to be 6 Indiana bats; over the 27-year operational life of the Project, this sums to 162 Indiana bats. To calculate the take expected to occur at the Project during migration, data from fatality studies conducted at Fowler Ridge Wind Farm (FRWF) were used. Both the Project and FRWF are located in predominantly agricultural landscapes in Indiana. Similar to FRWF, take at the Project is expected to occur only during the fall migration season (August 1-October 15), based on the seasonal distribution of bat activity recorded and the lack of suitable summer habitat and hibernacula near the projects. There is no summer roosting habitat within the Project's Action Area; therefore, take is unlikely to occur during the summer months. For a more detailed discussion on how the take estimate was derived, see Section 4.3 of the HCP.

The Service also recognizes that there is potential for sublethal or delayed-lethal effects to Indiana bats from interactions with turbines at the Project. Particularly, potential impairment of hearing from damage to the ear has been noted, but there are no data to quantify how many bats may suffer such damage and die at a later time. Thus, while there is insufficient information to include impaired hearing in our analyses at this time, the Service will incorporate any new information that becomes available on this topic into further evaluations of this and other projects.

In addition to impacts that occur in the area surrounding turbine blades (i.e., mortality from collisions with turbines), other potential effects of the operations and maintenance at WWF on Indiana bats include ground-level effects of lighting at the facility, vehicle traffic and other sounds, and vegetation management (e.g. mowing). Because listed bats are expected only to be active in the air space above the Project, these activities are not expected to adversely affect them at the ground level. Bats flying through the air space may perceive ground-level lights and sounds, but these are not expected to cause adverse effects.

Decommissioning of WWF

Adverse effects are not expected during decommissioning because the site does not support Indiana bat habitat. While listed bats migrating through the area may perceive some of the activities that occur at ground level during decommissioning, impacts are not expected to cause take.

Mitigation

The Conservation Plan in the Applicant's HCP focuses on minimizing potential impacts to Indiana bats at the Project, and mitigating for the incidental take. The mitigation measures that will be implemented (as described in detail in Chapter 5 of the HCP) are intended to provide conservation benefits to Indiana bats, and are not expected to cause take. Mitigation activities include protection and monitoring of summer maternity habitat for Indiana bats. As described above (and in detail in Chapter 4 of the HCP), the permitted level of Indiana bat mortality is 162 Indiana bats over the 27-year operational life of the Project. However, because of the required minimization measures, we expect take to be only 50% (81 Indiana bats) of the permitted take. The Applicant will mitigate for the impact of the expected take of 81 Indiana bats upfront; the Applicant will coordinate and provide funding for mitigation that is expected to result in an increase to the population of Indiana bats in the Midwest Recovery Unit by at least 176.2 female Indiana bats. If monitoring shows that the Project has resulted in take that is more than the expected 81 Indiana bats, but less than the permitted 162 bats, additional mitigation will be required. Reference the HCP for details (Section 5.2.2 Mitigation for Impact of the Taking).

Step 2- Effects to population(s)

In Step 2 of our analysis, we assessed the impact of the anticipated take of Indiana bats both on maternity colonies (colonies where bats migrating through WWF originated) and on hibernating populations (to which bats migrating through the Project were destined).

To analyze the effects of individual take of Indiana bats at the Project on Indiana bat populations, we used the model described by Thogmartin et al. 2013. Thogmartin et al. (2013) developed a stochastic, stage-based population model to forecast the population dynamics of the Indiana bat, subject to WNS. This model was developed in coordination with (and funding from) the Service as a tool for the Service to use in evaluating how the take of Indiana bats from various projects will affect populations that are impacted by WNS. The model explicitly incorporates environmental and demographic stochasticity. We began Step 2 by identifying the populations of interest, that is, by defining which maternity colonies and hibernating colonies to model; the process we used for identifying these colonies is described below.

Defining Populations to Model

NUMBER OF FEMALES TAKEN

As previously discussed, the estimated level of Indiana bat mortality at WWF is expected to be less than or equal to 6 Indiana bats per year over the 27-year operational life of the Project. Because the demographic model used in this analysis (Thogmartin et al. 2013) only considers female bats, we cannot directly input the total take number (which includes both male and female bats); we must first estimate the number of female bats taken.

To calculate the sex ratio of these bats, we assumed that all Indiana bats that migrate north of the Action Area in spring were females. We know that some males do migrate to areas north of the Action Area (USFWS 2007); however, we expect the number of males to be small (as most males are expected to summer closer to the hibernacula). By assuming that only female bats migrate north of the Action Area we will tend to overestimate the impact to the population because the death of a female bat will have a greater impact on the population than the death of a male (due to the polygynous nature of the species). Further, we assume that half of the bats that pass through WWF during fall migration will be adult females, and that half will be pups. We assume an equal sex ratio among pups, and therefore assume that 75% of the fall migrating bats that pass through WWF will be female (50% adult females and 25% female pups, with the remaining 25% composed of male pups). Total adult female take at WWF over the 27-year operational life of the Project is expected to be less than or equal to 81 Indiana bats, while the total juvenile female take is expected to be less than or equal to 41 Indiana bats.

Number of Maternity Colonies Impacted

The take is expected to occur during fall migratory periods to Indiana bats passing through the Action Area while moving from summer to winter habitat. Therefore, we needed to "assign" bats passing through the Project to maternity colonies and hibernating colonies, so that we could assess impacts of the taking on those particular populations.

To do so, we used a model that simulated Indiana bat migration pathways through WWF (WEST 2013). A summary of the development and results of this migration model follows. The model incorporated data on the location (and Indiana bat population size) of known hibernacula, known migration distances, and maternity colony habitat characteristics. Because maternity colony locations were largely unknown, suitable habitat was modeled based on amount of forest cover and simulated maternity colonies were distributed in the suitable habitat. Maternity colonies were simulated in several stages:

1. First, maternity colony sizes were generated such that the total number of female bats in all maternity colonies equaled the total female Indiana bat population within the Midwest RU (based on known populations of all hibernacula combined). Maternity colony sizes were generated from a distribution with an average size of 80 female bats, and minimum and maximum sizes of 20 and 150, respectively.

2. Second, the number of bats "contributed" by each hibernaculum to each simulated maternity colony was randomly generated such that, in general, each hibernaculum contributed to several colonies and each colony received contributions from several hibernacula. Total contributions from a hibernaculum equaled the known population, based on biennial survey data.

3. Third, location of maternity colonies on the landscape was modeled based on the location of suitable habitat. Colony locations were randomly located on the landscape but constrained such that all simulated colonies were within suitable habitat and not closer than 4.5 miles from each other. Further, maternity colony locations were restrained by the maximum known migration distance for Indiana bats (i.e., the distance between a maternity colony and its contributing hibernacula was never farther than the greatest known migration distance for Indiana bats).

Migrations were defined by broad, straight pathways between maternity colonies and the hibernacula that contributed to those colonies. In reality, it is unlikely that Indiana bats actually follow a straight line, although they may fly more or less direct routes. To account for this reality, we chose to incorporate a 5 km path width into this analysis (i.e., our simulation allowed for deviation from a straight-line migration pathway within a 5 km band). An "encounter" was defined as any overlap of a migration path and the Action Area.

Results from 250 iterations of the simulation model indicated that on average, there were 3477 migration paths connecting simulated maternity colonies with known hibernacula. An average of 61 maternity colonies supported bats that encountered the project, assuming a 5 km wide path (i.e., 61 maternity colonies were connected to paths that encountered the project). An average of 17 hibernacula of 160 total hibernacula (10.6%) supported bats that encountered the project.

WNS Impacts on Populations

As previously discussed, the Thogmartin et al. (2013) model was developed to take into account the impacts of WNS on Indiana bat populations. The model allowed us to forecast the dynamics of a given population of Indiana bats (e.g. a maternity colony or a hibernating colony) into the future.

To estimate the magnitude of impacts that will be experienced in the Midwest RU we used data from the Northeast RU. The Northeast RU has been affected the longest (mortality first observed the winter of 2006-2007) and therefore has the best data on mortality rates. As previously discussed, we predict that all RUs may eventually experience the level of population decline documented in the Northeast RU. To reflect this anticipated population decline in our analysis, we applied mortality rates derived from observed declines in Indiana bat populations in the Northeast RU (for the years for which data were available) in modeling impacts that will occur in the Midwest RU. We assumed that WNS mortality will abate over time (i.e., that the mortality rate will decline over time), but that some mortality will be experienced for 20 years after the onset of the disease.[1]

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[1] In modeling the impacts of WNS on Indiana bats, we considered three time periods after the onset of WNS mortality and applied a decreased survival probability (compared to pre-WNS survival) during each year for 20 years. Time periods considered and associated survival probabilities were: Year 1-7 survival probability .686-.836; Year 8-12 survival probability .836-.920; Year 13-20 survival probability .920-1. After 20 years, modeled populations returned to pre-WNS survival rates.

WNS was detected in the Midwest RU in the winter of 2010-2011, with large-scale mortality first observed in the winter of 2014-2015. We therefore assume that this upcoming winter (2016-2017) is the 3rd year of WNS mortality, and apply mortality rates from the Northeast RU accordingly.

Scenario Development

Maternity Colony Populations

Based on 250 iterations of the WEST (2013) model, migration pathways of individual Indiana bats from 61 maternity colonies, on average, will "encounter" the Action Area. We assumed that individuals from all 61 colonies will be similarly exposed to the wind turbines. For this reason, take was equally divided among all 61 colonies. Given that total female take is expected to be less than or equal to 122 female Indiana bats (81 adults and 41 juveniles) we presume that, on average, each colony will lose 2 bats over the 27-year operational life of the Project.

Because we assumed the impact of take is equal for all maternity colonies, we modeled the impact of take on one individual maternity colony (because we assumed the same impact on all colonies). Whitaker and Brack (2002) estimated that average maternity colony size in Indiana was approximately 80, so we used 80 adult females as the starting population size of our modeled maternity colony. However, since the Midwest RU has already experienced a 13.8% decline in the Indiana bat population due to WNS, we assume that the average colony size is 13.8% smaller than the pre-WNS average maternity colony size. Therefore, we use an average maternity colony size of 69.

Hibernating Populations

Relative to hibernating colonies impacted by the proposed project, the WEST (2013) model result was that 17 hibernacula have bats with migratory pathways that pass through the Action Area and that portions of their populations would be exposed to the project. Four hibernacula in Indiana accounted for over 80% of predicted bat encounters with the Action Area: Ray's Cave (30.4%), Coon Cave (20.6%), Wyandotte Cave (16.6%), and Jug Hole Cave (16.0%).

To simulate the impacts of take on hibernating colonies, we modeled that all take was distributed among only these four hibernacula. We actually expect take to be distributed among a greater number of hibernacula (as predicted by the model); we made the assumption that fewer hibernacula are affected because it concentrates the take on fewer hibernating populations (so we actually expect the impact on the hibernating colonies to be less than what we are modeling). The take was distributed among these four hibernacula (Table 5) based on proportions derived from the WEST (2013) model, as described above. Expressed as whole bats, of the 122 female bats that may be taken over the 21-year term of the ITP, we model that 44 (36%) will be from Ray's Cave, 31 (25%) will be from Coon Cave, 24 (20%) will be from Wyandotte Cave, and 23 (19%) will be from Jug Hole Cave. We modeled the impacts of take for each of the four individual hibernacula. For model inputs, we used complex-level lambda values (see Thogmartin et al. 2013) and 2015 Indiana bat population numbers specific to each hibernaculum.

TABLE 5. MODELED FEMALE TAKE FROM WWF DISTRIBUTED AMONG FOUR HIBERNACULA.

Hibernacula	Total Female Take over 27 years	Proportion of Total Female Take	Adult Female Take	Juvenile Female Take
Ray's Cave	44	36%	29	15
Coon Cave	31	25%	21	10
Wyandotte Cave	24	20%	16	8
Jug Hole Cave	23	19%	15	8
TOTAL	122	100%	81	41

Conservative Assumptions incorporated into Modeling

We made conservative assumptions when modeling, that is, assumptions that would cause us to overestimate the impacts of the taking on Indiana bat populations. We made conservative assumptions because we don't want the actual impacts to Indiana bats to be worse than impacts we are modeling (i.e., we want to model a "reasonable worst-case"). These assumptions were:

1. Use of full levels of take even as population declines due to WNS –
   We have no reason to believe that if the Indiana bat population decreases dramatically due to WNS (as the Thogmartin et al. 2013 model predicts), that the remaining individuals will have an increased risk of mortality from wind turbines. Therefore mortality caused by the project should decrease proportionally as the population decreases. However, for this analysis, we maintain the full level of take as described in the HCP, even though we model a dramatic population decrease due to WNS. Because we do not model decreasing take as the population declines, we model a greater level of take than we realistically expect.

2. Assume only female Indiana bats migrate north of the Project –
   Although we know some males do migrate north of the Action Area, we expect the number of males to be small. By assuming all bats migrating north of the Project are female we will tend to overestimate the impact to the population because the death of a female bat will have a greater impact on the population than the death of a male (due to the polygynous nature of the species).

3. No reduction of bat mortality due to operational minimization –
   The level of take as described in the HCP and modeled in this analysis is based on no reduction in take levels due to the implementation of minimization measures. However, as a requirement of the HCP, wind turbines will be feathered below a 5.0 m/s cut-in speed, which is expected to reduce take by at least 50%.

Model Runs and Results

We modeled four scenarios as follows (and described in Table 6):

Scenario 1A: Scenario 1A modeled the Baseline condition (i.e., without take from the project) of a maternity colony that had individuals that "encountered" the Action Area during migration (i.e., at least one of the migration paths from that maternity colony crossed through the Action Area). The population size of the maternity colony was modeled 50 years into the future. There is zero take modeled in this scenario. As previously discussed, we used a maternity colony starting population of 69 adult females and modeled population trajectories with WNS using the Northeast RU post-WNS survival rates.

Scenario 1B: Scenario 1B modeled the Expected Take of female bats that migrate through WWF during fall migration. This scenario distributed take among migrating females originating from maternity colonies outside of the Action Area (Table 6). Using the output of the WEST (2013) model, we assumed that 61 maternity colonies have migratory pathways that include the Action Area, and that females taken during migration originated from these colonies. Expected Take from the project was the only difference between Scenarios 1A and 1B; all other model inputs were identical. Therefore, any appreciable difference in outcomes between the Baseline and Expected Take scenarios (1A and 1B) can be attributed to the impact of take.

Scenario 2A: This scenario is the Baseline condition of the hibernating colonies of Indiana bats that "encounter" the Action Area during migration. Four no-take scenarios were simulated, one for each modeled hibernacula (Ray's, Coon, Wyandotte, and Jug Hole caves); each population was modeled 50 years into the future. Complex-level lambda values and 2015 Indiana bat population numbers specific to each hibernaculum were used as model inputs; we included impacts from WNS. There was no project take modeled in these scenarios.

Scenario 2B: This scenario is the Expected Take scenarios for the hibernating colonies, which distributed a portion of all Indiana bat take to females migrating to Coon, Wyandotte, Jug Hole and Ray's caves. Expected Take from the project was the only difference between Scenarios 2A and 2B; all other model inputs were identical. Therefore, any appreciable difference in outcomes between the Baseline and Expected Take scenarios (2A and 2B) can be attributed to the impact of take.

TABLE 6. AMOUNT AND DISTRIBUTION OF FEMALE TAKE OF INDIANA BATS FOR BASELINE AND EXPECTED TAKE SCENARIOS MODELED FOR WILDCAT WIND FARM I.

	Description of population	Scenario	Take quantity and distribution	Scenario Number
Maternity colonies	Pathways of individual Indiana bats from 61 maternity colonies (each with an average of 69 adult females) will "encounter" the Action Area (WEST 2013).	Baseline	No take	1A
		Expected Take	Take of 122 females over the lifetime of the project. Female take distributed equally among 61 maternity colonies.	1B
Winter population	Assume taken bats are hibernating in 4 large hibernacula in the Midwest RU. Used Ray's, Coon, Wyandotte, and Jug Hole cave complex lambda values in model.	Baseline	No take	2A
		Expected Take	Take of 122 females over the lifetime of the project. Female take distributed among 4 hibernacula.	2B

For each scenario, we ran 10,000 simulations and summarized the simulation results for the following metrics: probability of extinction in 50 years, median time to extinction, and median ending lambda after 50 years (Table 7). We compared the results of each Baseline scenario (1A, 2A) to the corresponding Expected Take Scenario (1B, 2B). We defined an "appreciable difference" as a difference of more than 5% in one of the three metrics between the Baseline and Expected Take scenario results (i.e., did the Expected Take cause 5% or more difference in the metric when compared to the Baseline).

TABLE 7. EXPLANATION FOR THE METRICS USED TO COMPARE BASELINE AND EXPECTED TAKE SCENARIOS.

Metric	Explanation
Probability of extinction in 50 years	the percentage of the 10,000 simulations in which the simulated population became extinct within 50 years
Median time to extinction	of the simulated populations that were predicted to become extinct, what was the median time to extinction
Median ending lambda at 50 years	median lambda for the 10,000 simulated populations at the end of 50 years

TABLE 8. MODEL RESULTS FOR BASELINE AND EXPECTED TAKE SCENARIOS, AND DIFFERENCE OF OUTCOMES.

		Scenario		Extinction Probability in 50 Years	Median Time to Extinction	Median Ending Lambda at 50 Years	Appreciable Difference?
Migratory Maternity Colony		Baseline	1A	71.34%	20	0	no
		Expected Take	1B	72.32%	19	0	
Winter Population	Ray's Cave	Baseline	2A	**0.43%**	44	0.9474	yes
		Expected Take	2B	**0.69%**	44	0.9474	
	Coon Cave	Baseline	2A	0.73%	44	0.9473	no
		Expected Take	2B	0.59%	44	0.9472	
	Wyandotte Cave	Baseline	2A	**0.26%**	45	0.9469	yes
		Expected Take	2B	**0.31%**	45	0.9473	
	Jug Hole Cave	Baseline	2A	0.40%	45.5	0.9476	no
		Expected Take	2B	0.36%	45.5	0.9469	

<u>Scenarios 1A and 1B</u>: For the Expected Take scenario (1B) with take allotted to a modeled maternity colony, the results did not show appreciable reductions relative to the Baseline scenario (1A) in any of the metrics. This indicates that factors other than take, such as demographics and WNS, were the primary drivers of the simulated maternity colony's population trajectory. Therefore, based on these metrics we concluded that take from the project will not cause an appreciable difference in the fitness of maternity colonies (Table 8).

<u>Scenarios 2A and 2B</u>: For the Expected Take scenario (2B) with take allotted among four hibernacula, the results did not show appreciable reductions relative to the Baseline scenario (2A) in any of the metrics for two of the hibernacula (Coon and Jug Hole Caves). Take had negligible impacts on the median time to extinction and ending lambda of these hibernating colonies. Probability of extinction for both these hibernacula actually decreased for the Expected Take scenario (2B) relative to the Baseline scenario (1A). This likely reflects the underlying variability within the model, rather than any directional change in the population caused by the modeled take; this is especially likely considering the extremely low probabilities of extinction (<1%).

For the Expected Take scenario (2B) with take allotted among four hibernacula, the results did show appreciable reductions relative to the Baseline scenario (2A) in one of the metrics for two of the hibernacula (Ray's and Wyandotte Caves). Take had negligible impacts on the median time to extinction and ending lambda of these hibernating colonies. The difference in the probability of extinction between the Expected Take (2b) and Baseline scenario (2A) was greater than 5%.

This outcome calls for a closer inspection of the model results. Although the relative change between the Baseline (2A) and Expected Take (2B) scenarios is greater than 5%, the probability of extinction for all model results were extremely low (<1%). Due to these low numbers, even small differences in probabilities can result in large relative changes. These results likely reflect the underlying variability within the model, rather than any change in the modeled population caused by the anticipated take.

Therefore, we conclude that impacts to the fitness of maternity colonies and/or hibernating colonies are not likely to occur.

Step 3- Effects to the Recovery Unit

Based on our conclusion that impacts of take from WWF will not have population-level effects to the Indiana bat, we further concluded that take will not have RU-level impacts. We concluded that appreciable reductions in the likelihood that survival and recovery of Indiana bats within the Midwest Recovery Unit were unlikely to result from the proposed action.

Step 4- Effects to the species

Based on our conclusion that impacts of take from the Project will not have RU-level effects to the Indiana bat, we further concluded that take will not have species-level impacts. We conclude that the operation and maintenance of the Project, as proposed, is not likely to jeopardize the continued existence of the Indiana bat.

Effects to Populations from WWF Mitigation

To mitigate for the impacts of incidental take, the Applicant will provide mitigation that is expected to result in an increase to the population by at least 176.2 Indiana bats. Mitigation will not necessarily benefit the same maternity colonies or hibernating populations that are affected by the Project, but it will benefit the population within the Midwest Recovery Unit. Maternity habitat mitigation is expected to compensate for the taking of Indiana bats by increasing the carrying capacity of maternity colony habitat in areas considered habitat limited (i.e., low forest cover).

It will be increasingly important to enhance survival and reproductive potential of remaining bats as the population declines due to WNS. Because the Applicant must mitigate in the vicinity of an existing maternity colony or colonies (i.e., the colony must be extant at the time the mitigation takes place), we know that any colony targeted for mitigation will be a colony that has survived WNS-induced population declines (up to this point in time). Maternity colonies that survive WNS will be increasingly important to the continued survival of the species; maximizing survival and reproductive potential in those colonies will be important to recovery. We expect that targeting surviving maternity colonies for mitigation may be an important tool for species survival, and hopefully recovery.

Northern Long-Eared Bat Response to the proposed action

Framework for Analysis

The intent of our analyses is to evaluate the response of northern long-eared bats to the proposed action, and ultimately to ensure that the proposed action is not likely to appreciably reduce the likelihood of both survival and recovery of the northern long-eared bat by reducing its reproduction, numbers, or distribution in the wild. That is, to ensure that proposed action is not likely to jeopardize the continued existence of the species.

Step 1- Effects to individuals

In this step, we evaluate the likelihood that the proposed action will adversely affect the fitness of individual northern long-eared bats. This analysis involves an evaluation of the likelihood that individual northern long-eared bats will be exposed to proposed action-related stressors. If exposure is likely, we then evaluate how the exposed individuals are likely to respond.

Step 2- Effects to population

In step 2, we evaluate whether the aggregated effect of the proposed action on individual northern long-eared bats is likely to cause appreciable reductions to the fitness of the population to which these individuals belong. We assess the impact of the anticipated take of individual northern long-eared bats to the population of bats in Indiana.

Step 3- Effects to the species

In this step, we evaluate whether the anticipated reductions in population fitness are likely to cause appreciable reductions in the likelihood of survival and recovery of northern long-eared bats rangewide. This analysis entails evaluating how the population-level consequences will affect reproduction, numbers, or distribution of northern long-eared bats throughout its range.

Analysis

Step 1- Effects to individuals

There are four Project Components that will be evaluated, in terms of impacts to northern long-eared bats, in this section. The components and, generally, the type of impact expected to northern long-eared bats are:

1. Operations and Maintenance of WWF – mortality of migrating northern long-eared bats is expected.
2. Decommissioning of WWF – not expected to adversely affect northern long-eared bats.
3. Mitigation activities proposed by the Applicant – beneficial effects to northern long-eared bats are expected.

Each of these components and effects are discussed below.

Operations and Maintenance of WWF

It is expected that Indiana bats will die at WWF as the result of collision with wind turbines during migration.

Annual take was estimated to be 3 northern long-eared bats; over the 27-year operational life of the Project, this sums to 81 northern long-eared bats. To calculate the take expected to occur at the Project during migration, data from fatality studies conducted at Fowler Ridge Wind Farm (FRWF) were used. Both WWF and FRWF are located in predominantly agricultural landscapes in Indiana. Similar to FRWF, take at the Project is expected to occur only during the fall migration season (August 1-October 15), based on the seasonal distribution of bat activity recorded and the lack of suitable summer habitat and hibernacula near the projects. There is no summer roosting habitat within the Project's Action Area; therefore, take is unlikely to occur during the summer months. For a more detailed discussion on how the take estimate was derived, see Section 4.3 of the HCP.

The Service also recognizes that there is potential for sublethal or delayed-lethal effects to northern long-eared bats from interactions with turbines at the Project. Particularly, potential impairment of hearing from damage to the ear has been noted, but there are no data to quantify how many bats may suffer such damage and die at a later time. Thus, while there is insufficient information to include impaired hearing in our analyses at this time, the Service will incorporate any new information that becomes available on this topic into further evaluations of this and other projects.

In addition to impacts that occur in the area surrounding turbine blades (i.e., mortality from collisions with turbines), other potential effects of the operations and maintenance at the Project on northern long-eared bats include ground-level effects of lighting at the facility, vehicle traffic and other sounds, and vegetation management (e.g. mowing). Because listed bats are expected only to be active in the air space above the Project, these activities are not expected to adversely affect them at the ground level. Bats flying through the air space may perceive ground-level lights and sounds, but these are not expected to cause adverse effects.

Decommissioning of WWF

Adverse effects are not expected during decommissioning because the site does not support northern long-eared bat habitat. While listed bats migrating through the area may perceive some of the activities that occur at ground level during decommissioning, impacts are not expected to cause take.

Mitigation

The Conservation Plan in the Applicant's HCP focuses on minimizing potential impacts to northern long-eared bats at the Project, and mitigating for the incidental take. The mitigation measures that will be implemented (as described in detail in Chapter 5 of the HCP) are intended to provide conservation benefits to northern long-eared bats, and are not expected to cause take. Mitigation activities include protection and monitoring of summer maternity habitat for northern long-eared bats. As described above (and in detail in Chapter 4 of the HCP), permitted level of northern long-eared bat mortality is 81 northern long-eared bats over the 27-year operational life of the Project. However, because of the required minimization measures, we expect take to be only 50% (41 northern long-eared bats) of the permitted take. The Applicant will mitigate for the impact of the expected take of 41 northern long-eared bats upfront; the Applicant will coordinate and provide funding for mitigation that is expected to result in an increase to the population by at least 58.7 female northern long-eared bats. If monitoring shows that the Project has resulted in take that is more than the expected 41 northern long-eared bats, but less than the permitted 81 bats, additional mitigation will be required. Reference the HCP for details (Section 5.2.2 Mitigation for Impact of the Taking).

Step 2- Effects to population

In Step 2 of our analysis, we assessed the impact of the anticipated take of northern long-eared bats at the population level. This is best done by looking at the maternity colony and hibernacula populations; however, we do not have enough biological information about these populations, especially in regards to where they occur, to meaningfully asses impacts of take at that level. The finest-scale of analysis we have to examine effects on local populations is at the state level.

Unlike Indiana bats, northern long-eared bats are difficult to detect in hibernacula, move between hibernacula during the winter, and likely inhabit many unknown hibernacula. Therefore, a northern long-eared bat population estimate for the state of Indiana is not available. For purposes of this Biological Opinion, we estimate northern long-eared numbers in Indiana based on the following:

- forested acres in Indiana
- Northern long-eared bat occupancy rates
- overlap between adult male home range and maternity colony home range
- maternity colony home-range size and overlap between maternity colonies
- number of adult females per maternity colony
- landscape-scale adult sex ratio (we assume 1:1)

Forested Acreage

We compiled the total forested acres for Indiana from the U.S. Forest Service's 2015 State and Private Forestry Fact sheets (available at http://stateforesters.org/regional-state). We assumed that all forested acres are suitable for the northern long-eared bat, which probably overestimates habitat availability but it is not unreasonable given the species' ability to use very small trees (≥3 in dbh). There are 4,830,395 acres of forest in the state of Indiana.

Occupancy Rates

To calculate the northern long-eared bat occupancy rate in Indiana, we totaled the number of summer mist-net survey sites and the number of sites that captured at least one northern long-eared bat (of either sex) for each year from 2008-2015 within the state. An annual occupancy rate was calculated for each year by dividing the number of sites with at least one northern long-eared bat captured by the number of total sites surveyed in that year.

WNS was detected in Indiana in the winter of 2010-2011. The data showed a steep decline in both occupancy rate and rate of northern long-eared bat capture in 2013. Therefore, we used data from 2008-2010 as pre-WNS data and data from 2013-2015 as post-WNS data.

We calculated the pre-WNS occupancy rate from the average of the annual occupancy rates from 2008-2010 and the post-WNS occupancy rate from the average of the annual occupancy rates from 2013-

2015. Before WNS was detected in Indiana, at least 1 northern long-eared bat was captured at 47% of sites surveyed; post-WNS, at least 1 northern long-eared bat was captured at 21.5% of sites.

Combining the number of forested acres in Indiana from the previous section with the post-WNS northern long-eared bat occupancy rate, we estimated that there are:

$$4{,}830{,}395 \text{ acres forest} * 21.5\% \text{ occupancy rate} = 1{,}038{,}655 \text{ acres occupied forest}$$

Overlap between non-reproductive bat home range and maternity colony home range

Occupied forest may be occupied by maternity colonies as well as adult males and non-reproductive females. Since non-reproductive bats are also using forested areas, there is a lower acreage of forest available for maternity colonies than the "occupied forest" acreage calculated in the previous section. To adjust for this, we analyzed mist-net capture data to determine the percentage of overlap between non-reproductive bats and maternity colony home ranges. We calculated the number of capture locations for males and non-reproductive females that were also capture locations for reproductive female captures or within 3 miles of a reproductive female capture location. Of 810 total capture locations, 720 had reproductively active females within 3 miles, suggesting an 88.9% overlap between the home range of individuals belonging to maternity colonies and non-reproductive individuals.

Combining the acreage of total occupied forest calculated in the previous section with the percent overlap, we estimated that there are:

$$1{,}038{,}655 \text{ acres occupied forest} * 88.9\% \text{ overlap}$$
$$= 923{,}249 \text{ acres forest occupied by mat. colonies}$$

Maternity colony home-range size

Summer home range includes both roosting and foraging areas, and range size may vary by sex. Maternity roosting areas, the area encompassing all roost trees used by the colony, have been reported to vary from a mean of 21 to 179 acres (Owen et al. 2003; Broders et al. 2006; Lacki et al. 2009) to a high of 425 acres (Lacki et al. 2009). Foraging areas, the area encompassing a bats nighttime movements as measured using telemetry, are three or more times larger for females than males (Broders et al. 2006; Henderson and Broders 2008). The distance traveled between consecutive roosts varies widely from 20 ft (Foster and Kurta 1999) to 2.4 miles (Timpone et al. 2010). Likewise, the distance traveled between roost trees and foraging areas in telemetry studies varies widely. For example, Sasse and Perkins (1996) reported a mean distance of 1,975 ft in "State" and Henderson and Broders (2008) reported a mean distance of 3,609 ft in "State". Circles with a radius of these distances have an area of 281 and 939 acres, respectively. Based on reported maximum individual home range (425 acres) and travel distances between roosts and foraging areas described above (939 acres), we use 1,000 acres for purposes of this Biological Opinion as the area a maternity colony uses.

Lacking information about the degree of spatial overlap between northern long-eared bat maternity colonies, we assume that colonies do not overlap, e.g., we assume that 1,000 acres of occupied habitat supports one colony. Research on other myotid bat species indicates that there is very little to no overlap between maternity colonies. As the northern long-eared bat occupancy rate is only 21.5%, it is unlikely that limited habitat availability would contribute to substantial colony-range overlap. If incorrect, the possible effect of this assumption is to underestimate the population size in the state (i.e., 1,000 acres supports more than 1 colony).

Combining the acres of forest occupied by maternity colonies calculated in the previous section with the non-overlapping maternity colony home range size, we estimated that there are:

$$923{,}249 \text{ acres of forest occupied by mat. colonies} * \frac{1 \text{maternity colony}}{1000 \text{ forested acres}} = 923 \text{ mat. colonies}$$

Number of adult females per colony

Northern long-eared colonies are comprised of variable numbers of adult females. Two important studies give a range of 30–60 adult females per colony. While colony sizes of 30-60 bats may be typical in areas unaffected by WNS, in areas with clear declines in bat populations, these estimates may no longer be appropriate.

Declines in total population can be distributed in two ways: 1) declines in the number of maternity colonies on the landscape and/or 2) declines in the average number of bats within maternity colonies. It is likely that total population declines are reflected in both changes in the number of maternity colonies on the landscape as well as the number of bats in an average maternity colony. A way to describe the mathematical relationship among these three factors is:

Total female reproductive population = Number of colonies * Mean females per colony

OR

N=C*F

While we have an estimate of the number of colonies in Indiana (calculated in the previous section), in order to use this formula to find an average maternity colony size, we need to know the total female reproductive population. Information about total female reproductive population sizes is not available. However, we can use mist-net capture data to approximate the *change* in the size of the total female reproductive population. Indiana has seen declines in northern long-eared bat captures per mist net site from a pre-WNS rate of 1.28 to a post-WNS rate of 0.62. Ideally, we would use the metric of bat captures per unit effort to measure population decline; however, this type of data is unavailable. Therefore, we use changes in bat captures per mist net site as a reasonable approximation for total population changes.

For the data on change in total female reproductive population size to be useful, we must modify the above formula. The change over time of the total female population is going to be a function of the change in the number of colonies and the change in the mean number of females per colony. The subscript “0” indicates a pre-WNS variable, while the subscript “t” indicates a post-WNS variable:

$$\text{Total Population Size Change} = \frac{\text{Nt}}{\text{N0}} = \frac{\text{Ct} * \text{Ft}}{\text{C0} * \text{F0}}$$

We can rearrange this formula to solve for the average post-WNS maternity colony size (Ct):

$$\text{Average postWNS maternity colony size} = \text{Ft} = \frac{\text{Nt}}{\text{N0}} * \frac{\text{C0}}{\text{Ct}} * \text{F0}$$

$\frac{\text{Nt}}{\text{N0}}$ is the change in total population change; we approximate this using the pre- to post-WNS change in northern long-eared bat capture rates.

$\frac{\text{C0}}{\text{Ct}}$ is the change in number of northern long-eared bat maternity colonies on the landscape; we approximate this using the pre- to post-WNS change in occupancy rate.

F0 is the average size of a pre-WNS maternity colony; we assume this to be 45.

Using this formula, we can estimate the average post-WNS maternity colony size:

$$\text{F}_{\text{t}} = \frac{0.62}{1.28} * \frac{47\%}{21.5\%} * 45 = \sim 47 \text{ female bats in a mat. colony}$$

This result is counterintuitive because it suggests the average maternity colony size post-WNS is larger than from before WNS. This is due to the data showing that the relative change in the total population size was less than the change in the number of maternity colonies on the landscape pre-and post-WNS. The result is likely a by-product of lack of data on declining populations. However, this result is not biologically impossible; for example, it is possible that the average maternity colony size would increase in situations where the survivors of WNS-impacted colonies fused together to form fewer, but larger maternity colonies.

Total Population Size

Combining all the above data, we can now estimate the total number of northern long-eared bats in Indiana:

$$4{,}830{,}395 \text{ acres forest} * 21.5\% \text{ occupancy rate} = 1{,}038{,}655 \text{ acres occupied forest}$$

$$1{,}038{,}655 \text{ acres occupied forest} * 88.9\% \text{ overlap} = 923{,}249 \text{ acres forest occupied by mat. colonies}$$

$$923{,}249 \text{ acres of forest occupied by mat. colonies} * \frac{1 \text{maternity colony}}{1000 \text{ forested acres}} = 923 \text{ mat. colonies}$$

$$923\ maternity\ colonies * \frac{47\ female\ bats}{maternity\ colony} = 43{,}381\ adult\ female\ bats$$

$$43{,}381\ adult\ female\ bats + 1\ adult\ male\ per\ female\ bat = \mathbf{86{,}762}\ \boldsymbol{total\ adult\ bats}$$

Take from the Project is estimated to be 3 northern long-eared bats per year. Based on the small number of bats affected annually compared to the estimated state population size of 86,762, we do not anticipate population-level effects to the northern long-eared bats. We conclude that impacts to the fitness of Indiana's population of northern long-eared bats are not likely to occur.

Step 3- Effects to the species

Based on our conclusion that impacts of take from the Project will not have population-level effects to the northern long-eared bat, we further concluded that take will not have species-level impacts. We conclude that the operation and maintenance of the Project, as proposed, is not likely to jeopardize the continued existence of the northern long-eared bat.

Effects to Populations from WWF Mitigation

To mitigate for the impacts of incidental take, the Applicant will provide mitigation that is expected to result in an increase to the population of northern long-eared bats by at least 58.7 individuals. Mitigation will not necessarily benefit the same maternity colonies or hibernating populations that are affected by the Project, but it will benefit the population within the state. Maternity habitat mitigation is expected to compensate for the taking of northern long-eared bats by increasing the carrying capacity of maternity colony habitat in areas considered habitat limited (i.e., low forest cover).

It will be increasingly important to enhance survival and reproductive potential of remaining bats as the population declines due to WNS. Because the Applicant must mitigate in the vicinity of an existing maternity colony or colonies (i.e., the colony must be extant at the time the mitigation takes place), we know that any colony targeted for mitigation will be a colony that has survived WNS-induced population declines (up to this point in time). Maternity colonies that survive WNS will be increasingly important to the continued survival of the species; maximizing survival and reproductive potential in those colonies will be important to recovery. We expect that targeting surviving maternity colonies for mitigation may be an important tool for species survival, and hopefully recovery.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the Action Area considered in this Biological Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

As previously stated in this Biological Opinion, the only known Indiana and northern long-eared bat use of the Action Area is that the airspace over WWF is used by migrating bats during migration. Therefore, actions on the ground (e.g. tree clearing, road construction) will not affect bat habitat, because none is present. We also do not anticipate that Indiana and northern long-eared bat habitat will develop in the action area in the foreseeable future. Land cover in the Action Area is over 93% cultivated crops, 5% open development space, and less than 1% forest; the area is likely to continue to be dominated by agriculture to the extent that it will not become suitable for Indiana or northern long-eared bats. The Service is unaware of any future state, tribal, local or private actions, other than the proposed project, which would impose significant cumulative effects on the listed bats that use the area.

Similarly, there is no designated critical habitat for the Indiana and northern long-eared bats in or near the Action Area. Thus, cumulative effects to critical habitat, from the proposed action in concert with any future state, tribal, local or private actions in the Action Area, are not anticipated.

Conclusion

After reviewing the current status of the Indiana and northern long-eared bats, the environmental baseline for the Action Area, the effects of the proposed actions at Wildcat Wind Farm I, and the cumulative effects, it is the Service's biological opinion that operation, maintenance and decommissioning of the Project, as proposed, is not likely to jeopardize the continued existence of the Indiana bat or northern long-eared bat.

Briefly, the basis for this conclusion (as detailed in the Biological Opinion) is as follows:

- The Applicant constructed WWF in an area that does not support Indiana or northern long-eared bat habitat. The only apparent use of the area by listed bats is passing through the air space above the Project during migration.
- Based on research at other wind facilities, we believe that the seasonal turbine operational adjustments to be implemented under this HCP will meet or exceed a 50% reduction in bat fatality compared to fully operational turbines.
- We used a hierarchal framework to analyze the effects of the proposed project to Indiana bats, including the following steps: 1) effects to individuals, 2) effects to maternity colonies and hibernating populations, 3) effects to the Midwest Recovery Unit, and 4) effects to the rangewide population. We expect that a maximum of 162 Indiana bats will die as the result of interactions with wind turbines at FRWF during the migration period over the 28-year life of the Project. In step 2, we analyzed the impacts of the taking of 162 individuals on the maternity colonies and hibernating populations to which those individuals belong. We concluded that take from the project does not cause an appreciable difference in the fitness of the maternity colonies or hibernating populations. Therefore, we concluded that it is unlikely that the proposed project will cause appreciable reductions in the likelihood of survival and recovery of Indiana bats within the Midwest Recovery Unit or the rangewide population.
- We used a hierarchal framework to analyze the effects of the proposed project to northern long-eared bats, including the following steps: 1) effects to individuals, 2) effects to populations in Indiana, 3) effects to the rangewide population. We expect that a maximum of 81 northern long-eared bats will die as the result of interactions with wind turbines at the Project during the migration period over the 28-year life of the project. In step 2, we analyzed the impacts of the taking of 81 individuals on the populations in the state of Indiana. We concluded that take from the project does not cause an appreciable difference in the fitness of the state population of northern long-eared bats. Therefore, we concluded that it is unlikely that the proposed project will cause appreciable reductions in the likelihood of survival and recovery of northern long-eared bats within the rangewide population.
- The mortality monitoring program that will be implemented as part of the HCP requires stringent monitoring protocols and utilizes the best science available to estimate bat fatalities at a wind facility. We are confident that the monitoring program will provide the data the Service needs to ensure compliance with permitted take levels. Adaptive management has been incorporated into the HCP to provide flexibility to make modifications, as needed, to the

proposed minimization and mitigation measures if the measures have been ineffective or insufficient to meet permitted take levels or other HCP objectives.

Critical habitat was designated for the Indiana bat on 24 September 1976 (41 FR 41914). Eleven caves and two mines in six states were listed as critical habitat:
Illinois - Blackball Mine (LaSalle Co.);
Indiana - Big Wyandotte Cave (Crawford Co.), Ray's Cave (Greene Co.);
Kentucky - Bat Cave (Carter Co.), Coach Cave (Edmonson Co.);
Missouri - Cave 021 (Crawford Co.), Caves 009 and 017 (Franklin Co.), Pilot Knob Mine (Iron Co.), Bat Cave (Shannon Co.), Cave 029 (Washington Co.);
Tennessee - White Oak Blowhole Cave (Blount Co.); and
West Virginia - Hellhole Cave (Pendleton Co.).

The proposed action does not affect any of these designated sites and no destruction or adverse modification of that critical habitat is anticipated.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the U.S. Fish and Wildlife Service (Service) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The Indiana Bat and Northern Long-Eared Bat HCP submitted by Wildcat Wind Farm, LLC and its associated documents clearly identify expected impacts to Indiana and northern long-eared bats likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the HCP, together with the terms and conditions described in the associated Implementing Agreement and any section 10(a)(1)(B) permit or permits issued with respect to the HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement pursuant to 50 CFR §402.14(i). Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the Act to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse.

The amount or extent of incidental take expected under the HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) permit.

In addition to the responsibilities of the Applicant, the Service has the responsibility to monitor compliance with provisions of the HCP, and to take appropriate steps if compliance is deficient.

Amount or Extent of Take

After reviewing the HCP and analyzing the effects of the proposed action, the Service anticipates that no more than 162 Indiana bats and 81 northern long-eared bats will be taken over the 27-year operational life of the proposed project. It is expected that Indiana and northern long-eared bats will die at the Project as the result of collision with wind turbines (and possibly barotrauma to the lungs caused by rapid air pressure reduction near moving turbine blades) during migration.

Effect of the Take

In this Biological Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the Indiana bat or the northern long-eared bat. The Service also determined that the Project is not likely to result in the destruction or adverse modification of Indiana bat critical habitat. There is no critical habitat designated for the northern long-eared bat.

Reasonable and Prudent Measures

As described above, all conservation measures described in the HCP, together with the terms and conditions described in the associated Implementing Agreement and the Incidental Take Permit issued with respect to the HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement.

Terms and Conditions

As described above, all conservation measures described in the HCP, together with the terms and conditions described in the associated Implementing Agreement and the Incidental Take Permit issued with respect to the HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement.

The Service has the responsibility to monitor implementation of the HCP and compliance with the provisions of the Implementing Agreement and this Incidental Take Statement.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The federal Action Agency in the case of this Biological Opinion is the U.S. Fish and Wildlife Service; the federal action considered is the issuance of a 10(a)(1)(B) Incidental Take Permit for Wildcat Wind Farm I. In furtherance of section 7(a)(1) of the Act, the following activities may be conducted at the discretion of the Service as time and funding allow:

1. Work with partners to support research focused on better understanding exposure of bats to wind turbines, measures to minimize collision risk, and monitoring methods.
2. Work with the wind industry to help wind energy developers avoid and minimize impacts of wind projects on federally listed species.
3. Incorporate new findings from research and post-construction monitoring programs into guidance documents, including the Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects (USFWS 2011).
4. Continue and expand efforts within the Service to ensure that all offices working on wind energy projects have access to the best scientific and commercial data available on bat/wind interactions and methods to avoid and minimize bat mortality at wind facilities.
5. Continue to develop tools for the Service to use that promote consistent, efficient, and effective methods for addressing wind impacts to federally listed species.
6. There is considerable uncertainty regarding how white-nose syndrome will impact populations of Indiana bats, northern long-eared bats, and other cave-hibernating bat species. Continue to promote the implementation of the White-Nose Syndrome National Plan and to develop tools for assessing how bat populations will respond to WNS in addition to other threats (including wind energy development).
7. Research and develop mitigation strategies that will be most effective at ameliorating the impacts of WNS on federally listed bats.

Reinitiation Notice

This concludes formal consultation on the proposed issuance of a section 10(a)(1)(B) Incidental Take Permit to the Applicant (pursuant to submission of their HCP and an ITP for Wildcat Wind Farm I). As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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