

**BIOLOGICAL OPINION**  
and  
**INCIDENTAL TAKE STATEMENT**

for the

**APPLICATION FOR AN INCIDENTAL TAKE PERMIT  
FOR THE FEDERALLY ENDANGERED INDIANA BAT  
(*Myotis sodalis*) FOR THE FOWLER RIDGE WIND  
FARM, BENTON COUNTY, INDIANA**

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## **INTRODUCTION**

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion based on our review of the Fowler Ridge Wind Farm, Benton County: Indiana Bat Habitat Conservation Plan (hereafter referred to as the HCP). The HCP was submitted by Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge IV Wind Farm LLC (hereafter referred to as FRWF 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*) resulting from actions associated with the Fowler Ridge Wind Farm Phases I, II, III, and IV (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.

The following sources of information, specific to the Project, were consulted extensively in the preparation of this Biological Opinion: 1) the Applicant's HCP (FRWF 2013) (draft dated March 2013 and final dated November 2013); 2) the Environmental Impact Statement (EIS) for the Proposed Habitat Conservation Plan and Incidental Take Permit, Fowler Ridge Wind Farm, Benton County, Indiana (USFWS 2013a); 3) reports on fatality studies and research conducted in the project area (Johnson et al. 2010a, 2010b; Good et al 2011, 2012, 2013, 2014); and 4) meetings, phone calls, site visits, and written correspondence with the Applicant and their consultants (see CONSULTATION HISTORY below).

## **CONSULTATION HISTORY**

The Service has been coordinating with the Applicant on the Project since 2006. The list below includes formal letters, meetings, site visits, and major milestones that occurred as part of the consultation process.

9/18/2006 – Early coordination initiated by Western EcoSystems Technology Inc. (WEST) for the proposed Fowler Ridge Wind Farm (FRWF) in Benton County, Indiana.

6/13/2007 – Meeting at the Bloomington, U.S. Fish and Wildlife Service Bloomington, Indiana Field Office (BFO) to discuss Bald and Golden Eagle Protection Act (BGEPA) and Migratory Bird Treaty Act (MBTA) issues, and specifically concerns regarding the American Golden Plover. Parties in attendance included representatives from BP Wind Energy, WEST, Indiana Department of Natural Resources (IDNR), National Audubon Society, BFO, USFWS Law

Enforcement, and USFWS Regional Office.

9/10/2007 – Letter issued by BFO to BP Wind Energy with recommendations for protecting the American Golden Plover.

1/29/2008 – Meeting at BFO to discuss project status and pre- and post-construction monitoring. Parties in attendance include representatives from BP Wind Energy, Dominion Energy, WEST, IDNR, National Audubon Society, BFO, and USFWS Regional Office.

9/10/2009 – Maintenance worker at Fowler Ridge Wind Farm finds a dead bat which is later identified as an Indiana bat during carcass analysis on 11/16/2009.

11/17/2009 – BFO is notified of the Indiana bat mortality. Carcass delivered to BFO the next day.

12/27/2009 – BFO received results of genetic analysis confirming that the bat found on 9/10/2009 was an Indiana bat.

1/14/2010 – Meeting at BFO to discuss post-construction monitoring results. Parties in attendance include representatives from BP Wind Energy, Dominion Energy, WEST, BFO, USFWS Law Enforcement, and USFWS Regional Office.

2/8/2010 – News release issued concerning the first documented Indiana bat killed at a wind farm.

2/24/2010 – Meeting at BFO to discuss potential for FRWF to prepare a Habitat Conservation Plan (HCP) and apply for an Incidental Take Permit (ITP). Discussions included the merit of completing research at FRWF that would be used to inform HCP development and potential for a Scientific Research and Recovery Permit (SRRP) to complete that work. Parties in attendance include representatives from BP Wind Energy, Sempra Generation, WEST, and BFO.

6/3/2010 – FRWF submits a SRRP application to study bat fatality in relation to various wind turbine cut-in speeds.

7/30/2010 – USFWS issued Scientific Research and Recovery Permit TE15075A-0 for research on bat fatality in relation to various wind turbine cut-in speeds.

9/18/2010 – Adult female Indiana bat found during research permitted under SRRP TE15075A-0.

12/14/2010 – HCP kick-off meeting at BFO. Parties in attendance include representatives from BP Wind Energy, Dominion Energy, Sempra Generation, WEST, BFO, USFWS External Affairs, and USFWS Regional Office.

1/28/2011 – USFWS received final report for Scientific Research and Recovery Permit TE15075A-0.

2/2/2011 – Meeting at BFO to discuss take assessment and impact of take. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, WEST Inc., and BFO.

2/16/2011 – Conference call to discuss National Environmental Policy Act (NEPA) process, BGEPA and MBTA requirements, and HCP timeline. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, Stantec Consulting, WEST, and BFO.

3/30/2011 – Conference call to discuss take assessment, SRRP research, and status of NEPA. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, Pillsbury Winthrop Shaw Pittman LLP, Stantec Consulting, WEST, and BFO.

3/30/2011 – FWRP requested renewal of SSRP TE15075A-0.

3/30/2011 – USFWS issued Scientific Research and Recovery Permit TE15075A-2 to study bat fatality in relation to raising cut-in speed of turbines and feathering blades prior to reaching cut-in speeds.

6/7/2011 – Environmental Impact Statement (EIS) public scoping meeting held in Fowler, IN. Parties in attendance include representatives from BP Wind, Stantec Consulting, BFO, and USFWS External Affairs.

7/13/2011 – Meeting at BFO to discuss HCP changed and unforeseen circumstances, HCP maximum extent practicable, and SRRP research. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, WEST, and BFO.

8/5/2011 – BFO letter to Fowler Ridge Wind Farm advising that operation of the facility is not likely to result in the mortality of Indiana bats during spring migration.

9/28/2011 – Conference call to discuss HCP conservation measures. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, Pillsbury Winthrop Shaw Pittman LLP, WEST, BFO, and USFWS Regional Office.

12/12/2011 – Meeting at BFO to discuss HCP take assessment, minimization measures, mitigation project, and HCP/NEPA schedule. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, Pillsbury Winthrop Shaw Pittman LLP, Stantec Consulting, WEST, and BFO.

1/30/2012 – Site visit to Wyandotte Cave followed by a meeting at O'Bannon Woods State Park to discuss mitigation project logistics, HCP/NEPA schedule, and SRRP research summary. Parties in attendance include representatives from BP Wind, Sempra Generation, BCI, WEST, IDNR, and BFO.

1/31/2012 – USFWS received final report for Scientific Research and Recovery Permit

TE15075A-2.

2/17/2012 – USFWS letter to Fowler Ridge Wind Farm concerning eagle risk at the existing wind facility.

2/24/2012 – Meeting at BFO to discuss HCP and NEPA status updates, and development of the Avian and Bat Protection Plan (note, this document is now titled Bird and Bat Conservation Strategy). Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, Stantec Consulting, WEST, and BFO.

5/1/2012 – FRWF submits an SRRP application for two research projects. One to study bat fatality in relation to adjustments in turbine cut-in speed and feathering. The second to study bat behavior in the vicinity of wind turbines using acoustic detectors, videography and radar.

6/8/2012 – Meeting at BFO to discuss take limit, mitigation project, NEPA update, and 2012 SRRP research update. Parties in attendance include representatives from BP Wind, Dominion Energy, Sempra Generation, WEST, BFO, and USFWS Regional Office.

7/11/2012 – USFWS issued Scientific Research and Recovery Permit TE73598A-0 for research at Fowler Ridge Wind Farm.

9/5/2012 – Conference call to discuss HCP adaptive management. Parties in attendance include representatives from BP Wind, WEST, and BFO.

1/15/2013 – Fowler Ridge Wind Farm submitted a valid application for an Incidental Take Permit for the operation of the wind farm, along with a Habitat Conservation Plan for the Indiana bat that included all required elements.

1/31/2013 – USFWS received the final report of the study of bat fatality in relation to adjustments in turbine cut-in speed and feathering for Scientific Research and Recovery Permit TE73598A-0.

4/5/2013 – USFWS published the Draft EIS and Draft HCP in the Federal Register (78 FR 20690–20692) for a 60-day public comment period.

4/18/2013 – A public information meeting for the Habitat Conservation Plan and the Environmental Impact Statement was held in Fowler, Indiana. Parties in attendance include representatives from BP Wind, Stantec Consulting, BFO, and USFWS External Affairs.

4/30/2013 – U.S. Geological Survey (USGS) submitted a report on the study of bat behavior in the vicinity of wind turbines using acoustic detectors, videography and radar conducted under Scientific Research and Recovery Permit TE73598A-0 to the USFWS. On 6/28/2013 USGS noted that some weather data that had been used in the report was inaccurate and that they were reevaluating the findings of the report and will submit a revision.

5/31/2013 – Fowler Ridge Wind Farm requested a renewal of Scientific Research and Recovery

Permit TE73598A-0 and subsequently completed a study of bat fatality in relation to adjustments in turbine cut-in speed and feathering along with acoustic and thermal imagery research (during the fall of 2013) under that permit.

6/25/2013 – Conference call to discuss public comments on the Draft EIS and Draft HCP. Parties in attendance include representatives from BP Wind, WEST, Stantec Consulting, BFO, and USFWS Regional Office.

7/3/2013 – Conference call to discuss the Indiana bat spatial model used for Fowler Ridge Wind Farm analysis of effects in the Biological Opinion. Parties in attendance include representatives from BP Wind, WEST, and BFO.

8/14/2013 - Conference call to discuss public comments on the Draft EIS and Draft HCP. Parties in attendance include representatives from BP Wind, Stantec Consulting, BFO, and USFWS Regional Office.

1/7/2014 – USFWS published the Final EIS and Final HCP in the Federal Register (79 FR 3224-3225) for a 30-day period.

1/31/14 – USFWS received the 2013 bat fatality in relation to adjustments in turbine cut-in speed and feathering portion of the final report for Scientific Research and Recovery Permit TE73598A-0. The acoustic and thermal imagery report is due 4/30/2014.

## **BIOLOGICAL OPINION**

### **DESCRIPTION OF THE PROPOSED ACTION**

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) for the incidental take of Indiana bats (*Myotis sodalis*) associated with the operation of Fowler Ridge Wind Farm. As part of the requirements for obtaining an ITP, the Applicant has prepared an HCP (FRWF 2013) in coordination with the Service. The ITP will cover the 21-year remaining operational life of the Project. The 21-year ITP term provides for a minimum 20-year functional operational life of all turbines. The Project is described in detail in the HCP and the EIS (USFWS 2013a); a summary follows.

The Fowler Ridge Wind Farm consists of four project phases owned by four separate Companies: Fowler Ridge Wind Farm LLC; Fowler Ridge II Wind Farm LLC; Fowler Ridge III Wind Farm LLC; and Fowler Ridge IV Wind Farm LLC. The FRWF currently consists of 355 wind turbines constructed through three development phases located in Benton County, Indiana. Construction of the first three phases (355 turbines) is complete. Phases I and III were constructed in 2008 and became operational during February of 2009. Phase II was constructed in 2009 and became operational by December 31, 2009. The HCP and ITP also include Phase IV of the Project, scheduled to be constructed in 2014, which will consist of up to 94 additional turbines, also in Benton County. See Figure 1 for a map of all four Phases. Impacts associated with the operation of a total of 449 turbines (Phases I, II, III, and IV) with a generating capacity

of 750 megawatts are covered in the HCP and ITP.

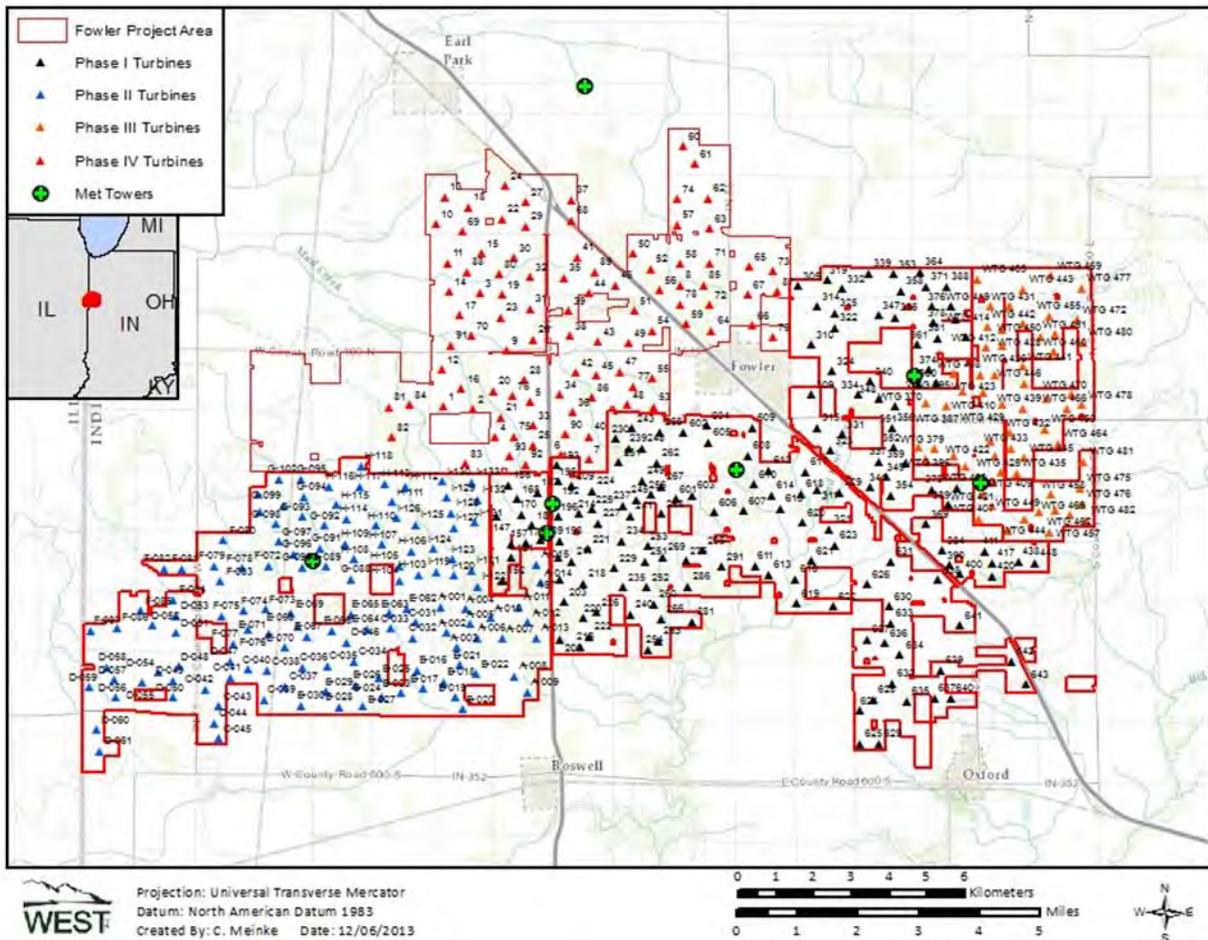


FIGURE 1. FOWLER RIDGE WIND FARM, PHASES I, II, III, AND IV.

### Action Area

The Project Action Area is defined as all areas to be affected directly or indirectly by the proposed project. Therefore, the Project Action Area includes the Project footprint and the geographic extent of the area that could be affected directly or indirectly by construction or operational activities associated with the proposed project and by interrelated or interdependent actions.

For purposes of this Biological Opinion, the Action Area includes all lands leased by the Permittees for the operation of the Project (see red outline on Figure 1). The Action Area encompasses all 355 existing Phases I, II, and III turbines, plus the area in which up to 94 additional Phase IV turbines will be located. In addition, the Action Area includes land leased for other facilities associated with the Project, such as the collection system, switchyard, meteorological tower, and connector lines.

The Action Area encompasses 25,900 hectares (64,000 acres) in Benton County, located in northwestern Indiana. The total area under lease for the FRWF Phases I, II, and III is approximately 23,310 hectares (57,600 acres); land is leased from 239 landowners. Additionally, approximately 2,590 hectares (6,400 acres) are under lease for Phase IV; land is leased from 50 landowners.

Benton County is one of the least forested counties in the State of Indiana. Land cover in Benton County is approximately 92% cultivated crops and additional 2% pasture/hay; approximately 1.2% is forested. Within the Action Area, land cover is over 93% cultivated crops, 2% hay/pasture, and less than 1% forest (.4%). For a detailed description of land cover and land use in the vicinity of the Project see Section 3.1 (Environmental Setting) in the HCP and Section 4 (Affected Environment) in the EIS.

## **Conservation Measures**

Impacts to Indiana bat habitat were avoided by siting the Project in an area that includes no suitable habitat for the Indiana bat. It was not until after Phases I, II, and III were constructed and became operational that the potential for take of Indiana bats during migration at this site was realized. At that point, the Applicant consulted with the Service and initiated development of the HCP.

The Applicant has incorporated conservation measures into the HCP; these measures are designed to avoid, minimize, and mitigate impacts of the proposed action on the Indiana bat. 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 – The Applicant will not construct FRWF in Indiana bat habitat.

Phases I, II, and III were constructed in an area with no suitable Indiana bat habitat. Indiana bats do not use this area in the summer (neither maternity colonies nor males use the area), and there are no hibernacula near the project area (the nearest hibernaculum is more than 100 miles away). Phase IV will be also be constructed in an area with no habitat suitable for Indiana bats, adjacent to existing Phases.

2) Minimization Measures – The Applicant will implement strategies to minimize the taking of Indiana bats, and through monitoring will ensure that those strategies are effective. Adaptive management will be used to modify minimization strategies as needed. See details of the operational adjustments in HCP Section 5.2.2 Minimization through Project Operations. A summary follows.

The Applicant will implement seasonal turbine operational adjustments designed to reduce Indiana bat mortality by at least 50% compared to fully operational levels. For the term of the ITP, the Applicant will raise the turbine cut-in wind speed of all turbines at FRWF to 5.0 meters

per second (m/s) from sunset to sunrise from August 1 to October 15 annually. Below the 5.0 m/s cut-in speed, turbines will have blades “feathered” (i.e., turbine blades will be pitched into the wind to minimize spinning). The only exception to turbine operational adjustments will be on nights when temperatures are below 10°C (50° F) from August 1 to October 15. Turbines will be allowed to operate at full capacity below these temperatures.

In addition to raising cut-in speeds to 5.0 m/s and feathering turbines below this cut-in speed, the Applicant will implement an adaptive management plan that includes raising cut-in speeds in 0.5 m/s increments, if needed, to assure compliance with authorized annual thresholds.

3) Mitigation Measures – To mitigate for the impacts of incidental take associated with the Project, the Applicant will coordinate, fund, implement, and monitor, the protection and restoration of both summer habitat and winter habitat for the Indiana bat. As described in Chapter 4 of the HCP, the estimated level of Indiana bat mortality with minimization measures in place is expected to be less than or equal to 184 Indiana bats over the 21-year term of the ITP. To mitigate for the impacts of this take, the Applicant will coordinate and provide funding for mitigation designed to increase the population of Indiana bats in the Midwest Recovery Unit by at least 336 bats by Year 21 of the permit term.

See details of the mitigation measures in HCP Section 5.3 Measures to Mitigate the Impact of the Taking. A summary follows:

The Applicant will preserve, restore, and permanently protect a minimum of 97 hectares (240 acres) of summer maternity habitat in the vicinity of existing maternity colonies in Putnam County, Tippecanoe County, Vermillion County, or Warren County, Indiana. Only lands within the home range of an extant Indiana bat maternity colony or colonies will be considered for summer habitat mitigation. See details in HCP Section 5.3.1 Measures for Mitigation of Summer Habitat. The Applicant has designed a monitoring program for maternity habitat mitigation lands to evaluate suitability of the habitat and to confirm persistence of a maternity colony (see details in HCP Section 5.4.3.1 Summer Habitat Mitigation Monitoring). Adaptive management will be implemented if the habitat is not suitable or if an Indiana bat maternity colony does not persist in the mitigation area through the life of the ITP (see HCP Table 5.9 Adaptive management framework for monitoring of summer mitigation projects). As an alternative to performing summer habitat mitigation, the Applicant has the option of using a mitigation bank as detailed in HCP Section 5.3.1.1 Mitigation Bank Option.

The Applicant will protect wintering bats vulnerable to human disturbance by installing a bat gate near the entrance of Wyandotte Cave, a Priority 1 hibernaculum in Crawford County, Indiana. See details in HCP Section 5.3.2 Measures for Mitigation of Winter Habitat. The monitoring program for the cave gating project will provide data to evaluate the response of bats to the gate, potential changes in cave microclimate, and effectiveness of the gate at reducing human disturbance (see details in HCP Section 5.4.3.2 Winter Habitat Mitigation Monitoring). Further, adaptive management provides for remedies if the gate does not produce the desired result (see HCP Table 5.10 Adaptive management framework for determining the response of hibernating Indiana bats to re-gating the Wyandotte Cave entrance).

#### 4) Monitoring, Reporting and Adaptive Management

The monitoring program that will be implemented as part of this HCP will provide the information necessary to assess ITP compliance, Project impacts, and verify progress towards meeting the biological goals and objectives identified in HCP Chapter 5.1. There are two components to the monitoring program: 1) take limit compliance monitoring (see HCP Section 5.4.1 Take Limit Compliance Monitoring), and 2) mitigation effectiveness monitoring (see HCP Section 5.4.3 Mitigation Monitoring). The goal of take limit compliance monitoring is to ensure compliance with the terms of the ITP, while the goal of mitigation effectiveness monitoring (which was discussed above under Mitigation Measures) is to ensure the success of projects designed to mitigate impacts of incidental take of Indiana bats from the FRWF.

Take limit compliance monitoring (i.e., mortality monitoring - searches for dead bats beneath turbines) will be conducted annually during fall migration (the period when Indiana bat fatality is expected to occur) throughout the life of the ITP. FRWF has been operational since 2009, and extensive mortality monitoring has already occurred at this facility (Johnson et al. 2010a, 2010b; Good et al 2011, 2012, 2013, 2014). The Applicant and the Service worked cooperatively using monitoring data that have been collected at this site to design a take compliance monitoring program for the HCP that will: 1) Provide the information necessary to calculate incidental take of Indiana bats and ensure that incidental Indiana bat take does not exceed the take limit permitted by the ITP; and 2) Provide the basis for adaptive management decisions related to turbine operational changes, the primary minimization measure implemented as part of this HCP. For details see HCP Section 5.4.1 Take Limit Compliance Monitoring.

Indiana bats can be difficult to distinguish morphologically from other bats of the genus *Myotis* (particularly if the identification is being made from a carcass that is not fresh). The Applicant will take steps to prevent misidentification. Carcasses of all bats of the genus *Myotis* found during mortality monitoring will be identified within seven days of collection by biologists trained in the identification of *Myotis* species, and approved by the Service. *Myotis* carcasses will be delivered to the Service within seven days of collection, for concurrence on species identification. In addition, genetic testing will be conducted to verify field identifications of any carcasses too decomposed for positive identification.

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 31 following completion of the field surveys. The Applicant will also meet with the Service following completion of monitoring in Years 1, 2, 6, 11, 16, and 21.

The Applicant will identify an HCP Coordinator. The role of the HCP Coordinator will be to oversee the HCP implementation, plan and coordinate all meetings with Project stakeholders, organize training of management staff, oversee allocation of funding for mitigation, monitoring, and changed circumstances, and ensure timely delivery of all reports to the Service and the Indiana Department of Natural Resources.

The general adaptive management approach for take compliance is raising cut-in speeds if it

appears that mortality thresholds may be met during the fall monitoring period (within-season adaptive management), or if thresholds are met at the conclusion of the monitoring year (end-of-year adaptive management). For a detailed discussion of adaptive management see HCP Section 5.4.2 Adaptive Management for Take Compliance. HCP Table 5.7 Adaptive management thresholds and responses for the Fowler Ridge Wind Farm Habitat Conservation Plan summarizes the framework that will be used to make adaptive management decisions related to minimization measures and monitoring, both within-season and at the end of the annual monitoring period.

## 5) Research

The primary goal of the mortality monitoring program at FRWF is to ensure compliance with the Incidental Take Permit, but the program is also designed to increase scientific understanding about impacts to Indiana bats, and bats generally, from wind turbines. Specifically, the Project will increase understanding of the timing of bat mortality, effectiveness of operational adjustments, impacts of weather on mortality, and juxtaposition of fatalities relative to landscape features.

The Applicant will prepare data sheets for monitoring that will be reviewed and approved by the Service. Raw data forms will be made available to the Service on request; raw data can be used by the Service for evaluating the impacts of wind energy development on bats.

Tissue and hair samples will be collected from all dead bats found at FRWF throughout the life of the Project. These will be made available for research (e.g., genetics, stable isotope analysis).

## **STATUS OF THE SPECIES**

### **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.

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).

### **Indiana Bat Life History**

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.

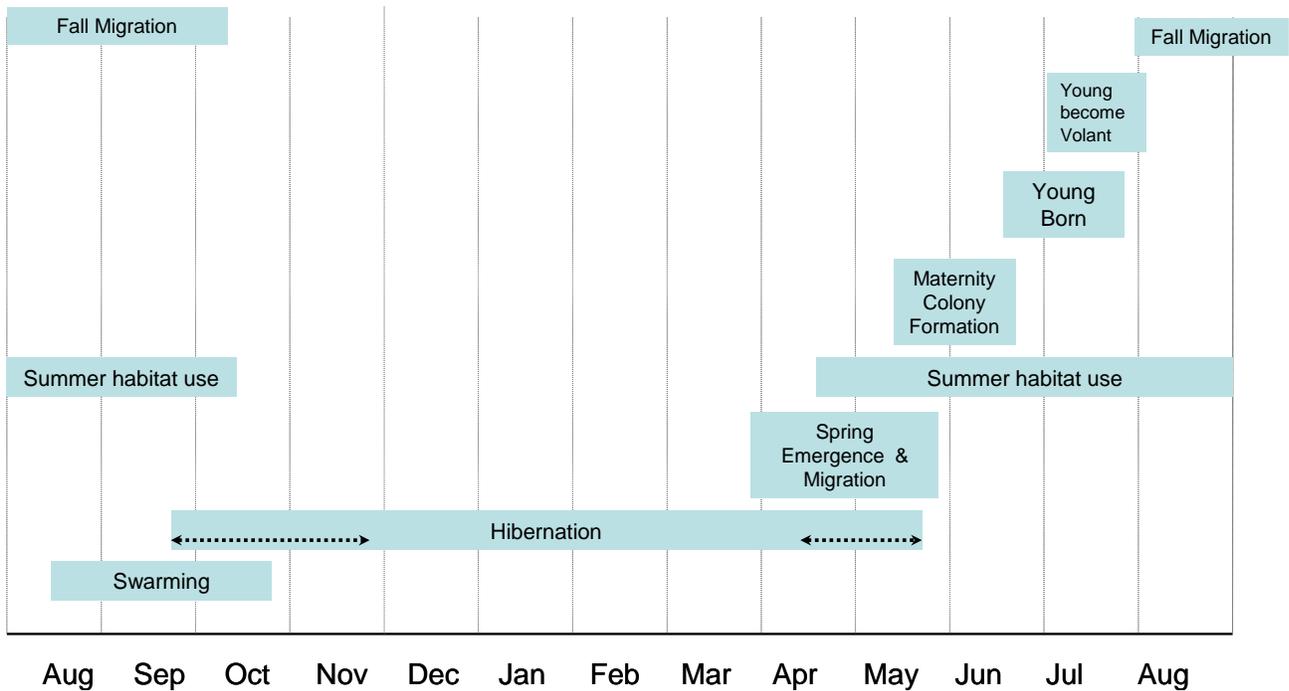


FIGURE 2. GENERALIZED INDIANA BAT ANNUAL CHRONOLOGY.

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 2013) 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 FRWF will be from the Midwest RU.

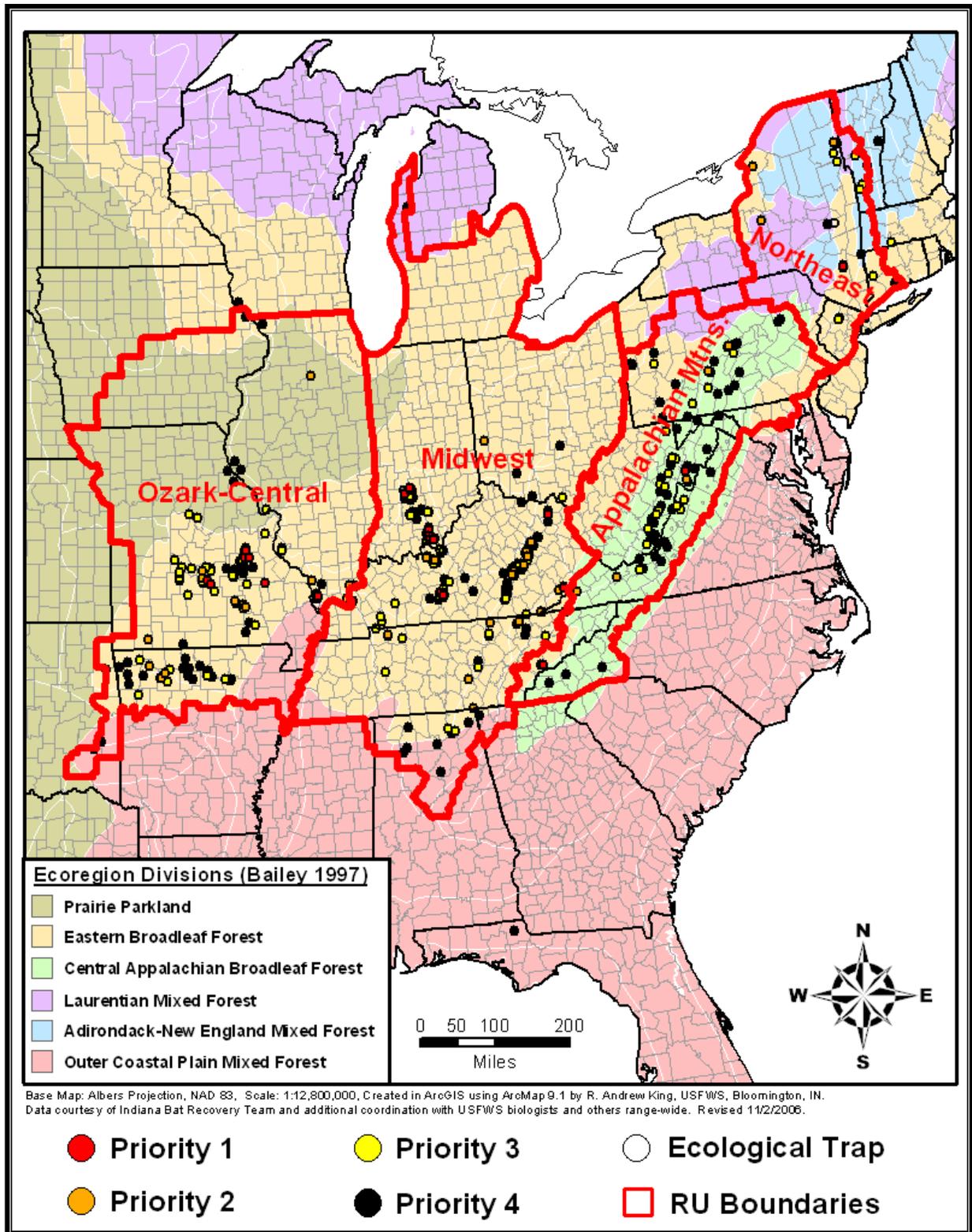


FIGURE 3. INDIANA BAT CURRENT RANGE (DELINEATED BY OUTER RED LINE) AND RECOVERY UNITS.

In 2013, more than 40% of Indiana bats (226,365 of 534,239) 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 56% of the population hibernated in the Midwest Recovery Unit (Table 1). Based on 2013 data, there are five caves and two mines that had 20,000 or more hibernating. Collectively, these seven sites contain 73% of the rangewide population. The 2013 population estimate (534,239) is almost 400,000 bats less than when the species was listed as endangered in 1967 (approximately 900,000).

TABLE 1. RANGEWIDE INDIANA BAT POPULATION ESTIMATE, SUMMARIZED BY RECOVERY UNIT.

IBat Recovery Unit	State	2005	2007	2009	2011	2013	% Change from 2011	% of 2013 Total
<b>Ozark-Central</b>	Illinois	55,090	53,823	53,342	55,956	57,074	2.0%	10.7%
	Missouri	139,038	138,831	136,624	138,379	139,772	1.0%	26.2%
	Arkansas	2,067	1,821	1,480	1,206	856	-29.0%	0.2%
	Oklahoma	2	0	0	13	5	0.0%	0.0%
	<b>Total</b>	<b>196,197</b>	<b>194,475</b>	<b>191,446</b>	<b>195,554</b>	<b>197,707</b>	<b>1.1%</b>	<b>37.0%</b>
<b>Midwest</b>	Indiana	206,610	238,068	213,244	225,477	226,365	0.4%	42.4%
	Kentucky	65,611	71,250	57,325	70,598	62,233	-11.8%	11.6%
	Ohio	9,769	7,629	9,261	9,870	9,259	-6.2%	1.7%
	Tennessee	3,221	2,929	1,657	1,791	2,337	30.5%	0.4%
	Alabama	296	258	253	261	247	-5.4%	0.0%
	SW Virginia	202	188	217	307	214	-30.3%	0.0%
	Michigan	20	20	20	20	20	0.0%	0.0%
	<b>Total</b>	<b>285,729</b>	<b>320,342</b>	<b>281,977</b>	<b>308,324</b>	<b>300,675</b>	<b>-2.5%</b>	<b>56.3%</b>
<b>Appalachian</b>	West Virginia	13,417	14,745	17,965	20,296	3,845	-81.1%	0.7%
	E. Tennessee	8,853	5,977	11,058	11,096	13,200	19.0%	2.5%
	Pennsylvania	835	1,038	1,031	519	120	-76.9%	0.0%
	Virginia	567	535	514	556	418	-24.8%	0.1%
	North Carolina	0	0	1	1	1	0.0%	0.0%
	<b>Total</b>	<b>23,672</b>	<b>22,295</b>	<b>30,569</b>	<b>32,468</b>	<b>17,584</b>	<b>-45.8%</b>	<b>3.3%</b>
<b>Northeast</b>	New York	41,745	52,779	33,172	15,654	17,772	13.5%	3.3%
	New Jersey	652	659	619	409	448	9.5%	0.1%
	Vermont	313	325	64	61	53	-13.1%	0.0%
	<b>Total</b>	<b>42,710</b>	<b>53,763</b>	<b>33,855</b>	<b>16,124</b>	<b>18,273</b>	<b>13.3%</b>	<b>3.4%</b>
<b>Rangewide Total:</b>		<b>548,308</b>	<b>590,875</b>	<b>537,847</b>	<b>552,470</b>	<b>534,239</b>	<b>-3.3%</b>	<b>100.0%</b>

The known summer distribution of the Indiana bat covers a broader geographic area than its winter distribution (Figure 4; note, this figure includes historic records from Wisconsin and Florida, states where the species is no longer known to occur). 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 534,239 in 2013 and an average maternity colony size of 80 adult females, we estimate that there are about 3,300 maternity colonies of Indiana bats. Of these, we know the location of approximately 269 colonies, which is less than 10% of the colonies we assume to be present.

## **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 2013 rangewide population estimate of Indiana bats was 534,239 individuals, based on winter hibernacula survey information compiled by the Service (Table 1). Figure 5 provides the rangewide Indiana bat population estimates from 1981-2013.

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.

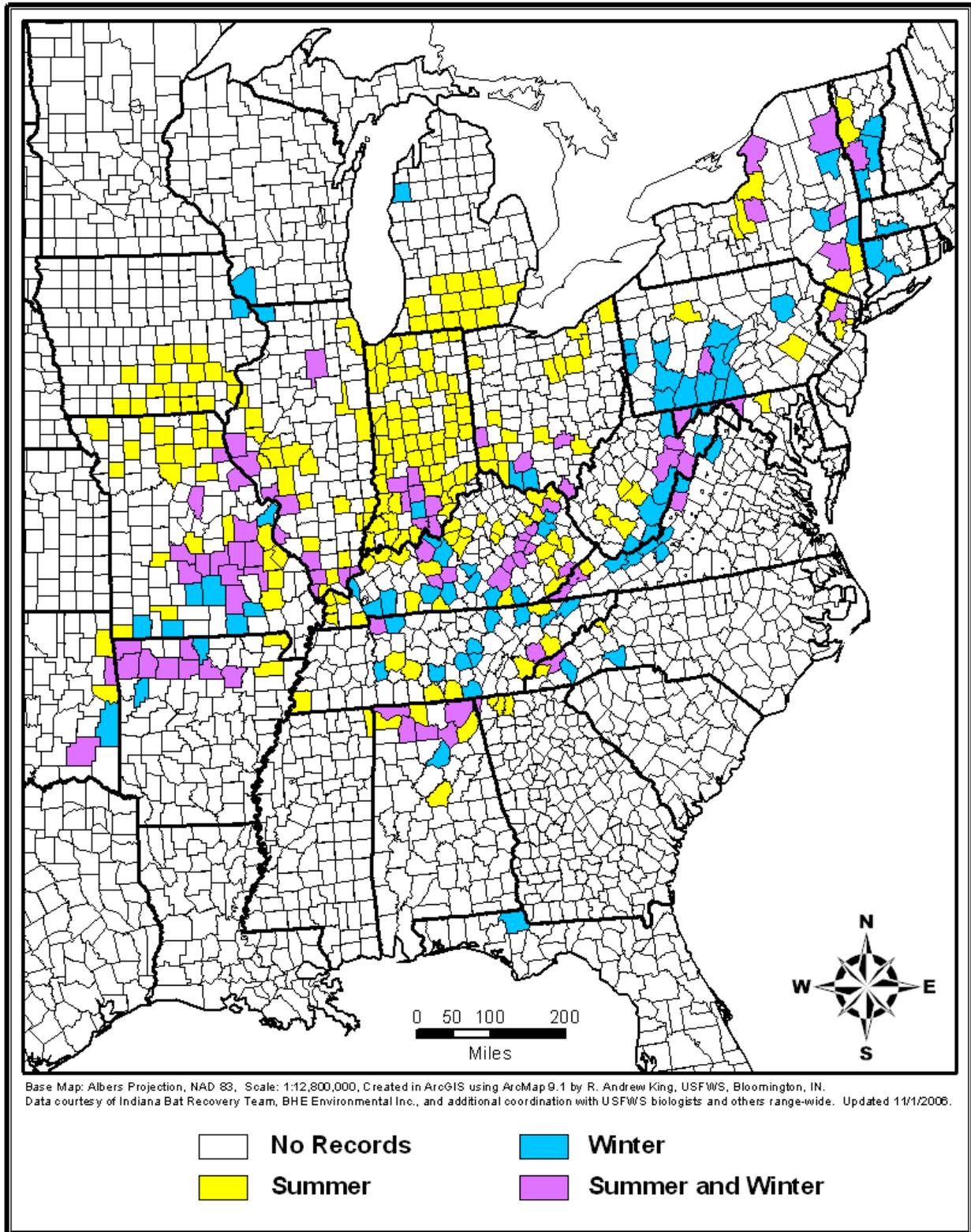
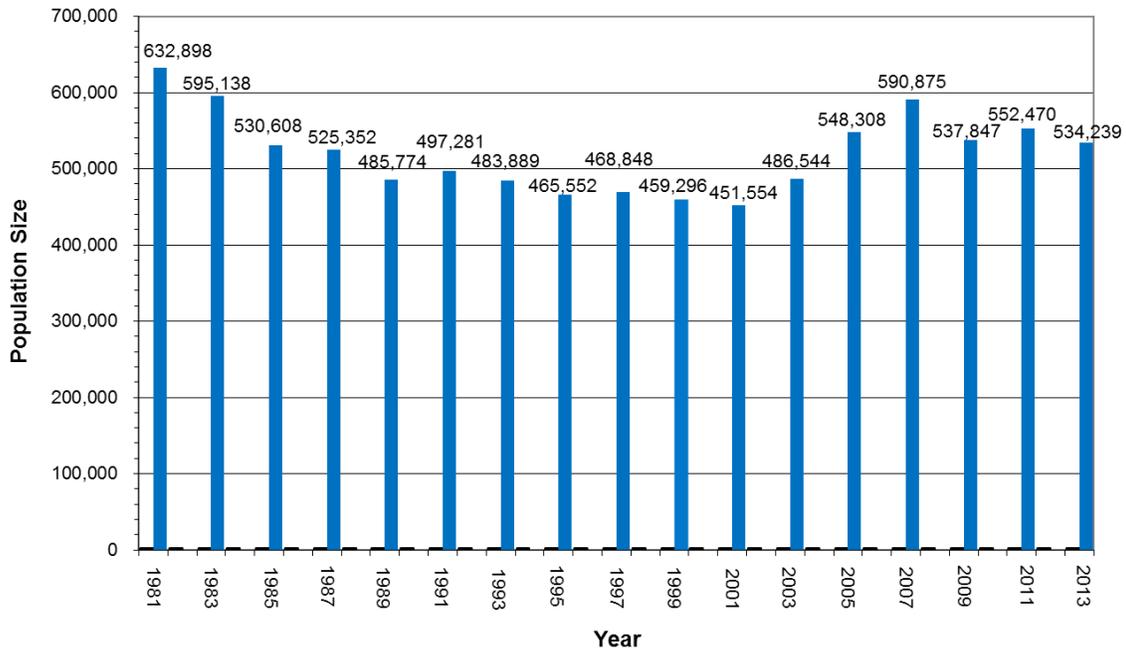


FIGURE 4. COUNTIES WITH KNOWN SUMMER AND WINTER RECORDS OF THE INDIANA BAT.

### Indiana Bat Rangewide Population Estimates from 1981 - 2013



Andy King, U.S. Fish and Wildlife Service, Bloomington, Indiana. Revised 8-26-2013

FIGURE 5. RANGEWIDE INDIANA BAT POPULATION ESTIMATES 1981-2013.

### 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 2). 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  $\geq$  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 2. 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 (0)	8% (2)	0 (0)	0 (0)	33% (8)
Priority 2 (N=54)	41% (22)	4% (2)	6% (3)	4% (2)	6% (3)	0 (0)	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 3), 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 3. 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 (0)	8% (1)	0 (0)	17% (2)	0 (0)	0 (0)	58% (7)
Priority 2 (N=27)	15% (4)	0 (0)	0 (0)	4% (1)	11% (3)	0 (0)	0 (0)	70% (19)
Priority 3 (N=74)	26% (19)	0 (0)	0 (0)	0 (0)	3% (2)	0 (0)	0 (0)	72% (53)
Priority 1, 2, 3 combined (N=113)	22% (25)	0 (0)	1% (1)	1% (1)	6% (7)	0 (0)	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].



- Williams Preserve Mine 98.5% decline from 13,014 in 2007 to 190 in 2010
- Williams Lake Mine 97.4% decline from 1,003 in 2007 to 26 in 2010
- Glen Park 73.6% decline from 1,928 in 2007 to 509 in 2010
- Williams Hotel Mine 66.5% decline from 24,317 in 2007 to 8,152 in 2010
- Jamesville 20.7% decline from 2,932 in 2007 to 2,324 in 2009
- Barton Hill Mine 13.7% increase from 9,393 in 2007 to 10,678 in 2010

The Northeast Recovery Unit, where WNS was first observed in the winter of 2006-2007, lost almost 70% of its Indiana bats between 2007 and 2013 (Table 1). 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 2013 the Appalachian Recovery Unit, where WNS was confirmed in the winter of 2008-2009, declined by 46%. The Midwest Recovery Unit, where WNS was confirmed in the winter of 2010-2011, declined by 2.5%. The Ozark-Central Recovery Unit, where WNS was confirmed in the winter of 2011-2012, had not yet experienced declines by 2013.

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).

Thogmartin et al. (2012a) suggested that all hibernating populations of Indiana bats are currently susceptible to WNS; throughout the range of the species there are infected source populations within the known migration distance for individual Indiana bats. They projected that all sizeable complexes of hibernating Indiana bat populations may be affected by WNS as early as 2016. Observed spread (see map at <http://www.whitenosesyndrome.org/about/where-is-it-now>) suggests that Thogmartin et al.'s (2012a) model is not overly pessimistic. 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 will 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 2013) 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 three additional known fatalities of Indiana bats at wind facilities throughout the range of the species (Pruitt and Okajima 2013). 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 2013). 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 Myotis 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 2,988 megawatts of operational wind generating capacity at the end of 2012 (AWEA 2013a). Given that the Midwest RU also has the most Indiana bats (56% of the rangewide population in 2013 – see Table 1) 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.

## **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 Indiana Bat in the Action Area**

Benton County is within the historic range of the Prairie Peninsula (Transeau 1935). Prior to 1860, prairies in the historic Peninsula were dominated by grass species such as big bluestem (*Andropogon gerardii*) and Indian grass (*Sorghastrum nutans*), and included diverse layers of forbs, flowering shrubs, and other grasses (Williams 1981). The area falls within the Grand Prairie Natural Region, and specifically the Grand Prairie Section, of Indiana (Homoya et al. 1985). Presettlement, a great variety of prairie natural communities likely existed. Other community types present included savanna, marsh, pond, bog and forest, the latter mostly along stream courses and in oak groves (Homoya et al. 1985). It is the most altered natural region in the state; only small remnants of the Grand Prairie remain. Farming and urban development, soil drainage, and introduction of non-native species have destroyed most of the historic prairie and other natural communities in this region. While there are no records of Indiana bats from Benton County (Whitaker and Mumford 2009, USFWS unpublished data), it is likely that Indiana bats were once found in forested areas and along forest interfaces with other communities in this area. It is possible that some Indiana bat use may still occur in the widely scattered forest remnants, although generally forest cover and connectivity in the county is considered too low to support Indiana bats.

Currently, the Action Area does not support wintering or summering habitat for the Indiana bat. There are no caves or mines suitable for use as hibernacula; the nearest known winter population is a Priority 2 hibernacula located approximately 169 km (105 mi) away in La Salle County, Illinois (USFWS 2007). The area does not have sufficient forest cover to be suitable as summer habitat. As discussed previously, landuse in the Action Area is almost entirely agricultural; less than 1 percent is forested. We do not know the minimum amount of forest required to support summering Indiana bats; however, composition of the landscape surrounding maternity colonies has been examined in a few areas, and all had at least 10 percent forest cover (USFWS 2007). In Illinois, 67 percent of the land near one colony was agricultural, 33 percent was forested, and 0.1 percent consisted of farm ponds (Gardner et al. 1991). In Michigan, landcover consisted of 55 percent agricultural land, 19 percent wetlands (including lowland hardwood forest), 17 percent other forests, 6 percent urban development, and 3 percent lakes/ponds/rivers (Kurta et al. 2002). Land within 4 km (2.5 mi) of primary roosts in Indiana contained an average of 37 percent deciduous forest cover, although forest cover varied from 10 to 80 percent (USFWS 2007). Duchamp (2006) found that probability of occurrence of Indiana bats in row-crop dominated areas of north-central Indiana was higher in those landscapes with greater amounts of forest cover. In agricultural areas with low forest cover, the connectivity of remaining forest patches is critical for Indiana bats; bats travel between patches of remaining forest along wooded travel

corridors (e.g., wooded fencerows, tree-lined stream banks). In the Action Area, neither the amount of forested habitat nor the connectivity of remaining patches is sufficient to provide habitat for summering Indiana 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, two Indiana bats have been killed at FRWF during fall migration. So, some Indiana bats clearly fly through the airspace at FRWF during fall migration, although we do not know how many. We do not have any documented occurrence of Indiana bats at FRWF during spring migration. Fatalities of bats (all species combined) at FRWF is much lower in spring than fall. During 2009, 17 dead bats were found at FRWF during spring (April 6 – May 31) (Johnson et al. 2010a, 2010b) and 135 were found during fall (August 1 – October 31) (Johnson et al. 2010a). During 2010, 36 dead bats were found at FRWF during spring (April 13 – May 15) and 773 were found during fall (July 30 - October 15) (Good et al. 2011). No dead Indiana bats were found in the spring, and there is only one documented fatality of a Myotis during spring – a little brown bat found May 5, 2009 (Johnson et al. 2010a). The estimated adjusted fatality rates were 0.02 bats/turbine/day in the spring and 0.39 bats/turbine/day in the fall; the bat fatality rate in fall is nearly 20 times higher than the bat fatality rate in the spring at the FRWF. (See additional discussion on adjusted fatality rates in the Analysis of the Effects of the Action: Operations and Maintenance of Phases I, II, III, and IV of FRWF section of this document). We conclude that Indiana bats may not be present at FRWF during spring migration due to lack of suitable forested habitat. (As discussed in the Migration in Indiana Bats section of this Biological Opinion, some studies have found that Indiana bats take routes associated with wooded cover during spring migration). Risk of collisions at FRWF is much lower for all bats in spring, and especially so for Myotis. If some Indiana bats do migrate through the area in spring, we have no evidence that they are vulnerable to collisions with turbines.

In conclusion, while there were probably native natural communities in the Action Area suitable for Indiana bats prior to settlement, currently the area supports no Indiana bat habitat. Based on information available we presume that the only Indiana 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 bat use of the airspace over the area.

## **Factors Affecting Indiana Bat Environment within the Action Area**

This analysis describes factors affecting the environment of the Indiana 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 bats in the Action Area are a subset of the threats affecting the species rangewide and in the Midwest Recovery Unit, as discussed above in the Population

Status and Threats section of this document. There is no Indiana bat habitat in the Action Area; therefore, impacts to habitat are not relevant to this discussion. However, Indiana bats utilize the airspace above FRWF during fall migration, making them susceptible to turbine strikes. Those bats are migrating from maternity colonies and returning to 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 FRWF, the main threats are disease (specifically WNS) and collisions with wind turbines.

### White-Nose Syndrome

As discussed in the Population Status and Threats section of this document, WNS is a devastating disease affecting many eastern U.S. bats including Indiana bats. The disease was first documented in the Midwest RU in 2011 and by the end of the 2013 hibernating season had spread to multiple hibernacula in all states in the RU with the exception of Michigan. In the adjoining Ozark-Central RU, WNS was also confirmed in 2011 and is now confirmed or suspected in all states in the RU, although in fewer sites compared to the Midwest RU. The nearest known hibernaculum to the Action Area is located in the Ozark-Central RU. It is a Priority 2 hibernacula located approximately 169 km (105 mi) away in La Salle County, Illinois (USFWS 2007); WNS was confirmed at this site in 2012. (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 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 2013 rangewide population estimates, the Northeast Recovery Unit has lost approximately 70% of its Indiana bats since the onset of WNS (Table 1). The Appalachian RU, first affected in 2008, had declined 46% and the Midwest RU, affected in 2010, had declined 2.5%. The Ozark-Central RU, where WNS was confirmed in 2011, had not yet experienced population declines by 2013. As previously discussed, we expect declines to continue in the coming years as WNS has now been documented in all RUs. So in assessing the effects of incidental take at FRWF, we will have to make assumptions regarding the impacts of WNS on Indiana bats that pass through the Action Area. Specifically, we will have to assess (in the Effects of the Action section) how WNS in concert with the incidental take of bats at FRWF is affecting the maternity and hibernating colonies of bats to which Indiana bats that migrate through FRWF belong.

### Collisions with Wind Turbines

As discussed in the Population Status and Threats section of this document, mortality of bats generally, and Indiana bats specifically, are an unintended byproduct of wind energy development. Wind energy is rapidly expanding. The U.S. wind industry installed 8,380 megawatts (MW) during the fourth quarter of 2012 bringing the total U.S. wind power capacity installations to 60,007 MW and 2012 installations to 13,124 MW (AWEA 2013b). There are now more than 45,100 wind turbines installed across the U.S. To what extent other wind installations are affecting the same bats that pass through FRWF during fall 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 FRWF bats are at potential risk from

a wind facility somewhere along their migratory route. Put another way, FRWF is likely not the only facility causing impacts to those maternity colonies – other members of the same maternity colonies are likely dying at other wind facilities. The same is true of hibernating colonies; bats that migrate through FRWF likely hibernate with bats that are at risk from collision at other wind facilities.

This take of Indiana bats that is already occurring at existing wind facilities is reflected in the baseline population estimates generated biennially during winter surveys of hibernacula. Population growth rates (lambda values) calculated for the Midwest RU from these biennial hibernacula survey data should capture this existing take. These lambda values will be used later in this Biological Opinion to analyze the effect of FRWF take on the Indiana bat at multiple population scales.

Take of Indiana bats that occurs in the future at facilities yet to be built may be addressed under future HCPs (just as the FRWF 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. This planning effort covers much of the Midwest and Ozark-Central RUs. Take of Indiana 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 bats (e.g., by not operating turbines at times when bats are at risk or reducing operation of turbines such that Indiana 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 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 bat 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 bat and/or critical habitat. For the proposed Project, effects will be analyzed for Indiana bats that migrate through the Action Area. There is no Indiana bat habitat in the Action Area; we assume that the only Indiana bat use of the area is bats flying through the airspace above FRWF during migration. Effects of proposed mitigation, which has been incorporated into the Applicant's project, will also be assessed. 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.

## **Analysis of the Effects of the Action**

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) Construction of Phase IV of FRWF – not expected to adversely affect Indiana bats.
- 2) Operations and Maintenance of Phases I, II, III, and IV of FRWF – mortality of fall migrating Indiana bats is expected.
- 3) Decommissioning of FRWF – not expected to adversely affect Indiana bats.
- 4) Mitigation activities proposed by the Applicant – beneficial effects to Indiana bats are expected.

Each of these components and effects are discussed below.

### Construction of Phase IV of FRWF

Adverse effects to Indiana bats are not expected to result from the construction of Phase IV of FRWF because the site does not support Indiana bat habitat. As discussed previously, there is no evidence that Indiana bats occupy habitat at FRWF at any time during the year. The only apparent use of the area is to pass through the air space above FRWF during migration.

Therefore, activities (e.g., increased vehicular traffic), destruction/manipulation of vegetation, and disturbance at ground level that will occur during construction are not expected to affect Indiana bats. Noise and light from construction activities may extend into the air space that is used by bats during migration (i.e. a bat migrating above the area may perceive the noise and light) but these are not expected to be of a magnitude that would adversely impact bats. Further, we expect that minimal construction will take place at night (when bats are moving through). We do not expect that any activities during construction will adversely affect Indiana bats.

### Operations and Maintenance of Phases I, II, III, and IV of FRWF

It is expected that Indiana bats will die at FRWF as the result of collision with wind turbines during fall migration. (Bats may also die from barotrauma, but see the subsection Collisions with Man-made Objects in the Population Status and Threats section of this document; collision with turbine blades, not barotrauma, is likely the major cause of bat fatality at wind facilities). Much is known regarding bat fatality at FRWF, as this has been an operational wind facility since 2009 and post-construction fatality monitoring has been conducted since that time. See the Previous Studies of Bat Fatalities at the Fowler Ridge Wind Farm (2009-2011) subsection of Chapter 4.0 IMPACT ASSESSMENT of the HCP for a detailed discussion of the results of post-construction searches conducted at FRWF. Based on these data, it was established that Indiana bats are vulnerable to strikes with turbines at FRWF during fall migration (Table 4).

TABLE 4. SPECIES COMPOSITION OF BATS FOUND DURING FALL (AUGUST 1 TO OCTOBER 15) MORTALITY MONITORING STUDIES AT THE FOWLER RIDGE WIND FARM.

Species	Scientific Name	Phase I	Phase I, II, III		Total	Percent Comp.
		Fall 2009	Fall 2010	Fall 2011		
eastern red bat	<i>Lasiurus borealis</i>	49	419	248	716	57.46
hoary bat	<i>Lasiurus cinereus</i>	47	112	120	279	22.39
silver-haired bat	<i>Lasionycteris noctivagans</i>	28	91	75	194	15.57
big brown bat	<i>Eptesicus fuscus</i>	3	24	12	39	3.13
little brown bat	<i>Myotis lucifugus</i>	2	2	1	5	0.40
tricolored bat	<i>Perimyotis subflavus</i>	0	2	3	5	0.40
Seminole bat	<i>Lasiurus seminolus</i>	0	0	3	3	0.24
Indiana bat	<i>Myotis sodalis</i>	1	1	0	2	0.16
evening bat	<i>Nycticeius humeralis</i>	0	0	1	1	0.08
northern long-eared bat	<i>Myotis septentrionalis</i>	1	0	0	1	0.08
unidentified <i>Lasiurus</i>		1	0	0	1	0.08
<b>Total</b>		<b>132</b>	<b>651</b>	<b>463</b>	<b>1,246</b>	<b>100</b>

In addition to fall monitoring, fatality monitoring was conducted during the spring in 2009 and 2010 (Johnson et al. 2010a, 2010b; Good et al. 2011). Adjusting the seasonal fatality rates for the differing number of search days in each season (33 days in spring and 76 days in fall) resulted in a daily estimated fatality rate of 0.02 bats/turbine/day in the spring and 0.39 bats/turbine/day in the fall. Based on these data, the bat fatality rate in fall is nearly 20 times higher than the bat fatality rate in the spring at the FRWF. No Indiana bats were detected during spring searches. Only one Myotid, a little brown bat found on May 5, 2009, was found during spring searches. These data suggest minimal risk to Indiana bats at FRWF during spring migration. Further, limited data available from spring radio-tracking studies suggest that, during spring migration, Indiana bats follow topographic features and fly near the ground (USFWS 2011). Because there are no topographic features (e.g., forested stream corridors) and no suitable habitat for Indiana bats to follow in the vicinity of FRWF, it was considered unlikely that migrating Indiana bats would use this area during spring migration. Based on the monitoring data and available information, the Applicant determined minimal risk to Indiana bats at FRWF during spring migration and chose not to request a permit for incidental take of Indiana bats during spring as part of their application.

To calculate take that is expected to occur at FRWF during fall migration, data from fatality studies conducted at FRWF were used to estimate take of Indiana bats that is likely occurring on an annual basis at FRWF in the absence of minimization measures that will be implemented as part of this HCP, as detailed in the Estimated Indiana Bat Mortality without Minimization Measures subsection of Chapter 4 of the HCP. Then, the operational adjustments that will be implemented as part of this HCP, specifically feathering turbines blades below a cut-in speed of 5.0 m/s at night during the fall migration season, were considered. Based on the results of curtailment effectiveness studies conducted at FRWF as well as studies from other wind

facilities, the Applicant conservatively estimated that these operational adjustments would reduce all bat mortality, including Indiana bat mortality, by at least 50%. Reference the Estimated Indiana Bat Mortality with Minimization Measures subsection of Chapter 4 of the HCP for details. Based on the number of years each phase of the Project is expected to be operational, the total estimated Indiana bat take over the 21-year ITP term is 184 Indiana bats, as detailed in Table 5.

TABLE 5. OPERATIONAL PHASES, NUMBER OF TURBINES, AND ESTIMATED INDIANA BAT MORTALITY WITH MINIMIZATION OVER THE 21-YEAR OPERATIONAL LIFE OF THE FOWLER RIDGE WIND FARM.

<b>Permit Year</b>	<b>Operational Phase</b>	<b>Calendar Year</b>	<b>Number of Turbines</b>	<b>Annual Mortality</b>
1	Phase I, II, III	2014	355	9
2	Phase I, II, III, IV	2015	449	11
3	Phase I, II, III, IV	2016	449	11
4	Phase I, II, III, IV	2017	449	11
5	Phase I, II, III, IV	2018	449	11
6	Phase I, II, III, IV	2019	449	11
7	Phase I, II, III, IV	2020	449	11
8	Phase I, II, III, IV	2021	449	11
9	Phase I, II, III, IV	2022	449	11
10	Phase I, II, III, IV	2023	449	11
11	Phase I, II, III, IV	2024	449	11
12	Phase I, II, III, IV	2025	449	11
13	Phase I, II, III, IV	2026	449	11
14	Phase I, II, III, IV	2027	449	11
15	Phase I, II, III, IV	2028	449	11
16	Phase I, II, III, IV	2029	449	11
17	Phase IV	2030	94	2
18	Phase IV	2031	94	2
19	Phase IV	2032	94	2
20	Phase IV	2033	94	2
21	Phase IV	2034	94	2
<b>21-Year Take Limit</b>				<b>184</b>

Actual Indiana bat mortality is likely to be lower than these estimates. The estimates were based on the minimum reductions in mortality that were observed in studies using similar operational adjustments (see HCP Table 4.5 Results from publicly available curtailment effectiveness studies and associated discussion for details). New data, available since the HCP was submitted to the Service, further reinforces that the actual reduction in bat fatalities at FRWF will exceed 50%.

Research was conducted at FRWF in 2012 to determine if the operational mitigation proposed in this HCP, feathering turbines below a cut-in speed of 5.0 m/s at night from August 1 to October 15, would reduce bat fatality by at least 50% compared to fatality at fully operational turbines. All but nine of the facility's 355 turbines were feathered below 5.0 m/s for the 2012 study. (The nine turbines not included in the operational monitoring strategy were part of a separate research project conducted by the U.S. Geological Survey and Bat Conservation International). Estimates of bat fatalities at feathered turbines were 84% lower than fatality estimates at fully operational turbines (estimated based on fatality at fully operational turbines in 2010). See Good et al. (2013) for a complete report on the 2012 feathering study. The feathering study was repeated in 2013 and estimated reduction in fatality was 69-77% (Good et al. 2014). (Estimates in 2013 were confounded by an operational shut down during part of the study period; see Good et al. 2014 for details). The 84% reduction was similar to that observed at a separate study conducted at the Casselman Wind Project in Pennsylvania (Arnett et al. 2011). Based on these results, the Service is confident that the actual Indiana bat fatality will likely be lower than the estimate calculated by the Applicant (184 Indiana bats over 21 years as detailed in Table 5). However, our analyses, as detailed in the Indiana Bat Response to the Proposed Action section below, will use the estimates provided by the Applicant (Table 5) to be protective of Indiana bats (i.e., impacts to Indiana bats are likely to be less than evaluated in this Biological Opinion).

The Service also recognizes that there is potential for sublethal or delayed-lethal effects to Indiana bats from interactions with turbines at FRWF. Particularly, potential impairment of hearing from damage to the ear (as detailed in Collisions with Man-made Objects in the Population Status and Threats section) 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 FRWF on Indiana bats include ground-level effects of lighting at the facility, vehicle traffic and other sounds, and vegetation management (e.g. mowing). Because Indiana bats are expected only to be active in the air space above FRWF, these activities are not expected to adversely affect Indiana bats 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 FRWF

As discussed above in the Construction of Phase IV of FRWF section of this document, adverse effects are not expected because the site does not support Indiana bat habitat. While Indiana 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 FRWF, 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 installation of a new bat gate at a Priority 1 hibernaculum and subsequent monitoring of bat activity, as well as protection, restoration, and monitoring of summer maternity habitat for Indiana bats. As described above (and in detail in Chapter 4 of the HCP), the estimated level of Indiana bat mortality with minimization measures in place is expected to be less than or equal to 184 Indiana bats over the 21-year ITP term. To mitigate for the impacts of this take, 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 336 bats by Year 21 of the permit term; reference the HCP for details (Section 5.3 Measures to Mitigate the Impact of the Taking).

## **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. The components of this analysis are identified as sequential steps in Figure 6.

The framework, in brief, entails: 1) evaluating individual Indiana bat exposure to action-related stressors and response to that exposure; 2) integrating those individual effects (exposure risk and subsequent response) to discern the consequences to the populations to which those individuals belong; and 3) determining the consequences of any population-level effects to the species rangewide. If, at any point, we demonstrate that the effects are unlikely, we conclude that action is not likely to jeopardize the continued existence of the species and our analysis is completed. Each step in the analysis is described in more detail below.

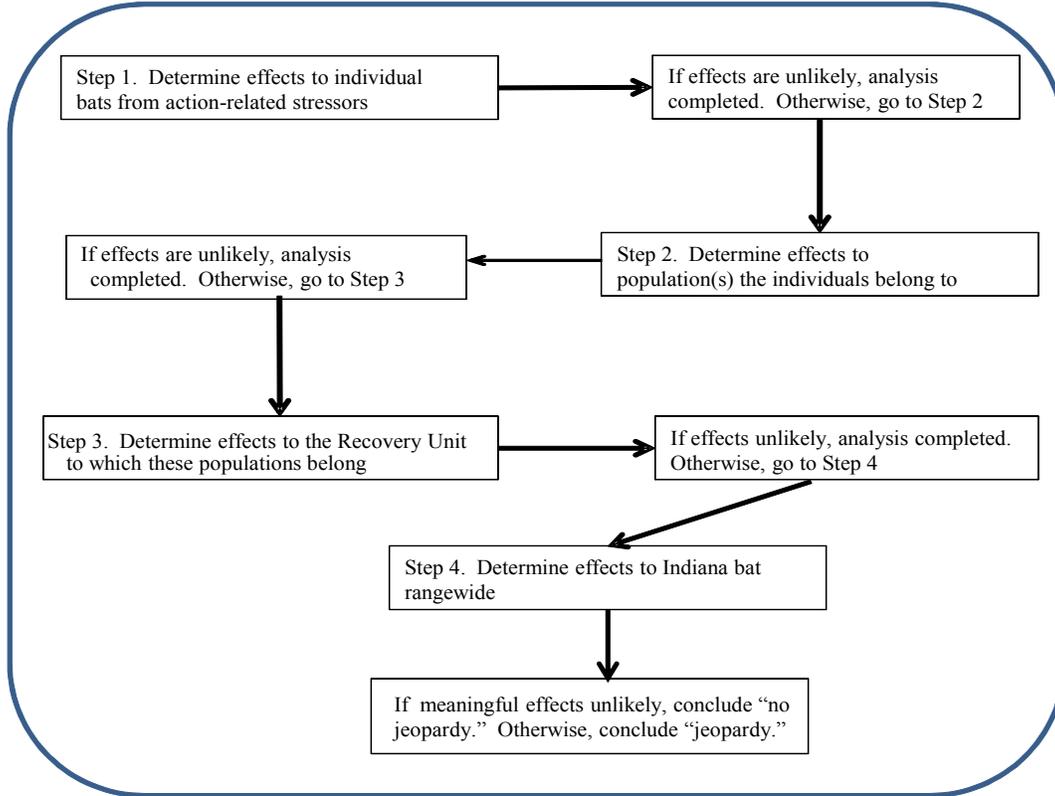


FIGURE 6. FRAMEWORK FOR EVALUATING THE RESPONSE OF INDIANA BATS TO THE PROPOSED ACTION.

### Step 1- Effects to individuals

In this step, we evaluate the likelihood that the proposed action will not 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. If at the conclusion of Step 1 we are unable to conclude that Indiana bats are unlikely to experience reductions in individual fitness, we will complete Step 2.

In the case of FRWF, we have established that the proposed action will result in death of Indiana bats. Therefore, we will proceed to Step 2.

### Step 2- Effects to population(s)

In step 2, we evaluate whether the aggregated effect of the proposed action on individual Indiana bats is unlikely to adversely affect the fitness of the population to which these individuals belong. If at the conclusion of this analysis we are unable to show that population-level impacts

are unlikely, we will complete Step 3.

In the case of FRWF, we evaluated how the take of individual Indiana bats will be manifested in the maternity colonies and hibernating colonies to which those individuals belong. This step in the analysis is described below in the Effects to Indiana Bat Populations from Taking at FRWF section of this Biological Opinion. We first defined our affected populations – the maternity colonies and hibernating colonies that will be affected by the proposed action. We then modeled these populations over the next 50 years under two scenarios – the “Baseline” scenario with no take from the project and the “Expected Take” scenario that included project take. We calculated three metrics for both the “Baseline” and “Expected Take” scenarios: probability of extinction in 50 years, median time to extinction, and median ending lambda (population growth rate) after 50 years. We then evaluated the difference in the metrics between the two scenarios; we defined an appreciable difference as a greater than 5% change in any of the metrics between the two scenarios. If any of the metrics approached this 5% change threshold, we would further evaluate the impacts. The demographic model that we used for our analysis (Thogmartin et al. 2013) incorporates both demographic and environmental stochasticity. As a result, there is variation in the results of model runs, even with identical inputs to the model. This is particularly a concern when modeling a relatively small population, such as a maternity colony. The 5% threshold was chosen because it balanced our concern for being protective of the Indiana bat with the need to have confidence that differences in the metrics were the result of the “Expected Take” and not simply the result of model stochasticity. For the project being evaluated in this Biological Opinion (details of the analysis follow in the Effects to Indiana Bat Populations from Taking at FRWF section) we determined that there was no appreciable difference and concluded that impacts to the fitness of maternity colonies and/or hibernating colonies are unlikely. Therefore, we did not conduct analysis in Step 3, as further explained below.

### Step 3- Effects to the Recovery Unit

In this step, we evaluate whether the anticipated reductions in population fitness are unlikely to cause appreciable reductions in the likelihood of survival and recovery of Indiana bats within the Recovery Unit where the populations occur. In this step, we evaluate whether the anticipated reductions in population fitness are unlikely to cause appreciable reductions in the likelihood of survival and recovery of Indiana bat at the RU level. This analysis entails evaluating how the population-level consequences will affect reproduction, numbers, or distribution of Indiana bats in the RU. If we are unable to show that such reductions are unlikely, then the likelihood of both survival and recovery of Indiana bats in the RU will be appreciably reduced, and we need to complete a fourth and final analysis.

In the case of FRWF, 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 (because of the results of Step 2). Therefore, we did not need to conduct Step 4, as further explained below.

### 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 unlikely 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.

In the case of FRWF, we concluded that the construction and operation of FRWF, as proposed, is not likely to jeopardize the continued existence of the Indiana bat. This result is further described in the Conclusion section of this Biological Opinion.

### Effects to Indiana Bat Populations from Taking at FRWF

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 used this model to analyze the effects to Indiana bat populations from the taking that is expected to occur at FRWF. We assessed the impact of the anticipated take of Indiana bats both on maternity colonies (where bats migrating through FRWF originated) and on hibernating populations (to which bats migrating through FRWF were destined). This represents Step 2 that is described in the Framework for Analysis section (above). 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

As previously discussed, the estimated level of Indiana bat mortality at FRWF is expected to be less than or equal to 184 Indiana bats over the 21-year term of the ITP. To model the impacts to the populations, we had to estimate the sex ratio of the bats taken, because the demographic model used (Thogmartin et al. 2013) models female bats. 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 FRWF 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 FRWF will be female (50% adult females and 25% female pups, with the remaining 25% composed of male

pups). Take of female pups is modeled as adult female take because of practical limitations of the demographic model (take input into the model is limited to adult females). Treating female pups as adults will also tend to overestimate the impacts of the taking, as survival and reproductive output of a female pup is lower compared to an adult female. Total adult female take at FRWF over the 21-year term of the ITP is expected to be less than or equal to 138 Indiana bats.

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 FRWF to maternity colonies and hibernating colonies, so that we could assess impacts of the taking on those populations.

To do so, we used a model that simulated Indiana bat migration pathways through FRWF (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. 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 total female RU population (based on known population of all hibernacula combined) was distributed among the simulated maternity colonies. The number of bats “contributed” by each hibernaculum to each 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. Migrations were defined by broad pathways between maternity colonies and the hibernacula that contributed to those colonies. The lengths of the pathways were constrained by the maximum known migration distance for Indiana bats (i.e., none of the pathways were longer than the greatest known migration distance for Indiana bats). Alternative straight-line paths of varying widths were simulated. In reality, it is unlikely that Indiana bats actually follow a straight line, although they may fly more or less direct routes (see discussion in the Migration in Indiana Bats section of this Biological Opinion). Results from a path width of 30 km were chosen to incorporate into this analysis (i.e., our simulation allowed for deviation from a straight-line migration pathway within a 30 km band). An “encounter” was defined as any overlap of a migration path and the Action Area.

For purposes of modeling we assumed that there were 1,938 maternity colonies within the Midwest RU (total female population of the RU divided by 80, which is the average number of females per maternity colony). Results from 250 iterations of the simulation model indicated that on average, there were 31,500 migration paths connecting simulated maternity colonies with known hibernacula, and 219 (0.7%) of these paths encountered the Action Area, assuming a 30 km wide path. Some of these paths were connected to the same maternity colony, so that an average of 29 maternity colonies (1.5% of all colonies) had encounters with the project (i.e., were connected to paths that encountered the project). Similarly, an average of 48 hibernacula of 137 total hibernacula (35%) 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. First, we had to estimate the magnitude of those impacts (i.e., mortality rates from WNS). Second, we had to predict when mortality from WNS will impact the Midwest RU. We will briefly discuss those two steps below.

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 in the Impacts of WNS on Indiana Bats section of this Biological Opinion, we predict that all RUs will 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.<sup>1</sup>

To predict when mortality from WNS will impact the Indiana bat population in the Midwest RU, we assumed that this RU will follow a similar pattern in WNS-related population declines as the Appalachian RU. The Appalachian RU experienced significant population declines five years after the fungus that causes WNS was documented in that RU. We use the Appalachian RU rather than the Northeast RU to predict when declines will begin because we do not know when the fungus first arrived in the Northeast RU. Our first knowledge of a problem in the Northeast was that large numbers of bats were dying; we do not know how long the fungus that causes the disease had been present. In contrast, as WNS spreads we now have the ability to detect the presence of the fungus before large-scale mortality is observed. Also, we start to see behavioral changes in bats prior to mass mortality. These “signs” were observed (fungus detected, behavioral changes in bats, and small numbers of dead bats) in the Midwest RU during the

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<sup>1</sup> 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.

winter of 2010-2011. For purposes of modeling the impacts of WNS we assume that significant mortality from the disease will begin five years from that time, as it did in the Appalachian RU. Therefore, in our analysis we modeled the population trajectory with WNS mortality rates applied to the population beginning in the winter of 2014-2015.

### Scenario Development

Based on 250 iterations of the WEST (2013) model, migration pathways of individual Indiana bats from 29 maternity colonies, on average, will “encounter” the Action Area. We assumed that individuals from all 29 colonies will be similarly exposed to the wind turbines. For this reason, take of adult females per year was equally divided among all 29 colonies (Table 6). Given that total female take is expected to be less than or equal to 138 Indiana bats we presume that, on average, each colony will lose 4.75 bats over the 21-year term of the ITP. Expressed in realistic terms (i.e., because death of a fractional bat is not possible), we expect that each of the 29 colonies will lose one female bat every four or five years during the operation of FRWF.

Take varies throughout the project because the number of turbines operational at FRWF will vary over the term of the permit (see Table 5). 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.

TABLE 6. EXPECTED INDIANA BAT TAKE AT FRWF. NUMBER OF MIGRATORY ADULT FEMALES TAKEN ANNUALLY FROM MATERNITY COLONIES IN THE MIDWEST RU, BY PROJECT YEARS.

Project Years	Total Take per Year	Total Female Take per Year (75% of Total Take)	Female Take per Year per Maternity Colony (averaged over 29 colonies)
1	9	6.75	0.23
2-16	11	8.25	0.28
17-21	2	1.5	0.05

Relative to hibernating colonies impacted by the proposed project, the WEST (2013) model result was that 48 hibernacula have bats with migratory pathways that pass through the Action Area and that portions of their populations would be exposed to the project. These four hibernacula in Indiana accounted for 75% of predicted bat encounters with the Action Area: Coon Cave (11.9%), Ray’s Cave (22.1%), Wyandotte Cave (20.4%), Jug Hole Cave (21.0%).

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 7) based on proportions derived from the WEST (2013) model, as described above. Expressed as whole bats, of the 138 female bats that may be taken over the 21-year term of the ITP, we model that 22 (16%) will be from Coon Cave, 37 (27%) will be from Wyandotte Cave, 39 (28%) will be from Jug Hole Cave, and 40 (29%) will be from Ray’s 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 2013 Indiana bat population numbers specific to each hibernaculum.

TABLE 7. EXPECTED FEMALE TAKE FROM FRWF DISTRIBUTED AMONG FOUR HIBERNACULA, BY PROJECT YEAR.

Hibernacula	Total Female Take over 21 years	Proportion of Total Female Take	Female Take: Project Year 1	Female Take: Project Years 2-16	Female Take: Project Years 17-21
Coon Cave	22	16%	1.08	1.32	0.24
Wyandotte Cave	37	27%	1.82	2.22	0.40
Jug Hole Cave	39	28%	1.89	2.31	0.42
Ray’s Cave	40	29%	1.96	2.39	0.44
TOTAL	138	100%	6.75	8.24	1.50

### Model Runs and Results

We modeled four scenarios as follows (and described in Table 8):

**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 80 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 FRWF 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 29 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 (Coon, Wyandotte, Jug Hole and Ray’s caves); each population was modeled 50 years into the future. Complex-level lambda values and 2013 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 8. AMOUNT AND DISTRIBUTION OF FEMALE TAKE OF INDIANA BATS FOR BASELINE AND EXPECTED TAKE SCENARIOS MODELED FOR FRWF.

	<b>Description of population</b>	<b>Scenario</b>	<b>Take quantity and distribution</b>	<b>Scenario Number</b>
<b>Maternity colonies</b>	Pathways of individual Indiana bats from 29 maternity colonies (each with an average of 80 adult females) will “encounter” the Action Area (WEST 2013).	Baseline	No take	1A
		Expected Take	Take per year of females: 6.75 Year 1; 8.25 Years 2-16; 1.5 Years 17-21. Female take distributed equally among 29 maternity colonies.	1B
<b>Winter population</b>	Assume taken bats are hibernating in 4 large hibernacula in the Midwest RU. Used Coon, Wyandotte, Jug Hole and Ray's cave complex lambda values in model.	Baseline	No take	2A
		Expected Take	Take per year of females: 6.75 Year 1; 8.25 Years 2-16; 1.5 Years 17-21. 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 9). 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 5% or more 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). See the [Framework for Analysis](#) section of this Biological Opinion for discussion of the 5% threshold.

TABLE 9. EXPLANATION FOR THE METRICS USED TO COMPARE BASELINE AND EXPECTED TAKE SCENARIOS.

<b>Metric</b>	<b>Explanation</b>
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

Scenarios 1A and 1B: The Thogmartin et al. (2013) model predicted that the maternity colony that we modeled had a median time to extinction of 19 years (with a median ending lambda at 50 years of zero), regardless of whether or not individuals from that colony encountered the Expected Take from the project. That is, WNS drove most of the simulated populations to extinction, and the median time to extinction and ending lambda were not different for the Baseline scenario (1A) and the Expected Take scenario (1B). Further, the probability of extinction for the Expected Take scenario was less than 1% different compared to the Baseline scenario (probability of extinction was .92% higher for the Expected Take scenario). Therefore, based on these metrics we concluded that take from the project will not cause an appreciable difference in the fitness of the maternity colony (Table 10).

Scenarios 2A and 2B: 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 any of the four hibernacula. For every modeled hibernaculum, regardless of take, there was no probability of population extinction within 50 years (i.e., none of the 10,000 simulations ended in extinction). Take also had a negligible impact on the ending lambda of the hibernating colonies. Median ending lambdas for the Expected Take scenarios were very similar to the Baseline scenarios for all hibernacula (less than 1% change in median ending lambda). Therefore, based on these metrics we concluded that the project will not cause appreciable reductions in the fitness of the hibernating colonies to which the taken individuals belong (Table 10).

Because we concluded that impacts to the fitness of maternity colonies and/or hibernating colonies are unlikely, we did not need to conduct further analysis in Step 3 as described in the Framework for Analysis section (above).

TABLE 10. MODEL RESULTS FOR BASELINE AND EXPECTED TAKE SCENARIOS, AND DIFFERENCE OF OUTCOMES.

			Extinction Probability in 50 Years	Median Time to Extinction	Median Ending Lambda at 50 Years	Appreciable Difference?	
Migratory Maternity Colony	Baseline	1A	80.4%	19	0	no	
	Expected Take	1B	81.1%	19	0		
Winter Population	Coon Cave	Baseline	2A	0%	NA	0.9536	no
		Expected Take	2B	0%	NA	0.9539	
	Ray's Cave	Baseline	2A	0%	NA	0.9537	no
		Expected Take	2B	0%	NA	0.9537	
	Wyandotte Cave	Baseline	2A	0%	NA	0.9542	no
		Expected Take	2B	0%	NA	0.9536	
	Jug Hole Cave	Baseline	2A	0%	NA	0.9540	no
		Expected Take	2B	0%	NA	0.9534	

#### Conservative Assumptions incorporated into Modeling

We made a number of 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. Operational mitigation will likely reduce mortality by more than 50% -  
A previously discussed in the Analysis of the Effects of the Action section of this Biological Opinion, the level of take as described in the HCP and modeled in this analysis is based on a projected 50% reduction in take levels due to the implementation of minimization measures, as compared to operation of the facility with no minimization measures. However, recent on-site survey data has demonstrated even greater reductions in take (69-84% take reduction; see Good et al. 2013, 2014). These results suggest that the actual Indiana bat fatality will likely be lower than the level modeled in this analysis.
3. Assuming that all adult bats killed at FRWF are female and treating female pups killed as adult females in the model (as discussed in the Defining Populations to Model section above).

### Effects to Populations and Recovery Unit from FRWF Mitigation

As discussed above, the estimated take of Indiana bats with minimization measures in place is expected to be less than or equal to 184 Indiana bats over the 21-year Incidental Take Permit term. The total impact of the taking (accounting for bats taken plus lost reproductive capacity) is estimated at 336 Indiana bats (see HCP Section 4.2 Impacts of the Taking for details). To mitigate for the impacts of this incidental take, the Applicant will provide mitigation that is expected to result in an increase to the population of Indiana bats in the Midwest Recovery Unit by at least 336 bats by Year 21 of the permit term. Mitigation will not necessarily benefit the same maternity colonies or hibernating populations that are affected by FRWF, but it will benefit the population within the Recovery Unit. It will be increasingly important to enhance survival and reproductive potential of remaining Indiana bats as the population within the Recovery Unit declines due to WNS, as discussed below.

The Applicant will protect wintering bats vulnerable to human disturbance by installing a bat gate near the entrance of Wyandotte Cave, a Priority 1 hibernaculum in Crawford County, Indiana. This mitigation is expected to compensate for the taking of 222 Indiana bats by reducing the vulnerability of bats to human disturbance at that site (for details, see HCP Section 5.3.2 Measures for Mitigation of Winter Habitat). Decreasing human disturbance may be increasingly important to Indiana bat survival at sites affected by WNS; bats already stressed by disease may be increasingly vulnerable to any additional stressors during hibernation, including human disturbance.

Maternity habitat mitigation is expected to compensate for the taking of 114 Indiana bats by increasing the carrying capacity of maternity colony habitat in areas considered habitat limited (i.e., low forest cover). See details in HCP Section 5.3.1 Measures for Mitigation of Summer Habitat. Summer habitat mitigation is not scheduled to proceed until Year 10 of the ITP (see HCP Table 6.1 for the mitigation schedule). By Year 10 of the ITP, we expect that the Indiana bat population in the Midwest RU will have declined due to WNS. We further expect that there will be fewer maternity colonies on the landscape than there are currently (i.e., we expect that some maternity colonies will collapse because there are not enough female bats remaining in

those colonies to maintain colony viability). 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 that point in time). Further, the colony must persist in the mitigation area through the life of the ITP, or adaptive management will trigger implementation of a Service-approved alternate mitigation project (see HCP Section 5.4.5.1 Adaptive Management for Summer Habitat Mitigation for details). 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.

## **CUMMULATIVE 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 bat use of the Action Area is that the airspace over FRWF is used by migrating bats during fall migration. Therefore, actions on the ground (e.g. tree clearing, road construction) will not affect Indiana bat habitat, because none is present. We also do not anticipate that Indiana bat habitat will develop in the action area in the foreseeable future. Land cover in the Action Area is over 93% cultivated crops, 2% hay/pasture, 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 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 Indiana bats that use the area.

Similarly, there is no designated critical habitat for the Indiana bat 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 bat, the environmental baseline for the Action Area, the effects of the proposed actions at Fowler Ridge Wind Farm (FRWF), and the cumulative effects, it is the Service's biological opinion that construction and operation of FRWF, as proposed, is not likely to jeopardize the continued existence of the Indiana bat.

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

- The Applicant constructed FRWF in an area that does not support Indiana bat habitat. The only apparent use of the area by Indiana bats is passing through the air space above FRWF during fall migration.
- Data from post-construction fatality monitoring from FRWF were integral in the development of the HCP and provided for improved predictability in levels of bat fatality that will be experienced at FRWF (compared to a facility where no such data are available).
- Based on research conducted at FRWF (in addition to research at other locations), we are confident that the seasonal turbine operational adjustments to be implemented under this HCP will meet or exceed the goal of 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 184 Indiana bats will die as the result of interactions with wind turbines at FRWF during the fall migration period over the 21-year life of the project. In step 2, we analyzed the impacts of the taking of 184 individuals on the maternity colonies and hibernating populations to which those individual 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.
- The mortality monitoring program that will be implemented as part of the HCP has been tested at FRWF and we are confident that it 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 Fowler Ridge Wind Farm HCP and its associated documents clearly identify expected impacts to Indiana 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 FRWF 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 184 Indiana bats will be taken over the 21-year operational life of the proposed project. It is expected that Indiana bats will die at FRWF 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 fall 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 destruction or adverse modification of Indiana bat critical habitat).

## **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 FRWF. 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, 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 Fowler Ridge Wind Farm). 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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