

BIOLOGICAL OPINION

Effects of the Shaffer Mountain Wind Farm
on the Indiana Bat (*Myotis sodalis*)

Somerset and Bedford Counties, Pennsylvania

Prepared by:
U.S. Fish and Wildlife Service
Pennsylvania Field Office

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EXECUTIVE SUMMARY

This biological opinion evaluates the direct, indirect, interrelated, and interdependent effects of the Corps' proposed issuance of a Section 404 permit for a wetland fill associated with road and transmission line construction for the Shaffer Mountain Wind Farm. An Indiana bat (*Myotis sodalis*) maternity colony and adult male Indiana bats are present in the action area, and the project is located near an Indiana bat hibernaculum. The loss of 145 acres of swarming and summer habitat is expected to occur during project construction. In addition, Indiana bats are likely to be killed due to turbine operation during the summer when they reside within the action area, and during the spring and fall migration period as they move to and from hibernacula. Take from turbine operation is expected to cause ongoing mortality of adult males and maternity colony members, but implementation of the Adaptive Management Plan is expected to reduce take to a level where the maternity colony and nearby hibernating population will persist. Consequently, the project is not expected to appreciably reduce the likelihood of survival and recovery of the Indiana bat.

INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) on the effects of the Shaffer Mountain Wind Farm on the federally-listed, endangered Indiana bat. On February 5, 2010, the U.S. Army Corps of Engineers' (Corps) requested formal consultation on the proposed issuance of a Section 404 permit for the subject project. This biological opinion is based on information in the February 2010 biological assessment provided by the Corps, the Shaffer Mountain Wind Farm Adaptive Management Plan (see Appendix A to this BO), as well as study reports, and emails and meetings among the Service, Corps, applicant, and applicant's consultants. This document is issued in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

CONSULTATION HISTORY

July 6, 2006 – Correspondence received, requesting Fish and Wildlife Service review of project.

August 16, 2006 – Service letter to applicant's consultant, advising them of the potential for the project to affect the federally-listed bald eagle and Indiana bat. An assessment of the project's effects on both species was requested.

December 13, 2006 – Correspondence received from applicant.

January 3, 2007 – Meeting between the Service, Gamesa Energy, and their consultants to discuss the scope of the project and concerns related to endangered species (Indiana bat, bald eagle) and migratory birds. A mist-net survey for bats was recommended, and the Service advised that no tree cutting occur until this survey had been completed.

February 1, 2007 – Meeting between the Service, Gamesa Energy, and their consultants. Gamesa expressed a desire to cut trees prior to conducting mist-net surveys for Indiana bats. The Service indicated they would respond back to Gamesa Energy within two weeks regarding this matter.

February 2, 2007 – Email from Gamesa Energy to Service indicating their desire to cut trees as

soon as possible.

February 20, 2007 – Email from the Service to Gamesa Energy, reiterating that tree cutting should not be done until such time as mist-net surveys are completed and the results are assessed.

March 13, 2007 – Telephone call from Service to Gamesa Energy to confirm Gamesa's receipt of the Service's February 20 email. Gamesa Energy indicated they did not receive the email. The Service faxed a copy of the email to them.

March 15, 2007 – Telephone call between the Service and Gamesa Energy. Gamesa Energy stated that the landowner had begun cutting trees at the landing area. This cutting occurred over a 2-day period. It has stopped and will not resume until after the mist-net surveys are completed.

May 30, 2007 – Telephone discussion between the Service, Gamesa Energy, and their consultants to discuss Indiana bat studies. Spring telemetry studies were completed and fall telemetry studies are planned. Gamesa Energy is seeking a clearance letter from the Service to receive their NPDES permit. The Service will defer comments until the studies are completed to avoid a piece-meal response to the applicant on the project's potential effects on Indiana bats.

May 31, 2007 – The Service received a map of proposed mist-net survey locations from the applicant's consultant.

June 4, 2007 – Email from Gamesa Energy questioning the need to submit fall telemetry studies to the Service in order to receive a project clearance letter.

June 5, 2007 – Email from Service to Gamesa Energy explaining the need for spring, summer and fall studies to assess risk to Indiana bats.

June 5 and 6, 2007 – Emails from the Service to the applicant's consultant (responding to their email of May 31), recommending the addition of one mist-net site to the proposed survey.

June 12, 2007 – Email from Gamesa Energy asking about a Service clearance letter for the project, pending submission of mist-net survey results.

June 14, 2007 – Telephone discussion between the Service and applicant's consultant to discuss the level of mist-net survey coverage necessary for the project. Consultant had not determined acreage of project area prior to submitting proposed mist-net survey plan.

June 14, 2007 – Email to Gamesa Energy indicating the Service can issue a comment letter on the spring telemetry and summer mist-net surveys, discussing the risk of the project to Indiana bats. Another letter would be issued following the Service's receipt of fall telemetry studies. The letter would also discuss the potential need for further section 7 consultation or an incidental take permit.

July 25, 2007 – Telephone discussion between the Service, Gamesa Energy, and their consultants regarding survey adequacy. Consultant under-calculated the number of mist-net sites necessary for the project, so they will be adding additional sites.

August 6, 2007 – Map of turbine locations, completed mist-net sites, and proposed mist-net sites received from applicant's consultant.

August 10, 2007 – Email from applicant's consultant, advising the Service that two juvenile Indiana bats were captured. Consultant plans to mist-net five additional sites to attempt to

further assess Indiana bats in project area.

August 14, 2007 – Telephone conversation between the Service and applicant's consultant, discussing the implications of finding Indiana bats in the project area. Capture results point to the presence of an Indiana bat maternity colony in the project area. Due to the risk of take, an HCP and section 10 permit were advised.

August 16, 2007 – Telephone conversation between the Service and Gamesa Energy to discuss the implications of finding Indiana bats in the project area.

October 24, 2007 – Meeting between the Service, Gamesa Energy, and their consultant to discuss spring telemetry and summer mist-net survey results, HCPs (including low-effect HCPs), the risk to Indiana bats, and the risk of proceeding with parts of the project without ESA coverage. The Service recommended that the project be moved to a different location due to the presence of Indiana bats.

October 26, 2007 – Spring telemetry and summer mist-net survey results received by the Service.

December 19, 2007 – Letter from the Service to Gamesa Energy, indicating this project does not meet the criteria for a categorical exclusion under NEPA, and therefore, a low-effect HCP would not be appropriate for the project.

February 11, 2008 – Meeting between the Service and Gamesa Energy to discuss an HCP for the project.

March 6, 2008 – Meeting between Gamesa Energy and representatives from the Service's Regional Office in Hadley, MA.

April 9, 2008 – Telephone conversation between the Corps and Service to discuss a potential federal nexus for the project.

June 5, 2008 – Meeting between the Service, Pennsylvania Game Commission, and Gamesa Energy and their consultants to discuss the Section 7 and Section 10 processes, and incidental take estimation for Indiana bats.

June 16, 2008 – Telephone conversation between the Service and Corps regarding action area and the federal nexus for this project. Reference materials were sent to the Corps regarding action area and the Section 7 consultation regulations.

June 22, 2008 – Email from the applicant's consultant regarding the capture of an Indiana bat in the project area.

June 24, 2008 – Telephone call from the applicant's consultant regarding the capture of a second Indiana bat in the project area.

June 27 and 30, 2008 – Email updates from the applicant's consultant on the status of Indiana bat tracking (radio-telemetry) in the project area.

August 21, 2008 – Email from the Service to the applicant's consultant, providing them with an example effects analysis.

October 6, 2008 – Telephone conversation between the Service and Corps, discussing the Corps' jurisdiction with respect to anticipated wetland encroachments.

February 17, 2009 – Meeting between the Service, Corps, and Gamesa Energy to discuss a federal nexus for the project via an anticipated Corps permit.

March 3, 2009 – Summer 2008 mist-net survey results were received by the Service, per the Service's request.

April 8, 2009 – Draft biological assessment received by the Service.

April 15, 2009 – Meeting between the Service, Corps, and Gamesa Energy and their consultants, to discuss the draft biological assessment. The project will undergo formal consultation.

April 21, 2009 – The Service received additional project information from the applicant's consultant.

May 19, 2009 – Service comments on the draft biological assessment were sent to Gamesa Energy and the Corps.

June 26, 2009 – Additional Service comments on the draft biological assessment were sent to Gamesa Energy and the Corps. Comments incorporated bat mortality data received from the Pennsylvania Game Commission.

August 18, 2009 – Additional Service comments on the draft biological assessment were sent to Gamesa Energy and the Corps.

September 8, 2009 – Email exchange between the Service and Gamesa Energy regarding the incorporation of conservation measures into the biological assessment, including habitat compensation.

February 5, 2010 – Service receives a request from the Corps to initiate formal consultation. A biological assessment is provided.

March 22, 2010 – Telephone conversation between the Service and Corps about the recent Notice of Intent to Sue related to tree cutting for the Shaffer Mountain project. The Corps indicated that the applicant would not be cutting any trees prior to receipt of the biological opinion, despite the timeline in the biological assessment indicating trees would be cut in early 2010.

May 19, 2010 – Letter from the Service to the Corps, requesting a 90-day extension of formal consultation.

June 16, 2010 – Letter from Gamesa Energy to the Service agreeing to an extension of the formal consultation period, indicating tree cutting would be done within the appropriate seasonal window, and indicating construction would not occur until section 7 consultation is complete.

June 22, 2010 – Letter from the Corps to the Service, granting request for an extension of the formal consultation, with expected delivery of a biological opinion by September 17, 2010.

November 19, 2010 – Service provided the effects analysis and adaptive management strategy from the draft biological opinion to the Corps for review.

December 7, 2010 – Corps provided the effects analysis and adaptive management strategy from the draft biological opinion to the applicant for review.

December 9, 2010 – Teleconference between the Corps and Service to discuss the draft

biological opinion.

January 13, 2011 – Meeting between the Service, Corps and applicant to discuss the draft biological opinion and adaptive management plan.

March 31, 2011 – USFWS contacted the Corps to recommend that the project description be modified to incorporate the Adaptive Management Plan, whose objective is to prevent maternity colony extirpation.

April 6, 2011 – Service received comments from the Corps (dated April 1, 2011) and applicant (dated January 27, 2011) on the draft biological opinion.

June 8, 2011 – Conference call between the Service, Corps, Gamesa Energy and their consultants to discuss modifying the project description to include the Adaptive Management Plan. All parties agreed to move forward with this approach.

June 15, 2011 – Letter from Shaffer Mountain Wind, LLC to the Corps requesting project modification to include the adaptive management plan.

August 11, 2011 – Letter from the Corps to the Service, confirming modification of the project description to include the Adaptive Management Plan.

September 27, 2011 – The Service provided the Corps with a final biological opinion.

BIOLOGICAL OPINION

This biological opinion is based on information provided in the following documents: 1) *Biological Assessment, Indiana Bat (Myotis sodalis), Shaffer Mountain Wind Farm, Somerset and Bedford Counties, Pennsylvania* (hereinafter referred to as the biological assessment or BA); 2) *Shaffer Mountain Wind Farm Adaptive Management Plan*; 3) *Summer Woodland Bat Survey Shaffer Mountain Wind Project*; 4) *2008 Summer Bat Survey Shaffer Mountain Wind Project*; 5) *South Penn Tunnel 2007 Indiana Bat Migration*; and 6) *South Penn Tunnel Fall 2007 Indiana Bat Telemetry*. It is also based on other information available in Fish and Wildlife Service files, as well as supporting information obtained via numerous meetings, telephone conversations, and electronic mail exchanges among the Service, Corps, the applicant, and the applicant's consultants. The complete administrative record of this consultation is on file at the Service's Pennsylvania Field Office.

DESCRIPTION OF THE PROPOSED ACTION

This biological opinion evaluates activities associated with the construction and operation of the Shaffer Mountain Wind Farm. The biological assessment outlines activities that may adversely affect the Indiana bat. The following opinion addresses whether implementation of the project is or is not likely to jeopardize the continued existence of the Indiana bat.

The following project and project area information is summarized from the biological assessment, whose project description was amended to include an Adaptive Management Plan. The Shaffer Mountain Wind Farm Adaptive Management Plan is included in its entirety as Appendix A of this biological opinion.

Project Area

The project area is located in Somerset and Bedford Counties, Pennsylvania, approximately four miles east of Central City in the Allegheny Front Section of the Appalachian Plateau (Figure 1). It is bounded by Gallitzin State Forest to the north, and by State Game Lands 228 to the south. The entire project area is on the west side of the Allegheny Front, placing it within the Ohio River watershed. Four of the eight streams within the project area have been designated as “high quality” or “exceptional value” by the Pennsylvania Department of Environmental Protection.

The project area is mountainous and predominantly forested. Forest communities include mixed mesophytic, oak-hickory, northern hardwoods, oak-pine, spruce-fir, maple, and white pine forests. Elevations range from 400 to 1010 feet above mean sea level. The project area is used primarily for timber production, outdoor recreation, hunting camps, and second homes.

Project Description

The proposed federal action is issuance of a Clean Water Act (33 U.S.C. §1344), Section 404 permit to Shaffer Mountain Wind, LLC for permanent impacts to wetlands under the jurisdiction of the Corps of Engineers. Approximately 0.022 acre of emergent wetland would be filled during construction of an access road needed to construct and upgrade electrical transmission lines associated with the Shaffer Mountain Wind Farm. The electric transmission lines are necessary for power transfer from the wind facility, and the access road is necessary to construct and upgrade the transmission lines. Consequently, the wind farm is interdependent with the proposed action, in that it has no independent utility apart from the proposed action (50 CFR 402.02).

The proposed project involves the construction and operation of wind turbines, transmission lines, access roads, and a substation. Thirty, 2.0-MW turbines will be installed on 260-foot-tall tubular towers which will be constructed on 100 x 100-foot pads. The project was originally designed to include 13 Gamesa “G90” and 17 Gamesa “G87” wind turbines, with cut-in speeds of 3 m/s and 4 m/s, respectively. However, it will now most likely consist entirely of G90 wind turbines (rotor diameter 90 meters) to take advantage of lower wind conditions. The turbine blades will reach approximately 403 feet into the air and clear the ground by 108 feet. Thirteen of the turbines will be lit with medium-intensity, red synchronized flashing LED obstruction lights with a flash frequency of 20 flashes per minute. Total nameplate capacity of the facility is 60 MW, and the life of the project is estimated at 30 years. The total project footprint (including the wind farm and supporting facilities) is approximately 168 acres of which 145 acres are forested.

Supporting facilities include a new substation, a staging area, support towers and foundations, access roads, and an underground and overhead electrical connection system. The substation and temporary staging area will each occupy five acres. The 16.1 miles of roadway needed for this project will include 12.88 miles of new road and an upgrade of 3.22 miles of existing road. The roadway corridor will be approximately 45 feet wide, and include a 30-foot travel way (15-foot gravel road and 15-foot grassy, periodically mowed area), a 9-foot corridor for buried electrical collection lines, and a 6-foot section for a drainage ditch. The existing road network will be used to the extent possible, as many of the existing roads have bridges and culverts over waterbodies within the area where the turbine strings will be built.

The wind farm will be connected to an existing 115-kV electric transmission line belonging to First Energy Company of Central City, Pennsylvania. Project development will require 1.3 miles of new transmission corridor and the retrofitting of 4.7 miles of an existing Somerset Rural Electric Cooperative transmission line corridor prior to the interconnection point. Vegetation in the 30-foot-wide transmission line corridor will be maintained as necessary to avoid interference with the lines.

Minimization Measures

The applicant has committed to implement the following measures to reduce the risk of adversely affecting Indiana bats. The Service has analyzed the effects of the proposed action considering the project and all project minimization measures will be implemented as proposed. The following minimization measures are summarized from the biological assessment and Adaptive Management Plan (Appendix A).

- Utilize and improve 3.2 miles of existing roads instead of constructing new roads. This represents 20 percent of total road length required, and reduces the amount of habitat to be removed.
- Minimize forest clearing for construction of new roads by minimizing road widths to 45 feet.
- Where practical, avoid removal of potential roost trees during construction.
- Within the 11.1-mile swarming radius associated with the South Penn Tunnel Indiana bat hibernaculum, only cut trees between November 15 and March 31. In all other areas associated with the project, only cut trees between October 15 and March 31.
- In response to the Indiana bat habitat survey results, move the construction staging area approximately one mile to the south away from potential roost trees.
- Where practical, locate ancillary construction activities (*e.g.*, landing and staging areas) and operations buildings (*e.g.*, substations) to avoid removal of potential roost trees.
- Limit human activity around potential primary roost trees that are not removed during construction to minimize disturbance to roosting bats.
- Use semi-circular lay-down areas, rather than traditional circular areas, during turbine construction to minimize habitat removal.
- During the active season (April 1 to October 15), constrain onsite construction activities and vehicle traffic to between sunrise and sunset to minimize the potential for vehicle collisions with foraging bats. In addition, the applicant will establish speed limits for construction and operations vehicles, will provide Indiana bat awareness training for construction and operational staff, and will develop a wildlife incident reporting system.
- To avoid and minimize potential effects on Indiana bat habitat due to stormwater runoff and erosion into wetlands and waterbodies due to construction activities, adhere to the Erosion and Sedimentation Control Plan approved by the Pennsylvania Department of Environmental Protection as part of applicant's Individual NPDES permit application for the project.

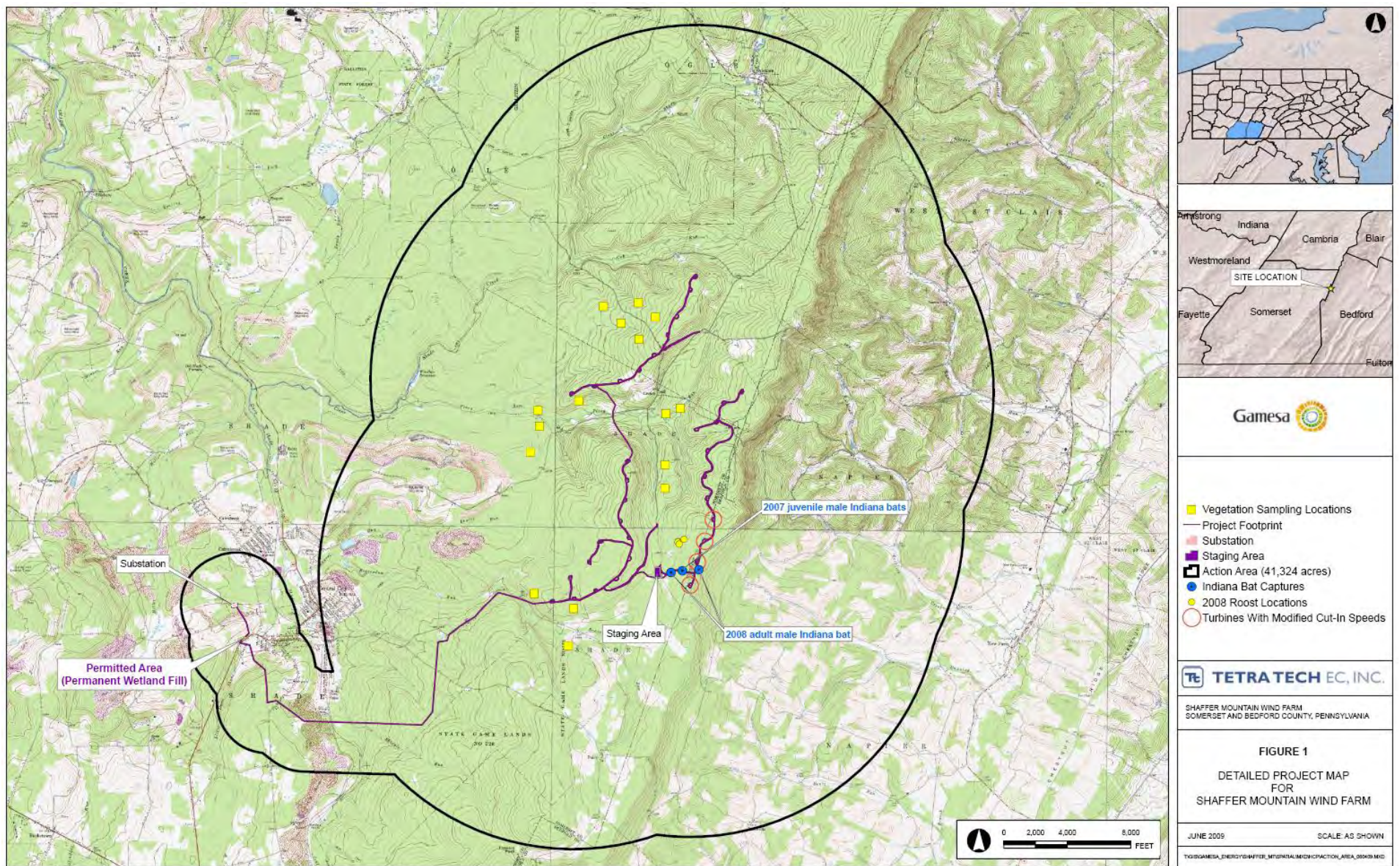


Figure 1. Shaffer Mountain Wind Farm Project Area

- Implement an Adaptive Management Plan (see Appendix A) to reduce take of Indiana bats due to turbine operation. The Adaptive Management Plan (AMP) includes increased turbine cut-in speeds to ensure incidental take remains low enough that the maternity colony is expected to persist. Turbine cut-in speed will be at least 5.5 m/s for all turbines (except those closest to the roost area) from sunset to sunrise from April 1 to October 15. When wind speeds are less than 5.5 m/s (from sunset to sunrise from April 1 to October 15), turbines will be idle and motionless. The three turbines closest to the identified roost trees will not be operated from sunset to sunrise from April 1 to October 15. If this level of curtailment does not reduce fatalities to a level that is AMP-compliant¹, turbine cut-in speeds will be increased to at least 6.5 m/s for all turbines, with the three turbines closest to the roost trees non-operational, as described above. If fatalities are still not AMP-compliant, further measures will be implemented to reduce fatalities, as described in the Adaptive Management Plan.
- Prior to placing wind turbines in operation, the applicant will partially offset the loss of 145 acres of forest habitat due to project construction by permanently protecting 145 acres of suitable forest habitat for an Indiana bat maternity colony. The biological assessment indicates that habitat conservation will be in a location that benefits active maternity colonies, but does not identify the location of the conservation parcel(s). The conservation acreage is subject to Service review and approval, and will come under the ownership of a conservation entity that is able and willing to protect and manage the habitat in perpetuity for Indiana bats. The Service has analyzed the effects of the proposed action in consideration that this measure will be implemented in a manner that benefits a maternity colony in or adjacent to the action area.
- Project effects on the Indiana bat will be monitored through mist-netting, radio-telemetry studies, and post-construction bat mortality monitoring, as described in the Adaptive Management Plan. The results of these monitoring efforts will be reported to the Fish and Wildlife Service, as described in the Adaptive Management Plan. Monitoring results will be used to evaluate the effectiveness of the Adaptive Management Plan in meeting its objective of ensuring turbine-related mortality remains at a low enough level that the maternity colony persists.

Conservation Measures

Conservation measures represent actions pledged in the project description that the action agency or the applicant will implement to further the species' recovery. Such measures may be tasks recommended in the species' recovery plan, should be closely related to the action, and should be achievable within the authority of the action agency or applicant. The beneficial effects of conservation measures are taken into consideration in the Service's conclusion of jeopardy or non-jeopardy to the listed species, and in the analysis of incidental take. If a conservation measure does not minimize impacts to affected individuals in the action area, the beneficial effects of the conservation measure are irrelevant to the determination of take levels, but may still be relevant to the conclusion of jeopardy or non-jeopardy to the listed species. No conservation measures were identified in the Biological Assessment to further the conservation or recovery of the Indiana bat.

¹ The AMP-compliant fatality rate will not exceed 2% of the maternity colony annually.

Action Area

The “action area” includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). It is the entire area within which direct and indirect project-associated environmental effects are anticipated to occur (*e.g.*, earth disturbance, habitat alterations, noise, flight path disruption). Consequently, the action area typically extends some distance beyond the project footprint.

In the biological assessment, the action area (Figure 1) includes the project area, plus buffer areas associated with the bats’ travel patterns and sensitivity to noise. A 3-mile buffer was applied to all turbine locations to encompass potential impacts to foraging bats. According to the biological assessment, this buffer represents the longest distance traveled by a radio-tracked Indiana bat captured on site (Chenger 2008). A 0.6-mile buffer was applied to the remaining project facilities to encompass potential noise-related impacts to roosting Indiana bats by daytime facility operations and management (USFWS 2005). The resulting action area is 41,324 acres.

The action area includes Indiana bat swarming habitat associated with the South Penn Tunnel hibernaculum, as well as summer foraging and roosting habitat occupied by an Indiana bat maternity colony and adult male Indiana bats (Figure 2).

STATUS OF THE SPECIES

Species Description

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. It is a medium-sized bat, having a wing span of 9 to 11 inches and weighing only one-quarter of an ounce. It has brown to dark-brown fur, and the facial area often has a pinkish appearance. The Indiana bat closely resembles the little brown bat (*Myotis lucifugus*) and the northern long-eared bat (*Myotis septentrionalis*). It is distinguished from these species by its foot structure and fur color.

Regulatory Status

The Indiana bat was officially 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]). The Endangered Species Act extended full protection to the species.

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. There is no designated critical habitat in the Commonwealth of Pennsylvania.

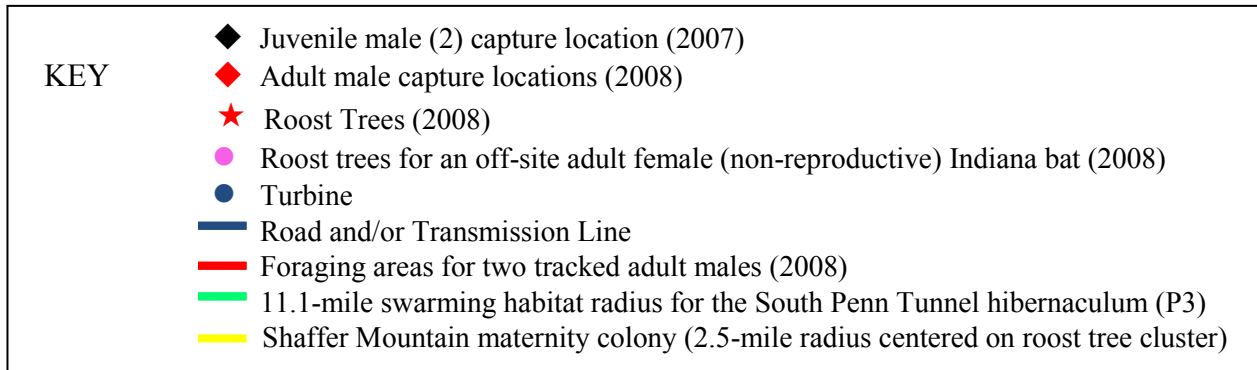
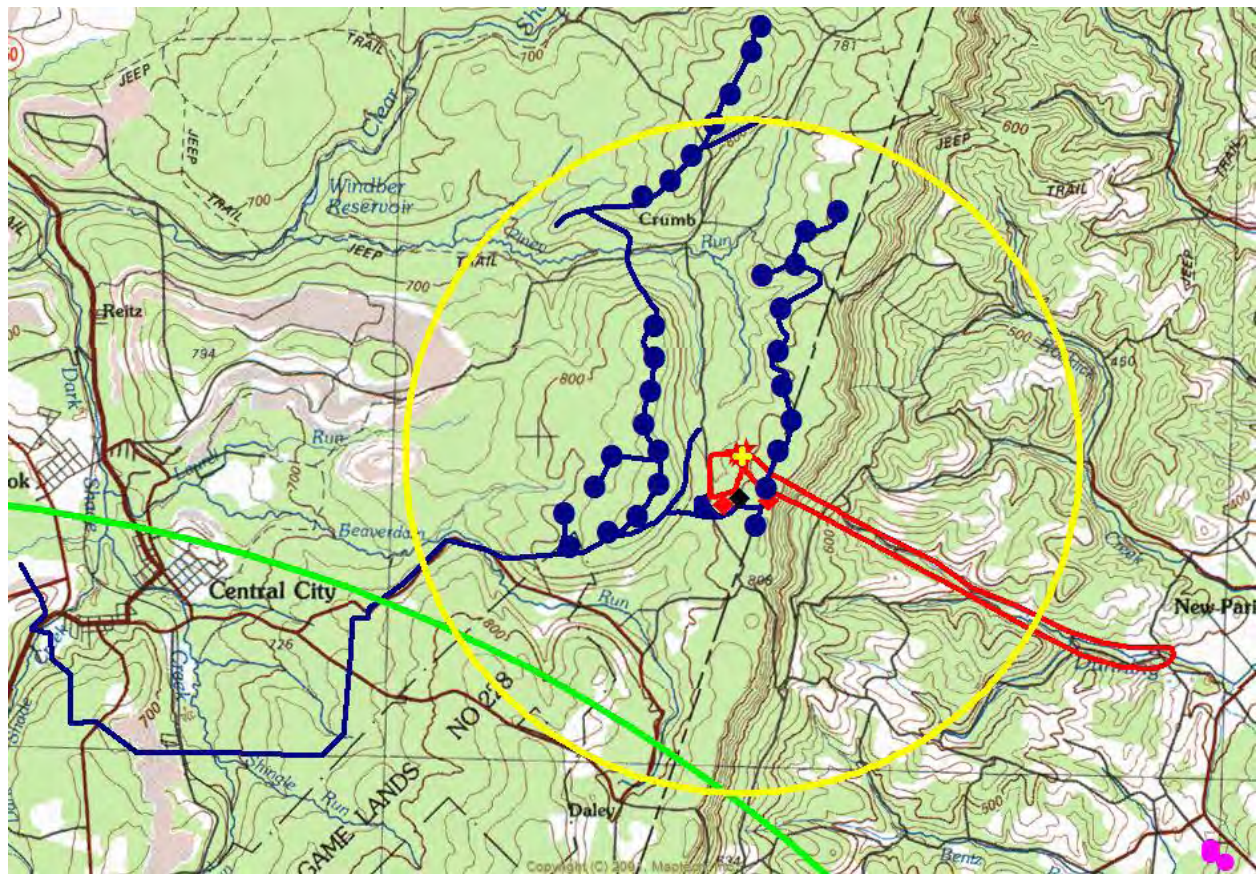


Figure 2. Indiana bat habitat in the Shaffer Mountain Wind Farm project area

Life History

The Indiana bat is a migratory bat, hibernating in caves and mines in the winter (typically October through April) and migrating to summer habitat. Figure 3 depicts this annual chronology (USFWS 2007). Although some Indiana bat bachelor colonies have been observed (Hall 1962, Carter *et al.* 2001), males and non-reproductive females typically do not roost in colonies and may stay close to their hibernacula (Whitaker and Brack 2002) or migrate long distances to their summer habitat (Kurta and Rice 2002). Reproductive females have been documented to migrate up to 357 miles (Winhold and Kurta 2006) to form maternity colonies to bear and raise their young. However, some females form maternity colonies within only a few

miles of their hibernacula. Both males and females return to hibernacula in late summer or early fall to mate and store up fat reserves for hibernation. By mid-November, male and female Indiana bats have entered hibernation. They typically emerge in April, at which time they again migrate to summer habitat. The Indiana Bat Draft Recovery Plan (USFWS 2007) provides a comprehensive summary of Indiana bat life history.

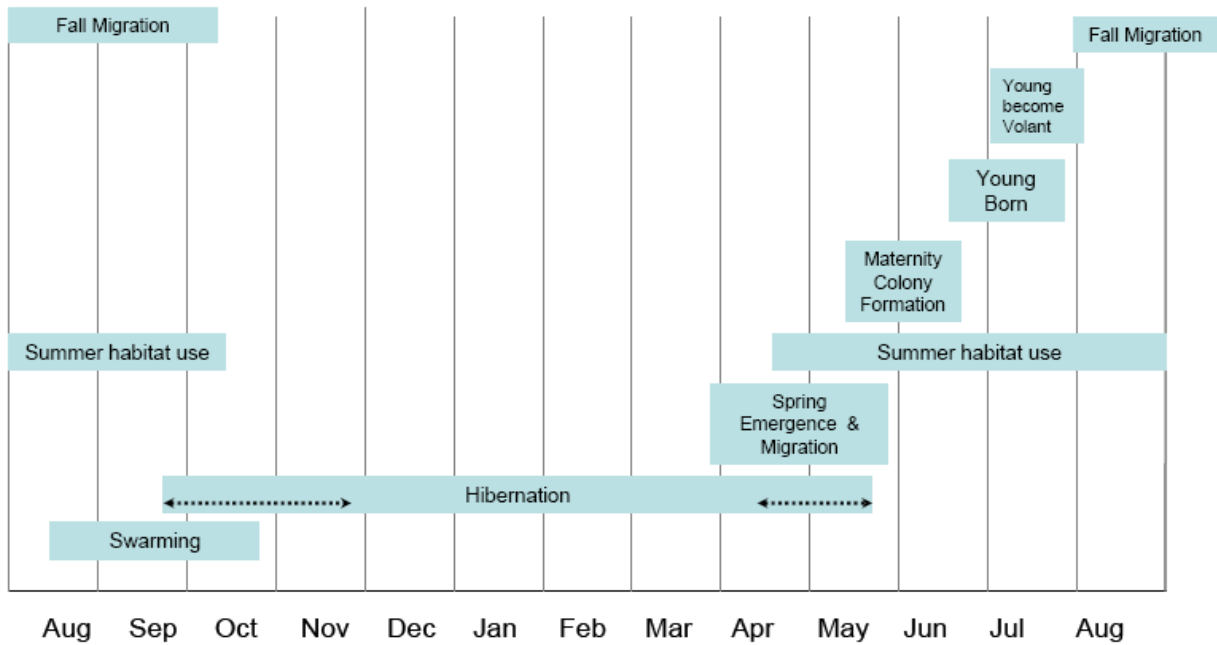


Figure 3. Indiana bat annual chronology

Survival and Reproduction

The average life span of the Indiana bat is 5 to 10 years, but banded individuals have been documented to live as long as 14 to 15 years (Humphrey and Cope 1977). No estimates of age structure have been made for winter populations, or for the population as a whole, due in part to the lack of an accurate technique for aging individuals once they are adults. To date, published estimates of the lifespan of the Indiana bat are based on survival after banding, from bats captured in winter. Using winter sampling of unknown-age bats over a 23-year period, Humphrey and Cope (1977) estimated annual survival. Survival rates following weaning are unknown, although they surmised that the lowest survival occurred in the first year after marking. Female survivorship in an Indiana population was 76% for ages 1 to 6 years, and 66% for ages 6 to 10 years. Male survivorship was 70% for ages 1 to 6 years, and 36% for ages 6 to 10 years. Following 10 years, the survival rate for females dropped to only 4 percent (Humphrey and Cope 1977).

Female Indiana bats, like most temperate vespertilionids, give birth to one young each year (Mumford and Calvert 1960, Humphrey *et al.* 1977, Thomson 1982). The proportion of female Indiana bats that produce young is not well documented. At a colony in Indiana, 23 of 25 female Indiana bats produced volant young during one year, and 28 females produced at least 23 young the following year (Humphrey *et al.* 1977). Based on cumulative mist-netting captures over

multiple years, Kurta and Rice (2002) estimated that 89 percent of adult females in Michigan maternity colonies were in reproductive condition (pregnant, lactating, or post-lactating). Reproductive rates of the closely related little brown bat often exceed 95 percent (*i.e.*, 95 percent of females give birth), but location and environmental factors (*e.g.*, amount of rainfall and temperature) can lead to lower rates (Kurta and Rice 2002, Barclay *et al.* 2004).

Racey (1982) notes that a particular ratio of fat to lean mass is normally necessary for puberty and the maintenance of female reproductive activity in mammals. He suggests further that the variation in the age of puberty in bats is due to nutritional factors, possibly resulting from the late birth of young and their failure to achieve threshold body weight in their first autumn. Once puberty is achieved, reproductive rates frequently reach 100 percent among healthy bats of the family Vespertilionidae, and young, healthy female bats can mate in their first autumn as long as their prey base is sufficient to allow them to reach a particular fat to lean mass ratio.

The sex ratio of the Indiana bat is generally reported as equal or nearly equal, based on early work by Hall (1962), Myers (1964), and LaVal and LaVal (1980). Humphrey *et al.* (1977) observed a nearly even sex ratio (nine females, eight males) in a sample of weaned young Indiana bats. However, differential survival in adults has been suggested (Humphrey and Cope 1977, LaVal and LaVal 1980).

Diet

The Indiana bat feeds primarily on aquatic and terrestrial insects. Diet varies seasonally and variations exist among different ages, sexes, and reproductive status (USFWS 1999). Numerous foraging habitat studies have been completed for the Indiana bat. These studies found that Indiana bats forage in closed to semi-open forested habitats and forest edges located in floodplains, riparian areas, lowlands, and uplands. Forested habitats are very important for foraging bats, but old fields and agricultural areas seem to also be somewhat important habitats in studies completed in Indiana (USFWS 2007). At a study site near the Indianapolis International Airport, Sparks *et al.* (2005) found Indiana bats spending nearly 50% of their time foraging over agricultural fields with movements focused on a riparian corridor. Indiana bats are probably utilizing forest-field edges and crowns of large scattered trees within the open canopy habitats.

Drinking water is essential, especially when bats actively forage. Throughout most of the summer range, Indiana bats frequently forage along riparian corridors and obtain water from streams. However, ponds and water-filled road ruts in the forest uplands are also very important water sources for Indiana bats.

Habitat Characteristics and Use

In this section we provide summaries of habitat characteristics and habitat use by Indiana bats. The Indiana Bat Draft Recovery Plan (USFWS 2007) provides more comprehensive summaries and can be referred to for additional information.

During winter, Indiana bats are restricted to suitable underground habitats known as hibernacula. The majority of hibernacula consist of limestone caves, especially in karst areas of east central United States, but abandoned underground mines, railroad tunnels, and even hydroelectric dams can provide winter habitat throughout the species' range (USFWS 2007). Hibernacula with stable and/or growing populations of Indiana bats have stable low temperatures that allow the bats to maintain a low metabolic rate and conserve fat reserves through the winter.

Spring emergence occurs when outside temperatures have increased and insects are more abundant (Richter *et al.* 1993). In central Pennsylvania, spring emergence typically peaks in mid-April. Some bats may remain in close proximity to the cave for a few days before migrating to summer habitats. This activity is known as spring staging. Others head directly to summer habitat. Migration distances range from a few miles to over 300 miles (Winhold and Kurta 2006). Some males spend the summer near their hibernacula (Whitaker and Brack 2002), while others disperse longer distances. Males roost individually or in small groups. In contrast, reproductive females form larger groups, referred to as maternity colonies, in which they raise their offspring. The average maternity colony size is 50 to 80 adult females (Whitaker and Brack 2002). Non-reproductive females may roost individually or in small groups, but occasionally are found roosting with reproductive females. While Indiana bats primarily roost in trees, some colonies have been found in artificial roost sites (USFWS 2007).

Home range size varies between seasons, sexes, and reproductive status of the females (Lacki *et al.* 2007). Menzel *et al.* (2005) tracked seven female and four male Indiana bats from May to August in Illinois. No significant differences in home ranges between males and females were observed and home range estimates were subsequently grouped to obtain a mean summer home range of 357 acres. Watrous *et al.* (2006) calculated a mean home range of 205 acres for 14 female Indiana bats in Vermont.

Indiana bats exhibit strong site fidelity to their traditional summer colony areas and foraging habitat, returning to the same summer range annually to bear their young (Kurta *et al.* 2002, USFWS 1999). Several monitoring studies have documented female Indiana bats returning to the same area to establish maternity colonies from year-to-year (Humphrey *et al.* 1977; Gardner *et al.* 1991a, b; Callahan *et al.* 1997; Kurta and Murray 2002; Butchkoski and Hassinger 2002; Gardner *et al.* 1991a, Gardner *et al.* 1996), and to the same roost tree as long as that tree is available. Traditional summer sites that maintain a variety of suitable roosts are essential to the reproductive success of local populations. It is not known how long or how far female Indiana bats will search to find new roosting habitat if their traditional roost habitat is lost or degraded during the winter. If they are required to search for new roosting habitat in the spring, it is assumed that this effort places additional stress on pregnant females at a time when fat reserves are low or depleted and they are already stressed from the energy demands of migration and pregnancy.

Gumbert *et al.* (2002) differentiated between roost tree and roost area fidelity in Indiana bats, and found that bats are faithful to both areas and particular trees within those areas. Indiana bats also show a high degree of fidelity to foraging ranges. Kurta and Murray (2002) documented recapturing 41 percent of females when mist netting within the same area in subsequent years. Indiana bat maternity colonies in Illinois, Indiana, Michigan, and Kentucky have been shown to

use the same roosting and foraging areas year after year (Gardner *et al.* 1991b; Humphrey *et al.* 1977; Kurta and Murray 2002; Kurta *et al.* 1996, 2002). Roosting/foraging area fidelity may serve to maintain social interactions between members of the population. Bats using familiar foraging and roosting areas are thought to have decreased susceptibility to predators and increased foraging efficiency, as well as the ability to switch roosts in case of emergencies or alterations surrounding the original roost (Gumbert *et al.* 2002).

Summering Indiana bats (males and females) roost in trees in riparian, bottomland, and upland forests. Roost trees generally have exfoliating bark which allows the bats to roost between the bark and bole of the tree. Cavities and crevices in trees also may be used for roosting. A variety of tree species are used for roosts including, but not limited to, silver maple (*Acer saccharinum*), sugar maple (*Acer saccharum*), shagbark hickory (*Carya ovata*), shellbark hickory (*Carya laciniosa*), bitternut hickory (*Carya cordiformis*), green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), eastern cottonwood (*Populus deltoides*), northern red oak (*Quercus rubra*), post oak (*Quercus stellata*), white oak (*Quercus alba*), shingle oak (*Quercus imbricaria*), slippery elm (*Ulmus rubra*), American elm (*Ulmus americana*), and sassafras (*Sassafras albidum*) (Rommé *et al.* 1995). Structure is probably more important than the species in determining if a tree is a suitable roost site; tree species that develop loose, exfoliating bark as they age and die are likely to provide roost sites.

Indiana bat roost trees have been described as either primary or alternate depending on the number of bats in a colony consistently occupying the roost site. Maternity colonies use a minimum of eight to 25 trees per season (Callahan *et al.* 1997, Kurta *et al.* 2002), and the primary and alternate roost trees tend to be clustered into roosting areas (Kurta *et al.* 1996, Kurta 2005). At sites with an abundance of suitable roosting habitat, roost trees tend to be more tightly clustered, with the distance between roosts as small as 1 meter (Kurta *et al.* 1996). However, where roosting habitat is sparse and fragmented, the maximum distance between roost trees used by the same colony has been reported to be 3.6 miles (Kurta *et al.* 2002).

In Missouri, Callahan (1993) defined primary roost trees as those with exit counts of more than 30 bats on more than one occasion; however, this number may not be applicable to small-to-moderate sized maternity colonies. Kurta (2005) summarized summer habitat information from 11 states and found most exit counts at primary roosts are at least 20-100 adults with a typical maximum of 60-70 adults in a primary roost at any given time. Primary roost trees are almost always located in either open canopy sites or in the portion of a tree that is above the canopy cover of the adjacent trees (Callahan *et al.* 1997, Kurta *et al.* 2002). Alternate roost trees can occur in either open or closed canopy habitats, and may be used when temperatures are above normal or during precipitation. Shagbark hickories are good alternate roosts because they are cooler during periods of high heat and tight bark shields the bats from rain (USFWS 1999). On average, Indiana bats typically switch roosts every two to three days. Switching behavior is influenced by reproductive condition of the female, roost type, weather conditions, and time of year (Kurta *et al.* 2002, Kurta 2005).

Despite the ephemeral nature of their roost trees, as long as adequate roosting opportunities are available in the general area, bats are probably not dependent on the continued suitability of a specific tree. There is evidence that colonies are able to relocate to other suitable roosting areas

within the colony's home range after the loss of a roost tree. In Michigan, the focal point of a colony's maternity activity shifted 1.24 miles over a three-year period after the primary roost tree fell down. The area that they shifted to had been previously used by a single radio-tracked female for roosting during the summer prior to loss of the roost tree (Kurta *et al.* 2002). This is consistent with a number of other situations, where the bats moved to nearby roosts but retained the same commuting corridors and foraging areas once a primary roost tree of a maternity colony had been lost (Humphrey 1977).

After grouping into maternity colonies, reproductively active females give birth to a single offspring in June or early July (Easterla and Watkins 1969, Humphrey *et al.* 1977). This life history strategy reduces thermoregulatory costs, which, in turn increases the amount of energy available for birthing and the raising of young (Barclay and Harder 2003). There are no documented occurrences in which a female Indiana bat has successfully given birth and raised a pup alone without the communal benefits, particularly thermoregulation, offered by establishment of a maternity colony. Studies by Belwood (2002) show asynchronous births among members of a colony. This results in great variation in size of juveniles (newborn to almost adult size young) in the same colony. In Indiana, lactating females have been recorded from June 10 to July 29 (Whitaker and Brack 2002). Young Indiana bats are capable of flight within a month of birth. Young born in early June may be flying as early as the first week of July (Clark *et al.* 1987), others from mid- to late July.

When young become capable of flight (early to late July), roosting behavior is similar to that in early summer. However, the maternity colony begins to disperse and use of primary maternity roosts diminishes, even though bats stay in the area prior to migrating back to their respective hibernacula. Bats become less gregarious and the colony utilizes more alternate roosts, possibly because there is no longer the need for the adult females to cluster to assist with thermoregulation and nurture the young.

This colonial roosting behavior is well documented for Indiana bat females at maternity colonies. Barclay and Kurta (2007) suggested four potential explanations for female aggregation (establishment of maternity colonies) in the summer: 1) roosts are limited, 2) foraging efficiency – members of a colony communicate regarding good foraging areas, 3) anti-predator mechanism, and 4) thermoregulation. Although there are probably many advantages to colonial roosting, the most important factor for Indiana bats is probably its thermoregulatory benefits (Humphrey *et al.* 1977; Kurta *et al.* 1996). Pups and adults in late pregnancy are poor thermoregulators (Speakman and Thomas 2003), and pre- and post-natal growth is controlled by metabolism and body temperature (Racey 1982). In the absence of clustering, the strict thermal conditions needed to support pre-natal and post-natal growth would not exist. Thus, colonial roosting is a life history strategy adopted by Indiana bats (like many other temperate zone bats) to improve their reproductive success (Barclay and Harder 2003). While there may be a loss or reduction of these communal benefits below a threshold colony size, it remains an important component of Indiana bat behavior (Racey and Entwistle 2003; Callahan 1993; Gardner *et al.* 1991b).

Distribution and Status

Because the vast majority of Indiana bats form dense aggregations or “clusters” on the ceilings of a relatively small number of hibernacula (*i.e.*, caves and mines) each winter, conducting standardized surveys of the hibernating bats is the most feasible and efficient means of estimating and tracking population and distribution trends across the species’ range. Collectively, winter hibernacula surveys provide the Service with the best representation of the overall population status and relative distribution that is available.

For several reasons, interpretation of the census data must be made with some caution. First, winter survey data have traditionally been subdivided by state due to the nature of the data collection. As described below, each state does not represent a discrete population center. Nevertheless, the range-wide population status of the Indiana bat has been organized by state thus far. Second, as will be further discussed, available information specific to the “reproductive unit” (*i.e.*, maternity colony) of the Indiana bat is limited. While winter distribution of the Indiana bat is well documented, relatively little is known as to the size, location, and number of maternity colonies for the Indiana bat. As described below, the locations of more than 90% of the estimated maternity colonies remain unknown. Additionally, the relationship between wintering populations and summering populations is not clearly understood. For example, while it is known that individuals of a particular maternity colony typically come from one to many different hibernacula, the source (hibernacula) of most, if any, of the individuals in a maternity colony is not known. Figure 4 illustrates the range-wide distribution of known hibernacula and maternity colonies by county. As discussed above, the county distribution of hibernacula is expected to be better represented and more complete than that of the species’ summer distribution.

There is limited information on the historic distribution and abundance of Indiana bats. However, paleontological evidence suggests that prehistoric abundance of Indiana bats may have exceeded our current population estimates, as well as historic estimates, by an order of magnitude (USFWS 2007). A summary of prehistoric and historic distribution and abundance can be found in the Indiana Bat Draft Recovery Plan (USFWS 2007).

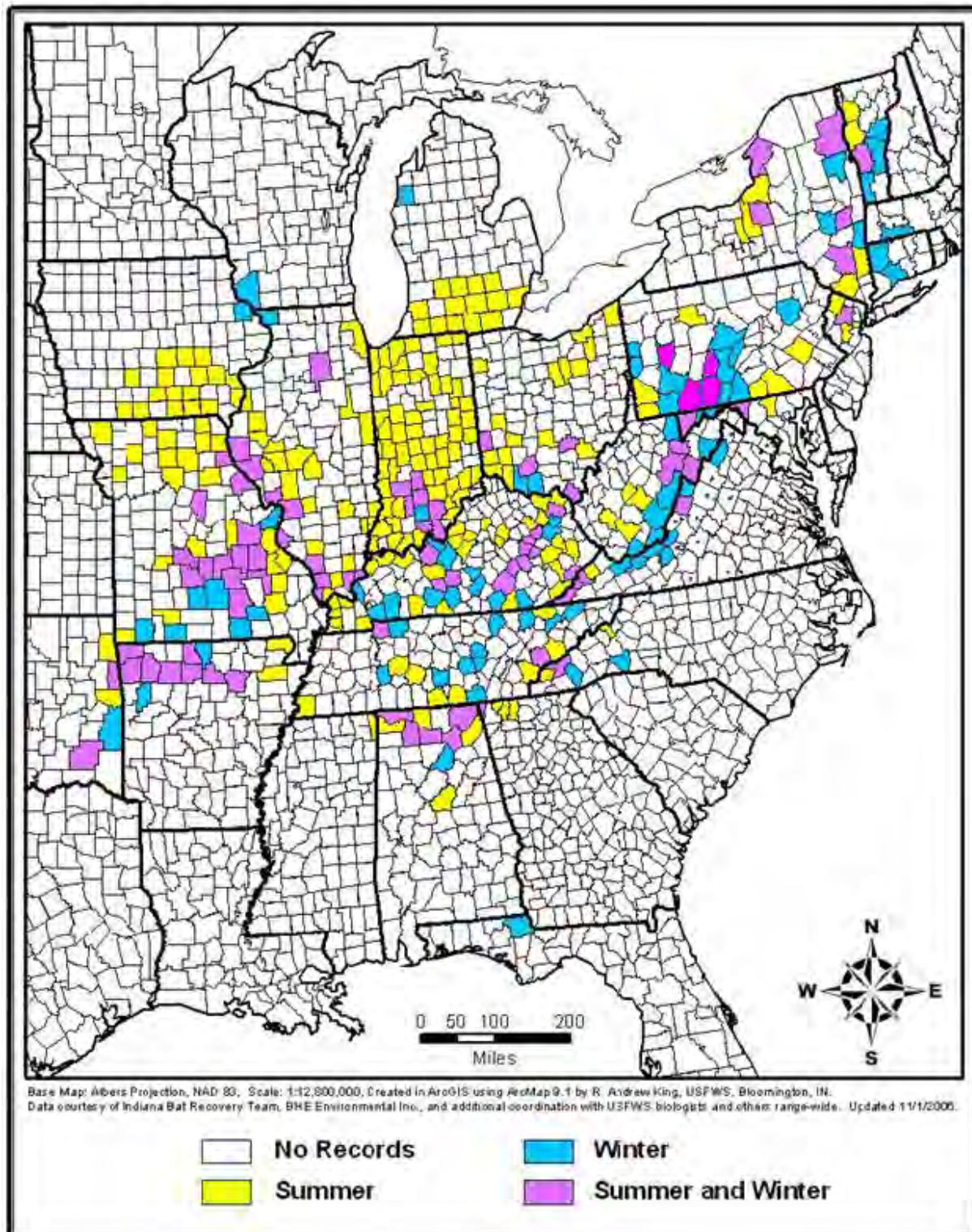


Figure 4. Distribution of counties with known summer and winter records of the Indiana bat as of publication of the Indiana Bat Draft Recovery Plan (USFWS 2007). Pennsylvania data updated and current through August 2010.

Current Abundance and Recent Trends

The Service compiled winter hibernacula survey information from 2008 and 2009 to develop the most recent range-wide population estimate of 387,835 Indiana bats. The declining trend in population size from 1981 to 2001 was reversed between 2003 and 2007, during which time the population rebounded to 468,181 bats (Figure 5). However, the 2009 survey results document a 17.2 percent population decline, some of which is attributed to white-nose syndrome (see “New Threats” section). Table 1 provides a detailed breakdown of the range-wide population estimates by Fish and Wildlife Service Region and by State from 2001 to 2009 (USFWS 2010).

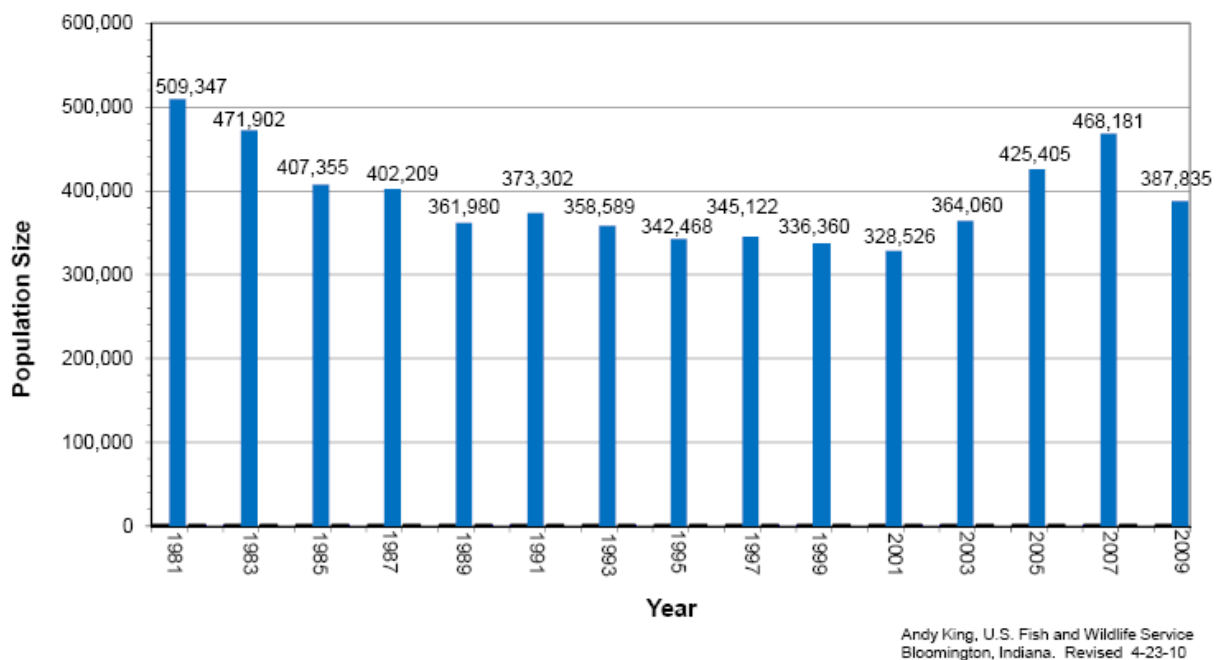


Figure 5. Indiana Bat Range-wide Population Estimates 1981-2009 (USFWS 2010)

The overall population distribution has not changed over the past several years. However, the abundance of Indiana bats in the northeast has declined significantly, and the threat to the species from white-nose syndrome (WNS) remains at a high level. Recovery efforts are primarily focused on the WNS investigation at this time because this poses a serious threat to the continued existence of the species throughout its range. When we consider the positive trends observed over the last several range-wide hibernacula counts (prior to WNS), along with the newly gathered information on WNS, we have concerns about the status of the species. As of the fall of 2009, the Service considers the population trend to be declining, with no expectation of a trend reversal in the foreseeable future.

Table 1. 2009 Range-wide Population Estimate* for the Indiana Bat (USFWS 2010)

USFWS Region	State	2001	2003	2005	2007	2009	% Change from 2007	% of 2009 Total
Region 2	Oklahoma	0	5	2	0	0	0.0%	0.0%
Region 3	Indiana	173,111	183,337	206,610	238,026	189,994	-20.2%	49.0%
	Missouri	18,999	17,752	16,102	15,895	13,674	-14.0%	3.5%
	Illinois	21,677	43,646	55,166	54,095	53,276	-1.5%	13.7%
	Ohio	9,817	9,831	9,769	7,629	9,261	21.4%	2.4%
	Michigan	20	20	20	20	20	0.0%	0.0%
	Total	223,624	254,586	287,667	315,665	266,225	-15.7%	68.6%
Region 4	Kentucky	51,053	49,544	65,611	71,250	57,325	-19.5%	14.8%
	Tennessee	9,564	9,802	12,074	8,906	12,721	42.8%	3.3%
	Arkansas	2,475	2,228	2,067	1,829	1,480	-19.1%	0.4%
	Alabama	173	265	296	258	253	-1.9%	0.1%
	North Carolina	0	0	0	0	1	0.0%	0.0%
	Total	63,265	61,839	80,048	82,243	71,780	-12.7%	18.5%
Region 5	New York	29,671	32,981	41,702	52,783	32,734	-38.0%	8.4%
	Pennsylvania	702	931	835	1,038	1,031	-0.7%	0.3%
	West Virginia	9,714	11,444	13,417	14,745	14,855	0.7%	3.8%
	Virginia	969	1,158	769	723	730	1.0%	0.2%
	New Jersey	335	644	652	659	416	-36.9%	0.1%
	Vermont	246	472	313	325	64	-80.3%	0.0%
	Total	41,637	47,630	57,688	70,273	49,830	-29.1%	12.8%
Range-wide Total:		328,526	364,060	425,405	468,181	387,835	-17.2%	100.0%
2-yr. Net Change:			35,534	61,345	42,776	-80,346		
2-yr. % Change:			10.8%	16.9%	10.1%	-17.2%		

* Estimates in Table 1 are primarily based on winter surveys conducted in January and February 2009 at known Priority 1 & 2 hibernacula throughout the species' range. Additional data from Priority 3 and 4 hibernacula were included when available. Compiled by Andy King (andrew_king@fws.gov), U.S. Fish and Wildlife Service, Bloomington, Indiana, Ecological Services Field Office from data gathered from bat biologists throughout the species' range.

Categorization of Hibernacula

In the Indiana Bat Draft Recovery Plan (USFWS 2007), Indiana bat hibernacula are assigned priority numbers on the basis of winter population sizes and to protect essential hibernation sites across the species' range. Priority numbers are defined below.

Priority 1 (P1) – Essential to recovery and long-term conservation of Indiana bat, Priority 1 hibernacula typically have (1) a current and/or historically observed winter population $\geq 10,000$ Indiana bats and (2) currently have suitable and stable microclimates. Priority 1 hibernacula are

further divided into one of two subcategories, “A” or “B,” depending on their recent population sizes. Priority 1A (P1A) hibernacula are those that have held 5,000 or more Indiana bats during one or more winter surveys conducted during the past 10 years. In contrast, Priority 1B (P1B) hibernacula are those that have sheltered $\geq 10,000$ Indiana bats at some point in their past, but have consistently contained fewer than 5,000 bats over the past 10 years.

Priority 2 (P2) – Contributes to recovery and long-term conservation of Indiana bat. Priority 2 hibernacula have a current or observed historic population of 1,000 or greater, but fewer than 10,000 and an appropriate microclimate.

Priority 3 (P3) – Contribute less to recovery and long-term conservation of Indiana bat. Priority 3 hibernacula have current or observed historic populations of 50 to 1,000 bats.

Priority 4 (P4) – Least important to recovery and long-term conservation of Indiana bat. Priority 4 hibernacula typically have current or observed historic populations of fewer than 50 bats.

Current Winter Distribution

The following is a summary from the Indiana Bat Draft Recovery Plan and 5-year review (USFWS 2007, USFWS 2009a). As of October 2008, the Service had records of extant winter populations (*i.e.*, positive winter occurrence since 1995) at approximately 281 different hibernacula located in 19 states (Figure 6). Based on the 2005 winter surveys, there was a total of 23 Priority 1 hibernacula in seven states – Illinois (n=1), Indiana (n=7), Kentucky (n=5), Missouri (n=6), New York (n=2), Tennessee (n=1), and West Virginia (n=1). A total of 53 Priority 2 hibernacula are known from the aforementioned states, as well as Arkansas, Ohio, Pennsylvania, and Virginia. A total of 150 Priority 3 hibernacula have been reported in 16 states, and 213 Priority 4 hibernacula have been reported in 23 states. Winter surveys in 2009 found hibernating Indiana bats dispersed across 16 states. However, 86% of the estimated range-wide population hibernated in four states, including Indiana (49.0%), Kentucky (14.8%), Illinois (13.7%), and New York (8.4%) (Table 1).

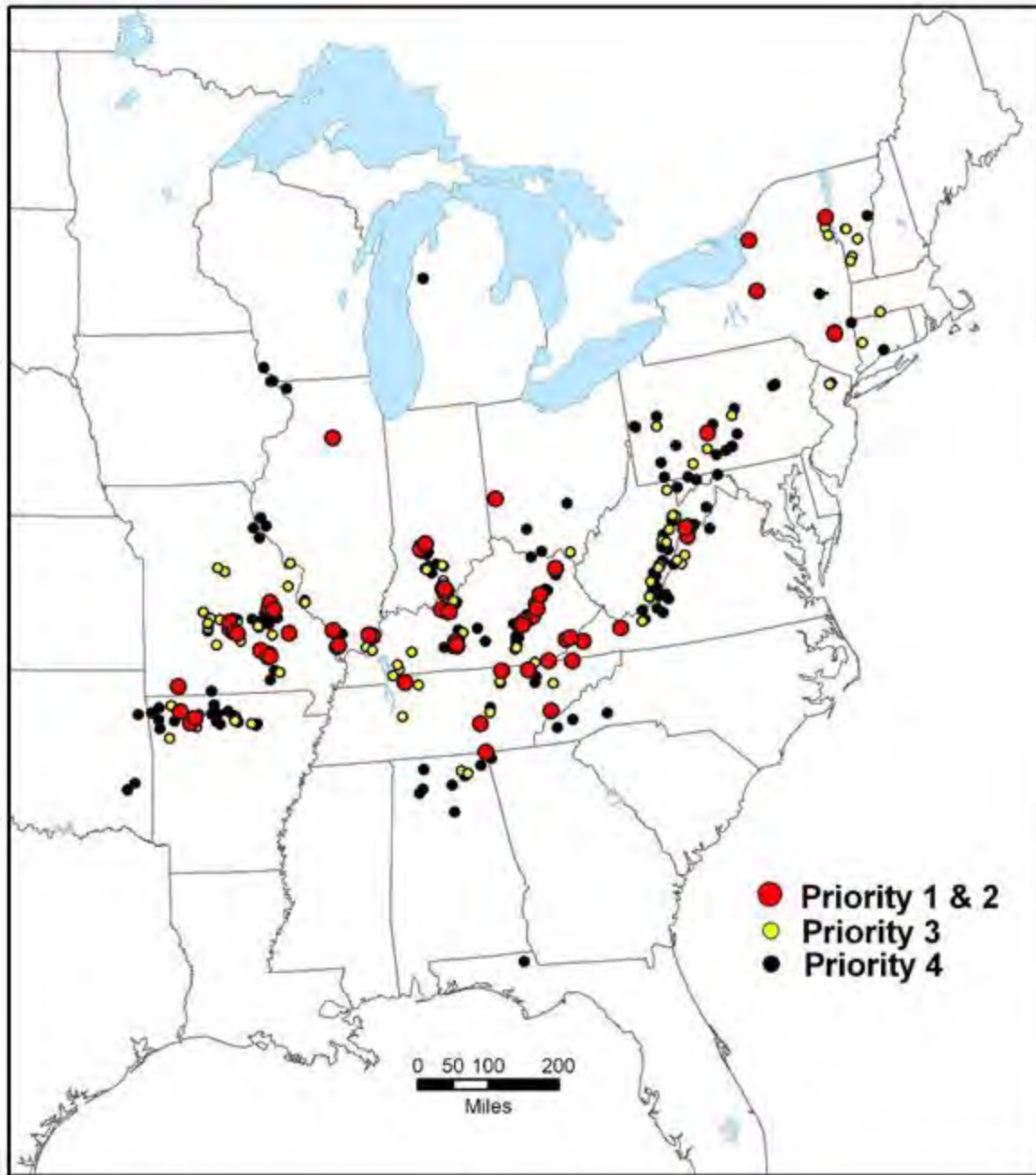


Figure 6. Distribution of known Indiana bat hibernacula and their current priority status (USFWS 2007).
Source: Andrew King, U.S. Fish and Service, Bloomington, Indiana

Current Summer Distribution

The summer distribution of the Indiana bat covers a broader geographic area than its winter distribution (Figure 4). Most of the known summer occurrences are from the upper Midwest including southern Iowa, northern Missouri, much of Illinois and Indiana, southern Michigan, Wisconsin, western Ohio, and Kentucky. In the past decade, many summer maternity colonies have been found in the northeastern states of Pennsylvania, Vermont, New Jersey, New York,

West Virginia, and Maryland. Maternity colonies extend south as far as northern Arkansas, southeastern Tennessee, and southwestern North Carolina (Britzke *et al.* 2003, USFWS 2007). Non-reproductive summer records for the Indiana bat have also been documented in eastern Oklahoma, northern Mississippi, Alabama, and Georgia.

Maternity Colonies

The first documented Indiana bat maternity colony, located in east-central Indiana, was not discovered until 1971 (Cope *et al.* 1974). As of publication of the Indiana Bat Draft Recovery Plan (USFWS 2007), 269 maternity colonies in 16 states were considered locally extant. Of those 269 colonies, 54% (n=146) had been found within the past 10 years (*i.e.* since 1997), primarily through the use of mist-netting surveys. In the northeast (*e.g.*, Pennsylvania, New York, Maryland, Vermont), several maternity colonies have been located through the use of radio-telemetry, as females have been tracked from hibernacula to summer habitat. Because maternity colonies are widely dispersed during the summer and difficult to locate, it is presumed that all the combined summer survey efforts have found only a small fraction of the maternity colonies that are thought to exist.

The total number of maternity colonies that exist range-wide is not known, but can be estimated based on population estimates derived from winter hibernacula surveys. Based on a range-wide population estimate of 468,181 bats, and assuming a 50:50 sex ratio and average maternity colony size of 50 to 80 adult females (Whitaker and Brack 2002), there were 3,804 (\pm 878) maternity colonies in 2007. Using the same set of assumptions, there were 3,151 (\pm 727) colonies in 2009, representing a loss of about 650 colonies over two years. However, this simple mathematical approach fails to incorporate regional variations in the decline, the effects of white-nose syndrome, and the social structure of maternity colonies. A decline in hibernating populations due to WNS may manifest itself first as a reduction in the size of maternity colonies, then the loss of whole colonies if the number of surviving colony members is too small to allow the colony to persist. In areas where WNS is just beginning to move through, maternity colonies are likely to be affected – at least initially – only by the loss of members from WNS-affected hibernacula. However, in areas where WNS has affected bat populations for multiple years, resulting in very high mortality rates, entire maternity colonies have probably been eliminated because all of the hibernating populations that supported those colonies have been decimated. If the resulting reduction in colony size is substantial, the colony may collapse because so few females remain to form the social clustering that is characteristic of the species and likely contributes to its survival and successful recruitment of young. Regardless of how one estimates the number of maternity colonies, the declining hibernating population translates to a declining summer population.

Adult Males

Male Indiana bats are found throughout the range of the species, but in summer are most common in areas near hibernacula (Gardner and Cook 2002). Because they typically roost solitarily in the summer, they are less likely to be detected by mist-netting than adult females, which tend to occur in high-density maternity colonies.

Threats

From 1965-2001, there was an overall decline in Indiana bat populations, with winter habitat modifications having been linked to changes in populations at some of the most important hibernacula (USFWS 2007). Most of these modifications were human-induced for either commercialization of the cave, control of cave access, or for mining. Improper gating and other structures have rendered many historical hibernacula unavailable to Indiana bats. Other documented threats involving hibernacula include human disturbance, vandalism, flooding of caves for reservoirs, destruction by limestone quarries, and indiscriminate collecting, handling, and/or banding of hibernating bats. Natural alterations of hibernacula can include flooding, entrance and passage collapse, and blocked sinkholes, all of which can alter the temperature regime within the cave and even prevent entry by bats. Both natural and human-induced changes to hibernacula can alter the climate required by Indiana bats, which in turn adversely affects the population.

Summer habitat modification is also suspected to have contributed to the decline of bat populations; however, it is difficult to quantify how forest management or disturbance may affect Indiana bats. Forests used by foraging and roosting Indiana bats during spring, summer, and autumn have changed dramatically from pre-settlement conditions. Forests have been fragmented in areas, fire has been suppressed, and much of the vegetation in flatlands (*i.e.*, prairie) has been converted to agriculture (USFWS 1999). Summer habitat can include extensive forests or small woodlots connected by hedgerows. The removal of such habitats is occurring rapidly in some portions of the Indiana bat's range due to residential and commercial development, mining, oil and gas development, and infrastructure development, including roadways and utility corridors. Even in areas of relatively abundant habitat, permanent and temporary impacts to forest habitat pose a risk of Indiana bat mortality during tree felling activities. Furthermore, the ongoing, permanent loss of forests and woodlots may have a significant cumulative effect on the species as habitat is lost, fragmented and degraded, and as maternity colonies are displaced from habitat to which they exhibit fidelity.

In addition, chemical contamination while bats are outside of hibernacula has been suggested as a cause for the decline of Indiana bats (USFWS 1999). The degree to which acute or chronic toxicity may be contributing to population declines is still unknown. However, additional research should improve our knowledge of the effects of chemical contaminants on bats. More recently, climate change has been suggested as a cause of population shift from southern to northern hibernacula (Clawson 2002). Collisions with man-made objects (*e.g.*, wind turbines, vehicles) also pose a risk to Indiana bats (Arnett *et al.* 2008, Russell *et al.* 2009).

Due to the species low reproductive potential, threats that increase mortality or decrease recruitment are of particular concern. In cases where threats have been reduced (*e.g.*, hibernacula have been properly gated to preclude disturbance), increases in population size have been noted. However, any increases in the population are expected to be gradual because biologically the species is not capable of responding through an increased reproductive rate (*e.g.*, in response to low population densities or the amelioration of threats).

New Threats

White-nose syndrome (WNS) is a malady of unknown origin that is killing cave-dwelling bats in unprecedented numbers in the northeastern United States. This affliction was first documented at four sites in eastern New York in the winter of 2006-07, but photographic evidence emerged subsequently of apparently affected bats at an additional site, Howe's Cave, collected the previous winter in February 2006. Data suggest that a newly identified fungus (*Geomyces destructans*) (Gargas *et al.* 2009) is responsible, at least in part, for the impacts and mortality associated with WNS (Blehert *et al.* 2009).

The most obvious symptom of WNS is the presence of a white fungus on the face, wing, or tail membranes of many, but not all, affected animals. Behavioral changes are also indicative of WNS affliction, characterized by a general shift of animals from traditional winter roosts to colder areas, or to roosts unusually close to hibernacula entrances. Affected bats are generally unresponsive to human activity in the hibernaculum, and may even fail to arouse from torpor when handled. Bats at affected sites are regularly observed flying across the mid-winter landscape, and on occasion, carcasses of little brown bats by the hundreds to thousands have been found outside affected hibernacula with more found inside. Affected animals appear to be dying as a result of depleted fat reserves, and mortalities are first apparent months before bats would be expected to emerge from hibernation.

Overall mortality rates (primarily of little brown bats) have ranged from 81% to over 97% at several of the sites where data have been collected for at least two years (Hicks *et al.* 2008). While little brown bats appear to be the most affected of the cave-wintering bat species in the Northeast, Indiana bats have also been greatly impacted by WNS. It is important to note, however, that most of these species do not form large clusters in the winter, as little brown bats and Indiana bats do, and so they are not easily counted. Therefore, we have poor baseline estimates for other species at most sites by which to compare post-WNS abundance estimates.

WNS has been confirmed in at least 190 bat hibernacula in 16 states (Connecticut, Indiana, Kentucky, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Tennessee, Vermont, West Virginia, Vermont, and Virginia), as well as four Canadian provinces (Frick *et al.* 2010a, Turner *et al.* 2011, Figure 7 below). Significant bat mortality (> 50% of known population) has been observed at several of these locations, especially in the northernmost regions. Through the winter of 2008/09, the distribution of WNS was mainly along the Appalachian Mountain range, which coincides with numerous bat hibernacula. However, in 2010 and 2011, WNS made a significant jump westward and was confirmed or suspected to occur far west of the Appalachian Mountains, in the States of Missouri, Oklahoma, Ohio, Indiana, Kentucky and Tennessee (Figure 7).

The annual distribution of WNS appears to be expanding rapidly from the initially affected hibernacula in western Albany/eastern Schoharie Counties, New York. The initial five sites where WNS was found in 2006 and 2007 were all within 15 km of a point that has come to be defined as the "epicenter." By April 2008, all of the hibernacula surveyed within 130 km of the epicenter were affected by WNS, and the farthest extent of the affliction reached approximately 200 km to a site near Watertown, New York. By the winter of 2008/09, affected sites had been

discovered as far as 900 km from the epicenter, and by the winter of 2009/10, WNS had been confirmed 1300 km from the epicenter (Figure 7).

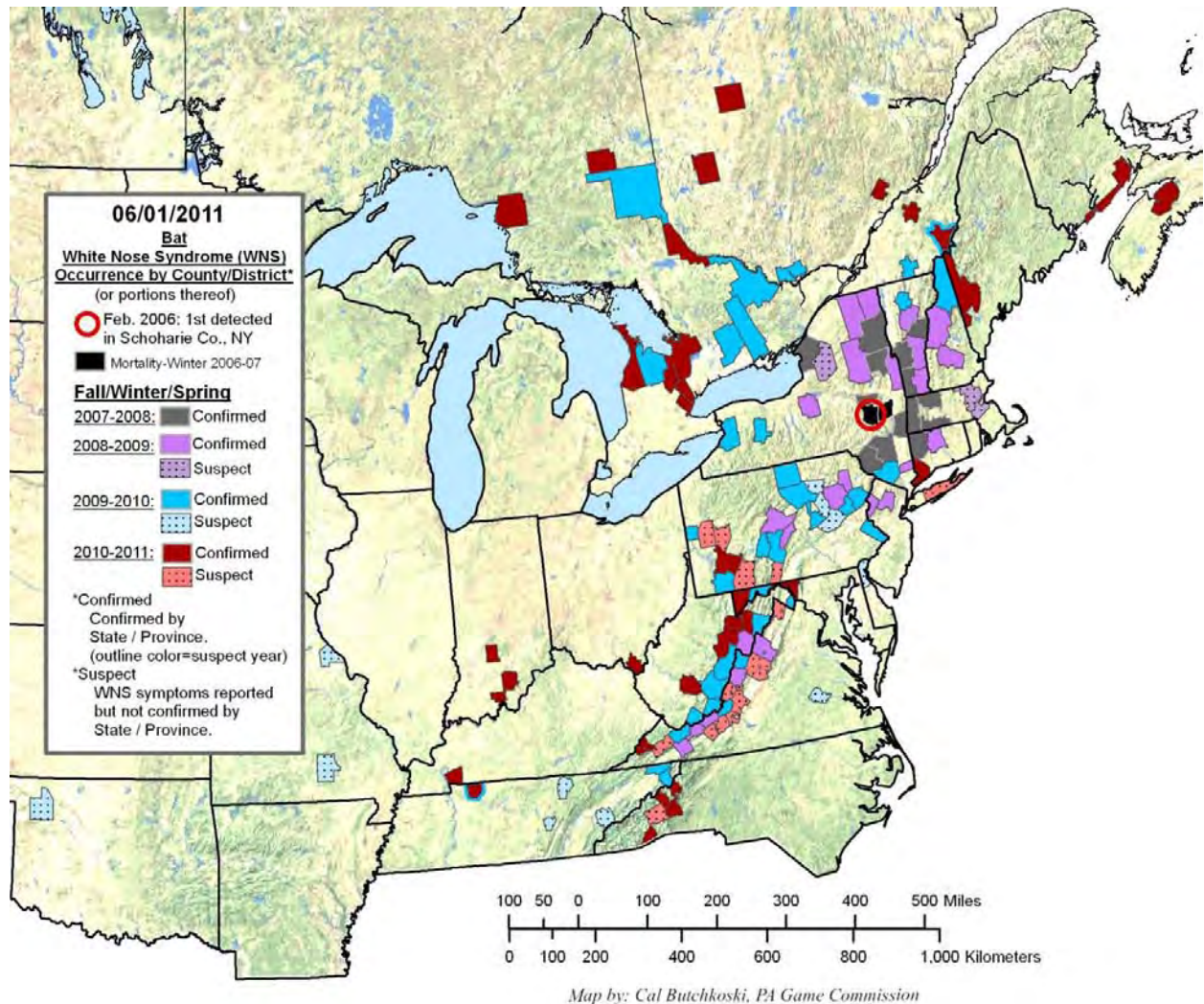


Figure 7. Distribution of counties and provinces affected by white-nose syndrome (WNS)

Research and field observations over the past few years have led to a better understanding of how WNS is and may be transmitted. The temporal presentation of WNS among bats in a single New York cave in 2006 to numerous sites in nine contiguous northeastern states by 2009 suggests that WNS is spread from bat-to-bat, and very likely from bat-to-hibernaculum and hibernaculum-to-bat (Hicks *et al.* 2010). This means of transmission is consistent with the rate of spread observed from 2006 through 2009, based on assumptions from available tracking data for local bat movements and from knowledge of inter- and intra-specific bat contact at spring, summer, and fall roosting and staging sites. However, an equally plausible, additional mode of transport for *Geomyces destructans*, the likely causative agent for WNS, is by anthropogenic sources. Fungal spores and other microscopic organisms can easily become attached to skin, hair, clothing, and equipment with which they come in contact, and it is possible that such

elements could remain viable for weeks or months after leaving a subterranean environment. Hard evidence that people are, or have been, responsible for transporting WNS to naïve hibernacula is currently not available. However, the occasionally discontinuous nature of the spread of WNS, especially to recently discovered sites in West Virginia and Virginia, does suggest that something other than bat-to-bat transmission is responsible. Another piece of supporting evidence for anthropogenic spread is the coincidental observation that many of the recently affected sites are also popular destinations for recreational users of caves and mines. In fact, the site where WNS was first documented photographically, Howe's Cave, is itself directly connected to one of the most visited commercial cave systems in the northeastern U.S. Therefore, although currently anecdotal, there is evidence to suggest that the spread of WNS may be multifactorial, and so precaution must be exercised to reduce any and all activities that may contribute to the continued transport of potential causative agents of WNS.

Another outstanding question regarding the effects of WNS is the degree to which susceptibility may vary by species within and among caves (*e.g.*, due to differences in cave microclimates, bat densities, *etc.*), or if observed symptoms are expressed differentially by species. For example, the New York State Department of Environmental Conservation (NYSDEC) has reported that observed mortality rates may differ between Indiana bats and little brown bats, even within the same site. While susceptibility may be influenced by cave micro-climate and other factors, varying levels of susceptibility by species have emerged over the past few years. Within a five-state area affected by WNS for multiple years (New York, Pennsylvania, Vermont, Virginia, West Virginia), population monitoring at 42 hibernacula documented a 98% decline in northern long-eared bats, 91% decline in little brown bats, 75% decline in tricolored bats (*Perimyotis subflavus*), 72% decline in Indiana bats, 41% decline in big brown bats (*Eptesicus fuscus*), and 12% decline in eastern small-footed bats (*Myotis leibii*) (Turner *et al.* 2011).

It is unclear how long symptoms take to manifest after exposure to the causative agent(s), but field observations indicate the time lapse between initial detection of the visible fungus and mass mortality of bats ranges from a few weeks to over a year (Turner *et al.* 2011). Recent captive inoculation trials at the USGS National Wildlife Health Center have demonstrated bat-to-bat transmission of *Geomyces destructans*, and data analyses are currently on-going which will advance knowledge about the disease process (David Blehert, National Wildlife Health Center, personal communication.) While it appears that bats are highly vulnerable to WNS during the hibernation period, it is not known to what degree or under what conditions WNS may be spread during other periods, such as during fall swarming and summer communal roosting.

Despite all of the unanswered questions about WNS, there are now five years of population monitoring data which provide valuable insights into the effects of WNS. Considering WNS has been affecting hibernating bat populations for the longest in New York (since February 2006), data from that State may provide the best indication of the effects of this disease on bats, including Indiana bats. By 2010, all known Indiana bat hibernacula in New York had been documented with WNS. However, the apparent effects of WNS on Indiana bats varied between affected hibernacula. Some Indiana bat hibernating populations have declined by 92 to 100%, while counts of Indiana bats at other WNS-affected New York hibernacula have declined to a lesser extent (Hicks *et al.* 2008, Turner *et al.* 2011). For example, there has been a 21% decline at the Barton Hill Mine, and a 77% decline at Glen Park Cave (Turner *et al.* 2011).

A more drastic decline (100%) was observed at Hailes Cave, where Indiana bats had been documented during every survey since 1981. In 2004-2005, 685 Indiana bats were observed at the site, but no Indiana bats (living or dead) were found at Hailes Cave during annual surveys from 2007 to 2011 (Hicks and Newman 2007, Turner *et al.* 2011). Hailes Cave has been classified as an ecological trap hibernaculum in the Indiana Bat Draft Recovery Plan (USFWS 2007) due to the history of occasional flooding and freezing events at this site; however, the total and persistent loss of all Indiana bats at this site is unprecedented.

The 2007-2008 counts at the Williams Preserve and Williams Lake hibernacula were down by 92-99% when compared to 2006-2007 mid-winter surveys. In 2006-2007, there were approximately 13,014 and 1,003 Indiana bats in the Williams Preserve and Williams Lake hibernacula, respectively. In April 2008, counts were closer to 124 and 80 Indiana bats, respectively (Hicks *et al.* 2008). Preliminary count data collected during the February 2009 survey were 341 and 32 Indiana bats at the Williams Preserve and Williams Lake hibernacula, respectively. The 2010-2011 Indiana bat counts for these hibernacula were 122 and 11, respectively, for overall declines of approximately 99% over four years. Williams Hotel, which is in the same complex of hibernacula, has declined by 74% (from 24,317 to 17,255 to 8,152 to 6,389 Indiana bats) over the same timeframe. Researchers have noted a progressive lessening of mortality rates at some hibernacula, but no clear evidence of resistant hibernating populations or decreased susceptibility of survivors to infection (Langwig *et al.* 2010).

Geomyces destructans has recently been confirmed in four European countries, including Germany, Hungary, Switzerland (Wibbelt *et al.* 2010), and France (Puechmaille *et al.* 2010). Sampling suggests the fungus is widespread in Europe, yet death rates similar to those in North America have not been observed in Europe over the past several decades of annual censuses. While bats with this fungus have been observed in several European hibernacula, these bats are not exhibiting the detrimental symptoms typical of WNS in North America. Based on these findings, it has been hypothesized that bat species in Europe are immunologically or behaviorally resistant to *G. destructans* because they have co-evolved with the fungus (Wibbelt *et al.* 2010). The authors did note that European hibernating populations tend to be very small (<1000 bats) and that this in itself may make the bats less vulnerable to the transmission and effects observed in North America. However, the spread and effects of WNS in North America suggest host density alone is not responsible for the observed deaths; bat populations appear to be reacting to an exotic pathogen to which they have not been previously exposed. Considering *G. destructans* has been detected on five different European myotis species – all of which appear to have resistance to it – there is hope that some level of resistance exists or will develop in North American myotis species, including the Indiana bat.

In summary, WNS has now been documented in 16 states, and the degree of impact to bats appears to vary greatly by site and species. Based on observations of continued mass-mortality at several sites, we anticipate the loss of Indiana bats to continue in the Northeast and mid-Atlantic regions. Based on the significant westward movement of WNS in 2010 and 2011, we anticipate that WNS will continue to spread rapidly, moving into and through the Midwest, South and eventually Great Plains over the next few years. The degree to which climate or other environmental factors may influence the spread of WNS, or the severity of its impact on affected

bats, is unknown. At this time, there is no concrete evidence of resistance to WNS among survivors, although some affected hibernacula continue to support low numbers of bats five years into WNS exposure, and a few hibernacula have substantially lower mortality levels than most. If current trends for spread and mortality at affected sites continue – and there is currently no indication that they will not – WNS threatens to drastically reduce the abundance of many species of hibernating bats in much of North America in what may only be a matter of years. Population modeling indicates a 99% chance of regional extinction of the little brown bat within the next 16 years due to WNS (Frick *et al.* 2010a). The closely related Indiana bat is just as vulnerable to regional extinction (if not more so) due to its smaller range-wide population and social behavior traits that increase the risk of bat-to-bat transmission. The declining mortality rates at some New York hibernacula and the apparent resistance of European myotis species to *G. destructans* suggest that some level of resistance may exist or develop within North American myotis species. The resistance in European bats may hold the key to preventing bat extinctions in North America due to WNS.

Previous Incidental Take Authorizations

All previously issued Service biological opinions involving the Indiana bat have been non-jeopardy. These formal consultations have involved a variety of action agencies, including 1) the U.S. Forest Service (USFS) for activities implemented under various Land and Resource Management Plans on National Forests in the eastern United States, 2) the Federal Highway Administration (FHWA) for various transportation projects, 3) the U.S. Army Corps of Engineers (Corps) for various water-related projects, 4) the Department of Defense for operations at several different military installations, and 5) the Office of Surface Mining (OSM) for coal mining activities nationwide. Additionally an incidental take permit has been issued under section 10 of the Endangered Species Act to an Interagency Taskforce for expansion and related development at the Indianapolis Airport in conjunction with the implementation of a habitat conservation plan (Six Points Road Interchange HCP). Links to previously issued biological opinions can be found at the Fish and Wildlife Service's website (<http://www.fws.gov/midwest/endangered/mammals/inba/inbaBOs.html>).

It is important to note that in some of these consultations (*e.g.*, those related to the Forest Service's Land and Resource Management Plans), survey information was lacking or incomplete. As Federal agencies are not required to conduct surveys, often the Service relied on a host of valid factors in helping the Federal agency determine whether Indiana bats were likely to be present. To ensure the Federal agency and Service met the mandate of Section 7(a)(2), if the best available information suggested that Indiana bats may be present, the assumption was often made that one or more maternity colonies occurred within the action area. Although this approach, we believe, fully accords with the intent of the Congress in writing the ESA, it likely resulted in an over-estimate of the number of individuals or colonies that may have been impacted by Federal actions.

Nearly all National Forests within the range of the Indiana bat have requested formal consultation at the programmatic level. Most of the previously authorized habitat loss on National Forests has not been a permanent loss. Rather, it has been varying degrees of temporary loss (short-term and long-term) as a result of timber management activities.

Conservation measures implemented by the Forest Service as part of the proposed action, as well as reasonable and prudent measures provided by the Service to minimize the impact of the annual allowable take for each of the National Forests, have ensured an abundance of available remaining Indiana bat roosting and foraging habitat on all National Forests, and the persistence of any known or newly discovered maternity colonies.

The remaining incidental take statements have been issued to other federal agencies (*e.g.*, Federal Highway Administration, Corps of Engineers, Department of Defense). Unlike those issued for National Forest Land and Resource Management Plans, many of these projects were certain to affect habitat known to be occupied by Indiana bats. To minimize adverse effects on Indiana bats due to the permanent or temporary loss of habitat, the action agencies agreed to implement various conservation measures. These typically included minimization of project footprints; seasonal tree cutting restrictions to avoid direct effects on female Indiana bats and young; protection of known primary and alternate roost trees with appropriate buffers; retention of adequate roosting and foraging habitat to sustain critical life history requirements of Indiana bats in the future; permanent protection of habitat; and habitat enhancement or creation measures to provide future roosting and foraging habitat.

Take has often been authorized in the form of harm through habitat loss (*i.e.*, acres of forest) because of the difficulty of detecting and quantifying take of Indiana bats. This is due to the bat's small body size, widely dispersed individuals under loose bark or in tree cracks/crevices, and the unknown spatial extent and density of much of the summer population. Where more detailed information about Indiana bats is available (*e.g.*, via telemetry studies), incidental take statements have included an estimate of the number of Indiana bats that are likely to be taken.

While the above biological opinions contained detailed effects analyses and estimated the amount of incidental take anticipated, this was not the case for the biological opinion issued to the Office of Surface Mining in 1996. In that opinion, the Service determined that surface coal mining activities conducted pursuant to the Surface Mining Control and Reclamation Act of 1977 would not jeopardize the continued existence of any federally listed species. The opinion did not quantify incidental take, but directed OSM and State Regulatory Authorities to coordinate project reviews with the Service to develop and implement species-specific protective measures. With regard to the Indiana bat, such measures were recently standardized across the species range for coal mining activities (USFWS 2009b). These national guidelines provide for seasonal restrictions on tree cutting, and either reforestation of a portion of the mined lands or off-site conservation of forest habitat. Hundreds of acres of known Indiana bat habitat, and thousands of acres of potential habitat, are lost annually due to coal mining. The cumulative effects of this habitat loss are not known, although in some cases an attempt is made to assess effects on individual maternity colonies or hibernating populations and to quantify take. State Regulatory Authorities have been charged with coordinating with the Service, integrating species-specific protective measures into mining permits, quantifying and tracking incidental take, and ensuring that federally listed species, including the Indiana bat, are not jeopardized. Due to the disparate levels of project coordination and record-keeping from state-to-state, as well as sporadic integration of species-specific protective measures in mining permits, it is not known how much Indiana bat habitat has been lost range-wide over the past 15 years (since issuance of the 1996 BO), or how many maternity colonies and hibernating populations have been harmed or

lost due to coal mining activities.

Two biological opinions (*i.e.*, Great Smoky Mountains National Park, and Laxare East and Black Castle Contour Coal Mining project) and their associated incidental take statements anticipated the loss of a maternity colony. However, the other biological opinions did not anticipate losses of this magnitude. Required monitoring for at least three formal consultations (Camp Atterbury, Newport Military Installation, and Indianapolis Airport) has confirmed that the affected colonies persisted through the life of the project and continue to exist today. We recognize that given the philopatric nature of Indiana bats and their long lifespan, the full extent of the anticipated impacts may not yet have occurred. Only with long-term monitoring will we be able to determine the true effectiveness of those conservation measures, and be able to judge whether our assumptions about project effects are accurate. However, the effects of WNS may confound monitoring, making it difficult to discern whether population declines have resulted from WNS, some aspect of the project, or both.

There have been two previous actions with incidental take authorization (via issuance of a biological opinion) for the Indiana bat in the Commonwealth of Pennsylvania: 1) the Land and Resource Management Plan for the Allegheny National Forest in northwestern Pennsylvania, and 2) the U.S. 6219 Transportation Improvement Project in Somerset County. In addition, numerous coal mining projects have proceeded pursuant to the 1996 biological opinion issued to OSM. These projects affected hundreds of acres of summer and fall habitat, as well as maternity colonies and hibernating populations. One Indiana bat maternity colony in Greene County, Pennsylvania has been affected to the point that it is likely to be extirpated in the near future due to the combined effects of white-nose syndrome and habitat loss resulting from coal mining.

Recovery

The first Indiana bat recovery plan was completed and approved in October 1983 (USFWS 1983). An agency draft of a revised plan was published in 1999 (USFWS 1999), but was never finalized. A revised draft recovery plan was published in 2007 (USFWS 2007), and although this plan has not been finalized, it represents the most complete synthesis of research, life history, status, and threat information, and therefore serves as a source of the best available information for the species.

The 2007 plan outlines actions necessary to recover the species. Briefly, these actions include 1) conserve and manage hibernacula and their winter populations, 2) conserve and manage summer habitat to maximize survival and fecundity, 3) plan and conduct research essential for recovery, and 4) develop and implement public information and an outreach program. The recovery program outlined in the 2007 draft plan focuses on protection of hibernacula, but also increases the focus on summer habitat. It is important to note that recovery planning and implementation are ongoing processes that do not culminate in the issuance of an official recovery plan for a species. For example, WNS was not a threat at the time of the release of the 2007 plan, but is now the primary threat being addressed by the Service.

In consideration of the conservation needs of the Indiana bat, the Service has proposed the use of Recovery Units to establish and focus recovery efforts. Recovery units are management sub-

units that are geographically identifiable and essential to the recovery of the entire listed entity. Indiana bat recovery units have been delineated to conserve genetic and demographic robustness, and ensure this wide-ranging species continues to survive and recover within its historic range. The Service's proposed delineation of Recovery Units relied on a combination of preliminary evidence of population discreteness and genetic differentiation, differences in population trends, and broad-level differences in macro-habitats and land use. When Recovery Unit delimitations suggested by these factors were geographically close to state boundaries, the Recovery Unit borders were shifted to match the state boundaries in order to facilitate future conservation and management. The Service is planning and implementing recovery efforts within the four Recovery Units (RU) for this species: Ozark-Central, Midwest, Appalachian Mountains, and Northeast (Figure 8, USFWS 2007).

The proposed project is located within the Appalachian Mountains Recovery Unit, which made up 7.0% of the range-wide Indiana bat population in 2009. Between 2001 and 2009, the hibernating population in this RU increased from 16,384 to 27,458. However, populations in this RU are expected to decline precipitously over the next few years due to WNS, which has been documented throughout most of the RU.

A 5-year review of the Indiana bat's status was completed and published in September 2009 (USFWS 2009a). In light of the ongoing threat of WNS, the Service changed the "degree of threat" to the Indiana bat from "moderate" to "high." The high category means "extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction", whereas the moderate category means "the species will not face extinction if recovery is temporarily held off, although there is continual population decline or threat to its habitat". Prior to emergence of the WNS threat, the Service considered the Indiana bat to have a "high" recovery potential (*i.e.*, biological/ecological limiting factors and threats were well understood and intensive management was not needed and/or recovery techniques had a high probability of success). The Service now considers the Indiana bat to have a "low" recovery potential, because WNS is poorly understood and we currently have very limited ability to alleviate this threat. Consequently, the Recovery Priority Number for the Indiana bat was changed from "8" to "5", reflecting a species that currently faces a high degree of threat and has a low recovery potential.

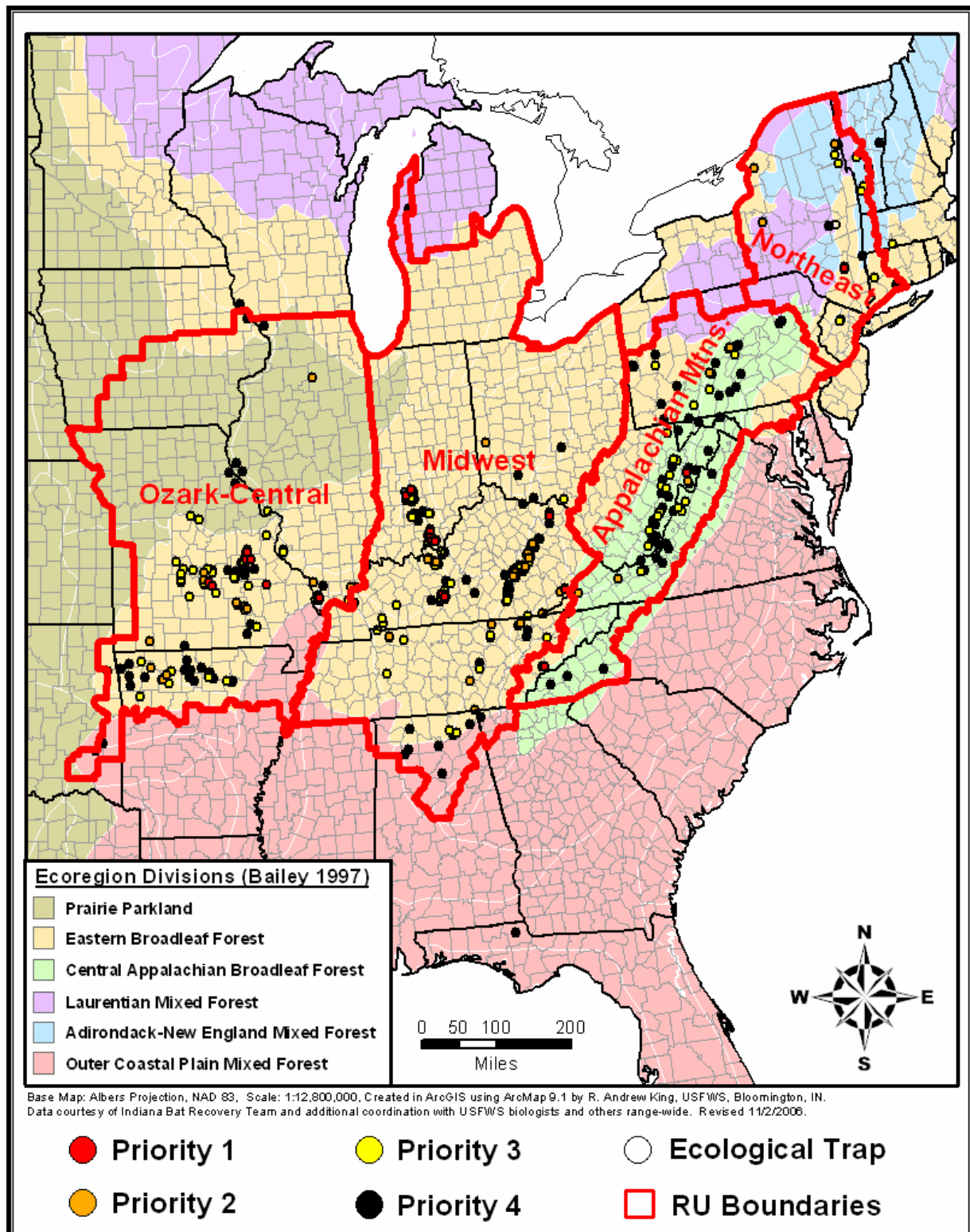


Figure 8. Indiana Bat Recovery Units. Hibernacula located outside of the Recovery Unit boundaries have not had an Indiana bat record for over 50 years (USFWS 2007).

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 (Service and National Marine Fisheries Service [NMFS] 1998, page 4-22).” The environmental baseline is, therefore, a “snapshot” of the species’ health at a given point in time, but it does not include the effects of the proposed action.

Status of the Species in Pennsylvania

Hibernating Population

There are 18 known Indiana bat hibernacula in Pennsylvania, distributed among ten counties, including Armstrong, Beaver, Blair, Centre, Fayette, Huntingdon, Lawrence, Luzerne, Mifflin and Somerset. These hibernacula include limestone caves, mines (limestone, anthracite coal), and an abandoned railroad tunnel. The total known Indiana bat hibernating population in Pennsylvania was estimated to be 1,038 bats in 2007 (USFWS 2010), with the largest concentration being found in the J.D. Hartman Mine (a.k.a. Canoe Creek hibernaculum) in Blair County. This is the State’s only Priority 2 hibernaculum, with Indiana bat population counts ranging from approximately 600 to 800 over the past decade. There are three Priority 3 hibernacula in Pennsylvania with extant populations, but only two of them (*i.e.*, South Penn Railroad Tunnel and Long Run Mine) currently support Indiana bat populations exceeding 100 bats.

White-nose syndrome was first detected in eastern Pennsylvania during the winter of 2008-2009, and by 2011, it had been documented across much of the State (PGC 2009, Figure 7). In April 2010, WNS was documented at the Hartman Mine hibernaculum, where the total bat population (of all species combined) had declined by 50 percent, from approximately 30,000 to 15,000 bats. Although the Game Commission did not attempt a full assessment and count of bats during this survey, they did not observe any clinical signs of WNS on the 82 Indiana bats that were observed (C. Butchkoski, Pennsylvania Game Commission, *in litt.* 2010). By 2011, WNS had been confirmed at all but one of Pennsylvania’s Indiana bat hibernacula.²

In Pennsylvania, the biennial Indiana bat survey scheduled for 2009 was called off in an attempt to reduce the risk of spreading WNS. Consequently, the 2009 population data (USFWS 2010) reflect a carry-over of data from the 2007 count. This suggests a stable Indiana bat population from 2007 to 2009 in Pennsylvania, when in fact, it is likely that a WNS-induced population decline had begun to occur. Based on the effects of WNS in the northeastern United States (Hicks *et al.* 2008, Langwig *et al.* 2010, Turner *et al.* 2011), Pennsylvania’s Indiana bat

² WNS has not been confirmed (yet) at the one hibernaculum where access has been denied.

hibernating population is expected to decline by at least 70%, with the decline at individual sites ranging from 20 to 100%.

Summer Population

Potential summer habitat occurs throughout Pennsylvania. Eleven Indiana bat maternity colonies have been identified in nine counties, including Adams, Armstrong, Bedford, Berks, Blair, Greene, Somerset, Washington and York. Most of these maternity sites were found by radio-tracking Indiana bats emerging from their hibernacula in the spring and following them to their summer habitat. These radio-telemetry studies have also tracked bats to maternity habitat in Maryland and West Virginia. The two Maryland maternity sites identified during the 2005 spring migration study were approximately 84 and 92 miles, respectively, to the southeast of the Hartman Mine (Butchkoski and Turner 2005).

The Indiana bat summer population in Pennsylvania is expected to decline commensurate with the decline in regional hibernating populations, as discussed above. This is expected to result in a decline in the size and/or number of maternity colonies.

Critical Habitat

There is no federally designated critical habitat for the Indiana bat in Pennsylvania.

Threats

The primary threats to Indiana bats in Pennsylvania are white-nose syndrome, and habitat losses due to a wide variety of land development and land use practices that remove forest. Forest habitat losses occur due to coal mining, wind power development, oil and gas development, commercial and residential development, and various forestry practices.

Status of the Species within the Action Area

The identified action area includes roosting and foraging habitat used by a maternity colony, and roosting and foraging habitat used by adult male Indiana bats during the summer (Figures 2 and 9). In addition, the action area contains fall foraging and roosting habitat due to its location within the swarming radius of the South Penn Tunnel hibernaculum (Figure 2). Therefore, the status of the maternity colony, adult males, and nearby hibernating population are discussed below.

Maternity Colony

An Indiana bat maternity colony was documented in the project area during mist-net surveys³, as evidenced by the capture of two juvenile male Indiana bats (Figure 9) in the southeastern part of

³ Wind farms are often treated as linear projects, resulting in a mist-netting effort of 1 mist-net site per linear km of project alignment. During the 2007 mist-netting effort, 27 sites were mist-netted within the action area to assess the anticipated 27 linear km of project alignment. In some cases, this approach may fail to assess the larger area within which direct and indirect project effects may occur. If wind farms are treated as projects having “area” rather than “linear” impacts, the Service’s mist-net survey guidelines would call for 1 mist-net site for every 123 acres of direct and indirect impact area.

the project area on August 8, 2007 (Chenger and Papenbrock 2007). The Service considers the capture of reproductive adult females and/or juvenile Indiana bats to be indicative of the presence of an Indiana bat maternity colony when the capture occurs between May 15 and August 15, which corresponds to the period when Indiana bats are known to be occupying their summer habitat (USFWS 2007). Because these individuals were juveniles, neither was fitted with a radio-transmitter, so no specific roost trees or foraging areas were identified.

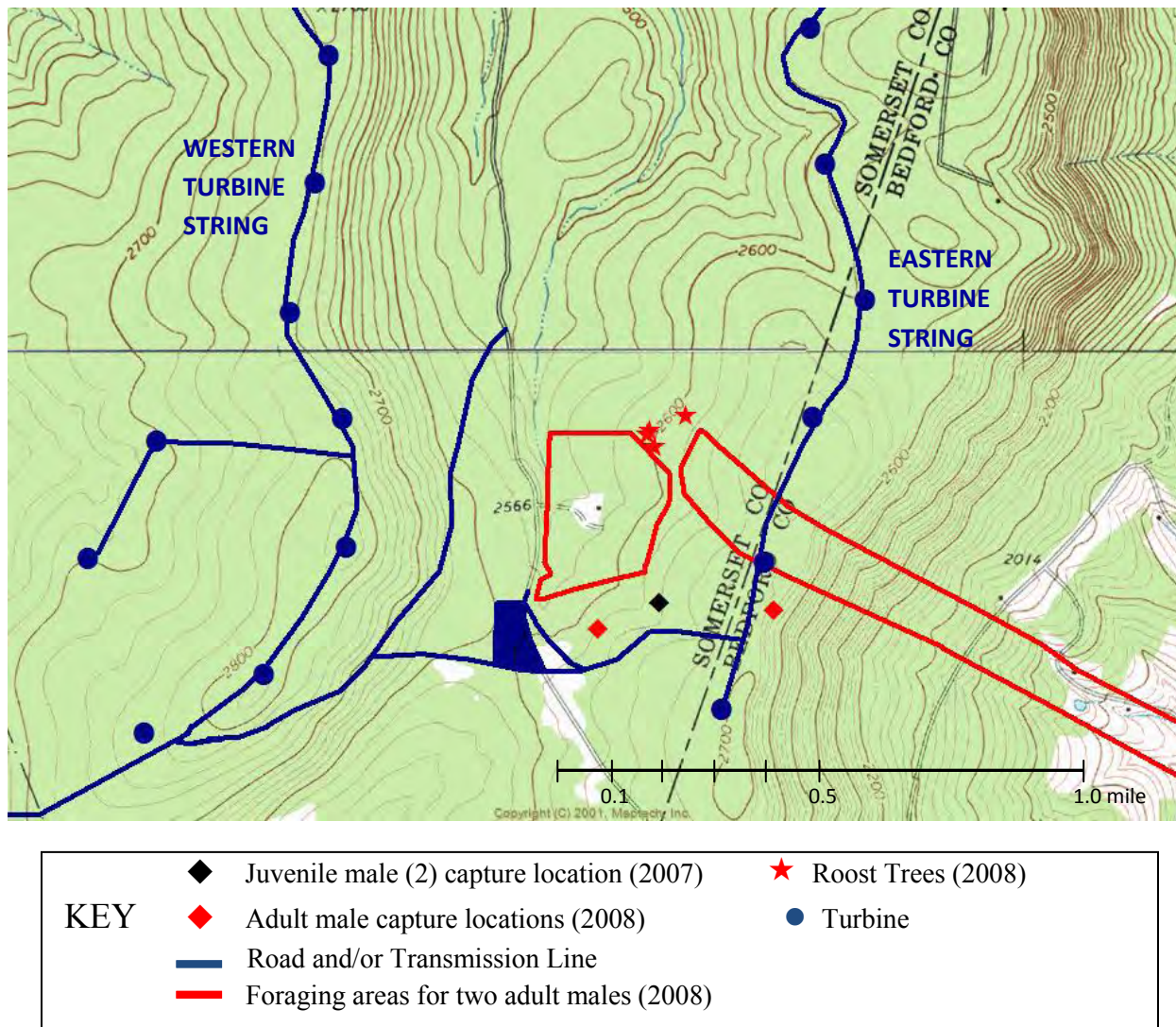


Figure 9. Indiana bat summer capture locations, roost trees, and foraging areas in the project area

Additional mist-netting was carried out in 2008 due to applicant concerns that the 2007 captures represented dispersing bats from a maternity colony in the valley east of the project area rather than actual presence of maternity colony members and maternity habitat within the project area. Mist-netting focused on the general area where Indiana bats had been captured previously, but mist-netting effort was significantly less than that which would be needed under the Service's

mist-net survey guidelines to fully assess this area for the presence of Indiana bats.⁴

During the 2008 mist-net surveys, two adult male Indiana bats were captured within 1000 feet of the location where the juvenile Indiana bats were captured in 2007. These bats were fitted with transmitters, leading to the identification of a cluster of four roost trees approximately 2000 feet north of the juvenile and adult capture locations (Figure 9). Combined exit counts from these trees over five nights in late June ranged from three to nine bats (Chenger 2008). While these counts are not typical for primary maternity roosts (which tend to have higher exit counts), they probably represent alternate maternity roost trees. Although we would have greater confidence in these being maternity roost trees (rather than solely male roosts) if an adult female or juvenile had been tracked to them, it should be acknowledged that these trees are very close to the location where juvenile Indiana bats were captured the previous year. In addition, the exit counts are similar to those documented at maternity roost tree clusters in the valley east of the project area (Chenger and Sanders 2007), suggesting the presence of a maternity roost tree cluster that is co-occupied by a few adult males. The lack of female or juvenile captures in 2008 is not particularly noteworthy, considering the low sampling effort in relation to the probable extent of the maternity colony's range (see next paragraph and footnote #4).

Roosting areas include clusters of primary and alternate roost trees, and in areas of abundant roosting habitat, the roost trees tend to be more tightly clustered (see "Status of the Species"). The action area contains an abundance of suitable roosting habitat, and the four identified roost trees are tightly clustered, ranging from 40 to 450 feet from each other. Although exit counts suggest these may be alternate roosts, their tight clustering and the abundance of suitable roosting habitat make it likely that primary maternity roosts are nearby (in the same roosting area) rather than miles away. Consequently, based on the available information, we are considering the identified roost tree cluster to represent the roosting focal area for the maternity colony. We have buffered this roost tree cluster with a 2.5-mile radius (USFWS 2009b), which represents the average maximum distance females typically forage from their roosting area. The estimated range of the Shaffer Mountain maternity colony is depicted in Figures 2 and 10. The Shawnee maternity colony is located outside the action area (Figure 10), and is discussed below.

Both the 2007 and 2008 mist-net surveys within the project area suggest the presence of a diverse bat community within relatively high-quality habitat. The 27 sites sampled in 2007 yielded 388 bats of seven species, with an overall sex ratio of 3:1 males to females, and about 35 percent of the females in reproductive condition (Chenger and Papenbrock 2007). The 21 sites sampled in 2008 yielded 228 bats of seven species, with an overall sex ratio of 3:1 males to females, and about 65 percent of the females in reproductive condition (Chenger 2008).

⁴ A 2.5-mile radius around the identified roost trees (see Figure 2) contains 12,566 acres, for which the Service's mist-net survey guidelines would call for 102 mist-net sites to reasonably determine whether or not Indiana bats are present (one mist-net site per 123 acres). The 2008 sampling effort only included 21 mist-net sites, which is 20% of the effort needed to assess this area for the presence of Indiana bats. The 2008 capture results (2 adult males) do not negate or minimize the significance of the 2007 capture results, which point to the presence of a maternity colony and maternity habitat in the project area.

Adult Males

Two adult male Indiana bats were captured in the southeastern part of the project area in 2008. They were tracked to a roost tree cluster that has exit counts indicative of maternity roosts, so it appears the males are sharing habitat with a maternity colony. A foraging area for one of the males was identified near the roost tree cluster, but this bat lost its transmitter the first night of tracking. The other adult male was tracked for four nights, and consistently foraged in the Dunning Creek watershed east of its roost tree cluster. The maximum distance between the roost trees and the easternmost extent of its foraging area was 3.5 miles (Figures 2 and 10). These foraging areas were identified based on radio-tracking for one and four nights, respectively. Thus, it is possible, and even likely that more foraging and roosting habitat for these adult males exists in the action area, but was not identified due to the short duration of the tracking study.

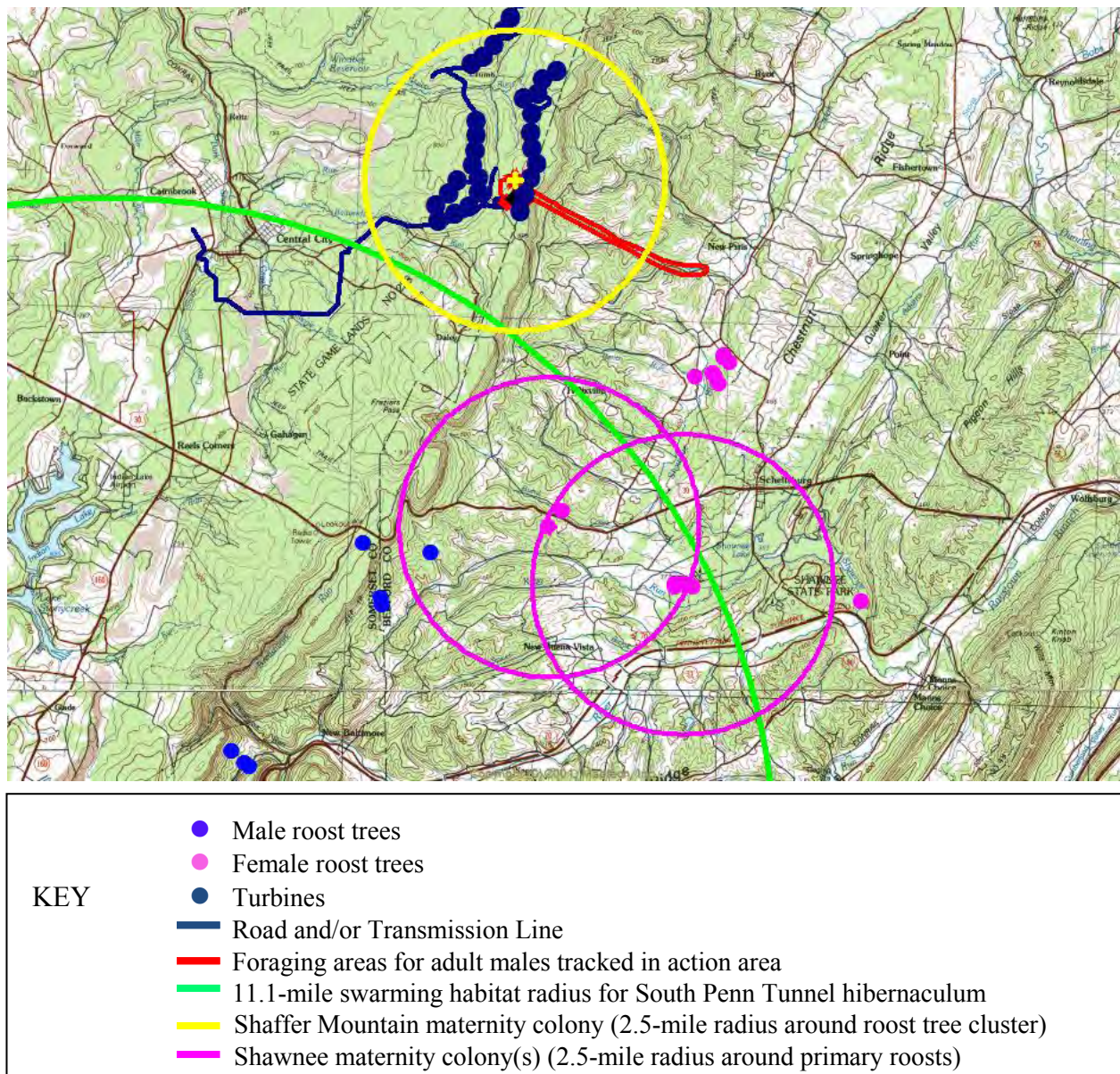


Figure 10. Indiana bat habitat use in and near the action area.

Hibernating Population

The South Penn Tunnel is a P3 hibernaculum located approximately 9.5 miles southwest of the project area, in Somerset County. This Indiana bat hibernating population was first discovered in 1999, and is monitored by the Pennsylvania Game Commission during biennial mid-winter counts. They have documented an increase in this population – from 23 bats in 1999, to 139 bats in 2007. In 2011, bats at this site were confirmed to have signs of WNS (G. Turner, Pennsylvania Game Commission, *in litt.* 2011).

A spring radio-telemetry study was carried out on the Indiana bat population at the South Penn Tunnel (Chenger and Sanders 2007). This study led to the discovery of an important dispersal corridor along the Raystown Branch of the Juniata River, as well as maternity colonies and habitat for adult males within 13 miles east, northeast, and southeast of the South Penn Tunnel (Chenger and Sanders 2007). During the spring telemetry study, 15 Indiana bats were fitted with transmitters and 11 of these, including five females and six males, were followed through migration to their presumed summer roosting areas. The five females settled into three distinct roost tree clusters scattered over a four-mile reach of the valley near Shawnee State Park (Figure 10). Most of the females occupied two roost tree clusters, located approximately five and seven miles southeast of the project area, respectively. Maximum exit counts from these two clusters were nine and 50, respectively. Based on the distance between these two roost tree clusters – approximately 2.4 miles – they may either represent a single maternity colony or two distinct colonies. We are referring to the female summer population in the valley near Shawnee State Park as the Shawnee maternity colony. One of the tracked females was followed to a third cluster of roost trees, located approximately four miles east of the project area in the valley below the Allegheny Front. Based on exit count surveys and tracking data, this female appeared to be roosting solitarily in this cluster of trees and did not interact with females from the Shawnee maternity colony, so she was probably non-reproductive that year. The Shawnee maternity colony is far enough from the project area (≥ 5 miles) that it is not expected to be affected by project construction or operation. It is not known whether the Shaffer Mountain maternity colony includes any individuals from the South Penn Tunnel hibernaculum, but this is likely considering several radio-tracked females from this hibernaculum have settled nearby in the adjacent valley.

The six males that were followed from the South Penn Tunnel to their summer habitat all established roosting and foraging areas within approximately eight miles of the hibernaculum. The roosting areas for some of those males are shown in Figure 10. Exit counts from male roost trees never exceeded one, suggesting the males all roosted solitarily. Unlike the females, the males roosted and foraged in hilly areas and around low order streams. Four of the males roosted and foraged in steep terrain on the eastern slope of the Allegheny Front. It is not known whether the adult males that were captured in the project area originated from the South Penn Tunnel, but it is likely considering males from the Tunnel have been documented to forage and roost within five miles of the project area during the summer.

A fall telemetry study was also carried out at the South Penn Tunnel (Chenger *et al.* 2007) in an attempt to identify fall (swarming) habitat used by male and female Indiana bats. During this study, eight female and nine male Indiana bats were radio-tagged. Four of the eight females

immediately entered hibernation, while the other four used habitat a maximum of 8.0, 10.1, 10.3, and 11.1 miles from the hibernaculum (average of 9.9 miles). Five of the nine males stayed within one mile of the hibernaculum, while the other four used habitat a maximum of 7.4, 7.8, 7.8, and 7.9 miles from the hibernaculum (average of 7.7 miles). As was the case with the summer habitat that was identified during the spring telemetry study, the fall habitat was located to the east and northeast of the South Penn Tunnel. Although some of the bats moved and foraged along the Allegheny Front, none of the tracked bats used habitat any closer than four miles from the project area.

Factors Affecting the Species' Environment within the Action Area

The primary uses of the action area include timber production, coal mining, agriculture, and oil and gas development. Active and reclaimed strip mines are evident in the western part of the action area, while agriculture is dominant east of the Allegheny Front, where forest cover is highly fragmented. The portion of the action area that overlaps the project footprint is predominantly forested, and most likely to be used for timber production.

In addition to land use activities, WNS is beginning to affect Indiana bats in the action area. It has been confirmed at the South Penn Tunnel hibernaculum, and is now confirmed or suspected to occur in several southwestern Pennsylvania counties (Figure 7).

EFFECTS OF THE ACTION

"Effects of the action" refers to the direct and indirect effects of an action on listed species or critical habitat, together with the effects of other activities interrelated and interdependent with that action which will be added to the environmental baseline. The ESA defines indirect effects as those caused by the proposed action and that are later in time, but are still reasonably certain to occur (50 CFR §402.02). Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. In conducting its effects analysis, the Service must consider the direct and indirect effects of the action in conjunction with the effects of other past and present federal, State, or private activities within the action area. The Service must also consider the cumulative effects of future State or private activities that are reasonably certain to occur within the action area.

This section includes an analysis of the direct and indirect effects of the proposed action on the Indiana bat, as well as the effects of actions that are interrelated and interdependent. As discussed under "Project Description", the proposed federal action is issuance of a Clean Water Act (33 U.S.C. §1344), Section 404 permit to Shaffer Mountain Wind, LLC for permanent impacts to wetlands under the jurisdiction of the Corps of Engineers. A portion of a wetland would be filled during construction of an access road needed for the construction and upgrade of electrical transmission lines associated with the Shaffer Mountain Wind Farm. The electric transmission lines are necessary for power transfer from the wind facility, and the access road is necessary to construct and upgrade the transmission lines. Consequently, the wind farm is interdependent with the proposed action, so the effect analysis will consider the effects of the wind farm on Indiana bats consistent with 50 CFR §402.02.

The proposed project will affect an Indiana bat maternity colony and adult male Indiana bats, as well as their summer foraging and roosting habitats. In addition, the project will affect swarming habitat, and swarming and migrating Indiana bats. The effects of the action depend, to a great extent, on the reaction of Indiana bats to changes in their environment. While most of the habitat impacts will occur during site preparation, most of the effects likely to result in take of the species will occur after construction, while the turbines are in operation.

Our effects analysis evaluates the anticipated impacts to each of the five stages of the Indiana bats' annual cycle: hibernation, spring migration, summer period, fall migration, and swarming. No critical habitat is located within the action area; therefore, no adverse effects on designated critical habitat are anticipated. Below we have assessed each of the various project components and their anticipated effects on Indiana bats. Minimization measures are considered part of the proposed action, so the effects of these measures in reducing or partially offsetting effects on Indiana bats are considered as well.

While analyzing the effects of the action, the Service considered the following factors:

Proximity of the action: 1) *Swarming bats and their habitat* – Site-specific studies have found Indiana bats foraging and roosting up to 11.1 miles from the South Penn Tunnel during the fall. Most of the proposed transmission line corridor occurs within this swarming habitat radius, which means swarming bats and their habitat could be affected by transmission line construction. The closest turbine is 12 miles from the hibernaculum (beyond the maximum identified swarming radius), so we do not expect turbine operation to affect fall swarming bats. 2) *Migrating bats* – Turbines are close enough to known Indiana bat hibernacula (12 miles from a P3 hibernaculum and 32 miles from a P2 hibernaculum) that they pose a risk to migrating Indiana bats as they move to and from hibernacula in the spring and fall. 3) *Maternity colonies and adult males* – As stated in the environmental baseline, maternity colonies occur in and near the action area. Based on the typical foraging range of female Indiana bats, the Shawnee maternity colony is unlikely to be exposed to wind turbines or to any changes that occur to the environment. However, the range of the Shaffer Mountain maternity colony occurs within the action area. We believe these bats, along with adult males found within the action area, are likely to be adversely affected. 4) *Hibernaculum and hibernating bats* – Due to the distance from the nearest known Indiana bat hibernaculum (South Penn Tunnel – 9.5 miles from the project area), we do not anticipate that hibernacula or hibernating bats will be affected by project construction or operation. However, the hibernating population(s) to which Shaffer Mountain maternity colony members belong are expected to be affected due to loss of bats in the action area from turbine operation.

Distribution: Turbines will be distributed in two strings within a heavily-forested, 2 x 4 mile area, making this a high-risk zone for bats due to turbine operation. Habitat loss will follow the turbine strings and also continue along approximately six miles of transmission line and road to the southwest of the turbine strings. The 145 acres of forest loss will be widely distributed over this large project area, and occur in narrow corridors as a result of road, transmission line, and turbine construction.

Timing: Direct effects on bats in their swarming habitat will be avoided because tree cutting will occur when bats are hibernating (November 15 to March 31). Direct effects on bats in their summer habitat will be avoided as tree removal activities will occur while bats are in hibernation or concentrated near their hibernacula (October 15 to March 31). The indirect effects of habitat loss on the maternity colony will be experienced in the season(s) immediately following habitat removal. Turbine operation will occur year-round, posing a risk of killing or injuring Indiana bats during the summer, and during the spring and fall migration periods.

Nature of the effect: The proposed project activities are expected to result in 1) permanent loss of summer foraging and roosting habitat through removal of that habitat, potentially harming maternity colony members and adult males; 2) permanent loss of swarming habitat; 3) modification of Indiana bat behaviors in response to habitat loss; and 4) death and injury of bats due to turbine operation.

Duration: The proposed action will cause the permanent destruction and alteration of the available habitat for Indiana bats using the site. Turbine operation will remain a risk to bats throughout the life of the project.

Disturbance frequency: Land clearing for turbine, road, and transmission line construction is expected to occur over a single winter season, with the resulting harm due to habitat loss occurring primarily during the first year following habitat removal. Turbine operation is expected to occur year-round, posing an ongoing risk of harm during the spring, summer and fall, when bats are active.

Disturbance intensity: 145 acres of forest will be permanently lost, but this is widely dispersed over a largely forested area. The air space around and between 30 turbines covering a 2 x 4 mile area will become a high-risk area for bats throughout their spring, summer and fall activity periods over the life of the project.

Disturbance severity: The additive mortality from wind turbine operation will affect local Indiana bat populations, but implementation of the Adaptive Management Plan will reduce mortality such that the maternity colony is expected to persist.

Site Preparation

Site preparation will range from the cutting of trees and shrubs in some areas, to the complete removal of all vegetation in others. As a result, approximately 23 acres of non-forested land and 145 acres of forested land will be cleared (Table 2, section 6.1 of the BA). Non-forested land includes agricultural or pasture lands (2 acres), developed open space (19 acres), and barren lands (2 acres). Forests to be affected include deciduous (123.3 acres), evergreen (14.3 acres), and mixed deciduous (7.8 acres).

In the transmission line right-of-way, impacts to vegetation will primarily involve tree and shrub removal to ensure vegetation will not interfere with the transmission line. Vegetation in the transmission line right-of-way will be maintained in an herbaceous or shrubby state, providing suitable foraging habitat for Indiana bats, especially where the right-of-way is bordered by forest.

Where roads, turbine pads, and the staging area are proposed, vegetation will be completely cleared and the project footprint will be graded as necessary to accommodate these features. The areas immediately adjacent to these features will be re-seeded and allowed to establish as herbaceous vegetation.

Swarming Habitat

Approximately 4.7 miles of transmission line in the western part of the project area occurs within an 11.1-mile radius (swarming radius) of the South Penn Tunnel hibernaculum (Figures 2 and 10). Due to the proximity of this hibernaculum to the project area, there is a detailed discussion of how Indiana bats associated with the hibernaculum use fall habitat (see “Status of the Species within the Action Area”). In the fall, radio-tracked females tended to forage and roost in the same valley that the Shawnee maternity colony used during the summer, while males tended to forage and roost in higher elevation, hilly areas and around low order streams (Chenger *et al.* 2007). Although none of the radio-tracked bats foraged or roosted in the area of the proposed transmission line, this area is certainly within the maximum radius (11.1 miles) that Indiana bats were found to swarm in the fall (Chenger *et al.* 2007). Considering only 12% of the hibernating population (17 of 139 bats) was tracked, the swarming habitat for 88% of the population has not been identified, but likely occurs within the identified swarming radius. Because all of the tracked bats used swarming habitat close to the hibernaculum or in the valley east of the hibernaculum (within or near documented summer habitat), we expect much of the hibernating population may exhibit similar habitat use patterns.

The applicant has committed to implement a seasonal restriction on tree clearing, with all tree cutting occurring between November 15 and March 31 within the swarming radius of the South Penn Tunnel hibernaculum. Because Indiana bats will be hibernating at this time, they will not be vulnerable to death and injury from the felling of roost trees within the transmission line right-of-way. However, these bats may be indirectly affected by the loss of fall swarming habitat when they emerge from hibernation the following spring.

While most of the swarming habitat use is expected to occur near the hibernaculum or in the valley east of the hibernaculum (Chenger *et al.* 2007), this does not preclude the use of forest habitat elsewhere within the swarming radius. Assuming the nine radio-tracked males are representative of the male swarming population, we would expect approximately half of the males (35) to forage and roost within one mile of the hibernaculum and the remainder (35) to occupy individual territories scattered throughout suitable forest habitat within the swarming radius. Based on the distribution of forest habitat within the swarming radius, we estimate that potentially one or two males could have foraging and/or roosting habitat in the area of the proposed transmission line right-of-way. These are the individuals who would be most affected by the loss of forest habitat.

Within the swarming radius, trees will be cut within a 30-foot-wide transmission line corridor. Where the corridor passes through forests, the surrounding habitat on either side of the cleared corridor will continue to serve as foraging and roosting habitat. We would expect Indiana bats whose foraging ranges overlap the right-of-way to continue to use undisturbed forests on either

side of the transmission line for foraging, as well as to use open herbaceous or scrub-shrub habitat within the transmission line corridor for foraging. Male Indiana bats are more flexible in their roost tree selection than females, so if a male does lose a roost tree within the transmission line corridor, we would expect the male to shift to other available roost trees on either side of the corridor. We do not expect female Indiana bats to lose fall foraging or roosting habitat during transmission line construction because the corridor is far from the valley where the tracked females occupied both summer and swarming habitat.

Fidelity to Summer Habitat

An important feature of Indiana bat behavioral biology that is integral to the discussion of the effects of the proposed project is the fact that female Indiana bats exhibit site fidelity to summer roosting and foraging areas (see “Life History”). That is, Indiana bats return to the same summer range annually to bear their young (Kurta and Murray 2002; Kurta *et al.* 2002; Garner and Gardner 1992; Gardner *et al.* 1991b; Humphrey *et al.* 1977; Gardner *et al.* 1996). Indiana bats may migrate up to 300 miles from their hibernacula to their maternity areas, and members of one maternity colony may come from many different hibernacula (Kurta and Murray 2002; Gardner and Cook 2002). The Indiana bat’s site fidelity may serve to allow members of a maternity colony to relocate each other and regroup in the spring. When Indiana bats return to their summer range, they will attempt to use the same roosting and foraging areas that were used in previous years.

Summer Roosting Habitat

Removal of a roost tree while Indiana bats are present would likely result in the direct killing, injuring, or harassing of individual bats or potentially of several bats roosting together in a maternity roost tree. To avoid this potential, the applicant will cut trees from October 15 to March 31, when Indiana bats are hibernating or concentrated near their hibernacula.⁵ Based on this seasonal restriction, we do not anticipate any direct adverse effects from the felling of summer roost trees. In addition, Indiana bats will not be subject to the noise and disturbance associated with tree cutting and removal.

The southeastern part of the action area appears to be particularly important for roosting, based on the presence of four confirmed roost trees in that area (Figure 9). These roost trees are approximately 1300 feet from an existing road, and will be 1000 feet from the new road associated with the eastern turbine string. Even though direct bat mortality will be avoided due to the seasonal restriction on tree cutting, primary or alternate roost trees may be felled during site preparation. Although none of the four identified Indiana bat roost trees are located within the areas to be cleared, only limited telemetry data for two adult male Indiana bats has been collected. Radio-tracked bats represent only a sub-set of the total number of Indiana bats present on-site, so it is likely that both the maternity colony and the adult males are using additional roost trees that have not been identified. Furthermore, there are no telemetry data available for the female or juvenile bats associated with the maternity colony. Based on roost tree exit counts, the identified roosts may be alternate rather than primary maternity roosts. Therefore, the

⁵ As discussed above, in the portion of the project area that occurs within the swarming radius of the South Penn Tunnel hibernaculum, trees will be cut between November 15 and March 31.

location of the maternity colony's primary roosts remains unknown.

If primary or alternate roost trees are removed, it will result in indirect effects on the bats that return to this area in subsequent years to roost. When roost trees remain suitable for roosting from one year to the next, Indiana bats often use the same trees. The premature removal of a roost tree – particularly a primary maternity roost – will force bats to relocate to another roost tree upon their return in the spring. Roost trees, however, are an ephemeral resource. Due to weathering, decay, and insect activity, roost trees naturally become less suitable over time as their exfoliating bark eventually falls off or the snag falls over. It is likely that due to the ephemeral nature of roost trees, the Indiana bat has evolved to be able to locate replacement roosts when their previously used roost trees become unsuitable. Studies have shown that adults in maternity colonies use multiple roosts (Humphrey *et al.* 1977; Gardner *et al.* 1991a; Garner and Gardner 1992; Callahan 1993; Kurta *et al.* 1993). Bats that are aware of alternate roost sites are more likely to survive the sudden, unpredictable destruction of their present roost than bats which have never identified such an alternate (Kurta *et al.* 2002; Kurta and Murray 2002; Gumbert *et al.* 2002).

In the case of the subject project, trees will be cut primarily in narrow corridors associated with the transmission line and roadway. Most of the remaining, surrounding habitat is heavily forested and provides an abundant supply of potential roost trees. Sampling indicates there is a density of 2.3 potential roost trees per acre in the project area, and 43.0 potential roost trees per acre in the surrounding action area (BA, p. 14). Considering the availability of potential roost trees in the action area, the loss of any unidentified roost trees as a result of the project is not expected to significantly disrupt maternity colony structure, unless a primary maternity roost is cut. It appears that when a primary roost tree falls, members of the colony may initially distribute themselves among several previously used, alternate roost trees, and the colony becomes more dispersed (Kurta *et al.* 2002). It is not known how long it takes for the colony to attain the same level of roosting cohesiveness that it experienced prior to the loss of a primary roost tree. Until the bats from the colony locate another desirable primary roost tree and reunite, it is likely that individual members of the colony will be subject to increased stress resulting from 1) having to search for a replacement primary roost tree(s); 2) having to roost in alternate trees that are less effective in meeting thermoregulatory needs; and 3) having to roost singly, rather than together, which decreases the likelihood of meeting thermoregulatory needs, thereby reducing reproductive success. The use of sub-optimal roosts has been shown to result in reduced reproductive success in other bats species such as the big brown bat (*Eptesicus fuscus*) (Kunz and Lumsden 2003).

The locations of the maternity colony's primary roost trees are unknown, but it is reasonable to believe they are in the same general area as the cluster of identified roost trees (see "Status of the Species in the Action Area"). Within 0.5 mile of this roost tree cluster, trees will be cut for roads, turbines, and a staging area (Figure 9). If one or more primary roosts are cut, we would expect Indiana bats to be harmed due to the effects described above. The retention of the known cluster of roost trees may minimize the harm that would be expected from loss of a primary roost, as this roosting area will continue to serve as an established area for the colony to gather and search out additional primary and alternate roost trees. We would expect harm (reduced survival and/or reduced reproduction) from the loss of one or more primary maternity roosts to

occur during the first season following tree removal. By the second season following tree removal, we anticipate the colony would find a replacement primary roost(s) and be able to reunite, because 1) known, alternative roost trees are located nearby and will remain, making relocation possible for the colony, and 2) the remaining forest habitat in the action area should provide adequate roosting opportunities for the colony.

Based on capture and telemetry data, it appears that adult male Indiana bats are sharing habitat with a maternity colony. Adult males are less selective in their choice of roost trees (Kurta 2005), probably because they are not faced with the thermoregulatory needs unique to pregnant and lactating females and their young. As a result, males are probably better able to adapt to the loss of a roost tree, particularly when there is an abundance of potential roost trees nearby. Loss of any unidentified roost trees is not expected to significantly disrupt the ability of males to roost or reduce their ability to survive. The known roost tree cluster for the two radio-tracked adult males will be retained, serving as an established area for at least these males to continue to roost and search out additional roost trees.

Summer Foraging Habitat

The southeastern part of the action area appears to be particularly important for foraging, based on the capture of both juvenile and adult Indiana bats in that area for two consecutive years (Figure 9). As discussed above, it is not surprising that Indiana bats would be captured in the same area over multiple years, considering the species' fidelity to its habitat. The area of identified foraging habitat is based on a telemetry study which was conducted for a very short period of time (one to four nights per bat) during a single season (Chenger 2008), so it is unlikely that the study captured the full extent of habitat use by these bats. Furthermore, this telemetry study did not include any adult females or juveniles, so the distribution of maternity foraging habitat is not known. Nevertheless, it is likely that all or most of the foraging habitat for the maternity colony occurs within the defined action area, based on the delineation of the maternity colony's range around the identified roost tree cluster (see Figures 1 and 2, and also "Status of the Species within the Action Area").

Approximately 145 acres of foraging habitat will be affected during site preparation activities. Of the 145 acres of forest, approximately 80% will be developed with the wind farm and 20% converted to vegetated open land (*e.g.*, utility line rights-of-way). As discussed above, herbaceous and shrubby vegetation within the transmission line right-of-way will probably be suitable for foraging, particularly where these open-canopy habitats are adjacent to forests.

Forest impacts from this project correspond to 0.4% of the action area (145 of 41,324 acres). The project area itself is heavily forested ($\geq 80\%$), with very little fragmentation from permanent openings (*e.g.*, roads, houses, fields). East of the Allegheny Front, the action area descends into a valley with fragmented forest interspersed with agricultural fields. Forest cover in this part of the valley ranges from approximately 40-60%, and it is in this area where one of the adult male Indiana bats consistently foraged (Chenger 2008). The western part of the action area is forested, but includes large clearings (100+ acres) associated with past and current mining operations.

Considering forest loss will occur in narrow corridors (e.g., 45-foot roadways) within a heavily-forested landscape, it is likely that Indiana bats will continue to use forests on both sides of the cleared corridors. This conclusion is supported by observations of Indiana bats associated with a maternity colony in central Pennsylvania. In that study (Butchkoski and Hassinger 2002), the size of the foraging areas used by tracked Indiana bats ranged from 96 to 276 acres, and some of these foraging areas were bisected by a heavily used, two-lane highway. Indiana bats whose foraging areas were bisected by the road routinely foraged on both sides of the road, although they faced an increased risk of mortality due to collisions with vehicles. Therefore, while the proposed project will fragment forest habitat, the level of fragmentation is not expected to isolate or preclude the use of foraging areas due to the narrow, linear nature of the clearings.

The effect of tree clearing on individual bats will depend on the location and size of their foraging ranges with respect to the cleared areas. Using the minimum and maximum foraging area sizes noted above (96 and 276 acres), tree clearing associated with road and transmission line corridors would be expected to affect 2.4 - 4.0 acres (1.5 - 3.1%) of the habitat within a foraging area that is 80-100% forested and is bisected by a single corridor. However, bats with foraging areas in the southern part of the project area will experience greater impacts on their foraging habitat due to the presence of multiple project features, including a staging area and denser road network. For example, the male bat that foraged in the vicinity of the pond (Chenger 2008) is likely to lose at least 10 acres of its foraging habitat due to clearing associated with roads, turbines, and a staging area. Conversely, bats whose foraging areas do not coincide with project features will not experience any loss of foraging habitat.

A minimum threshold, or optimum amount of summer foraging habitat has yet to be defined for Indiana bats. However, even in light of the projected forest loss, the project area will be more heavily forested than the valley where an Indiana bat routinely foraged in fragmented forests interspersed with agricultural fields (Chenger 2008). The two tracked Indiana bats foraged in a variety of wooded areas, including wooded hillsides, woodlots surrounded by meadows, a small clearing near a pond, and unbroken forests on the eastern slope of the Allegheny Front. Because the project is largely linear in shape, loss of forest habitat in any particular area important to the bats is minimized as compared to the effects that might be anticipated due to clearing of large blocks of forest with simultaneous loss of multiple roost trees.

Although forest clearing during site preparation may not represent an appreciable reduction in the amount or quality of foraging habitat, individual Indiana bats will have to adjust to this habitat loss by adjusting the size or configuration of their foraging areas. Indiana bats using the affected forest areas for foraging will have alternative foraging habitat available within the action area, but they will likely have to shift or expand their foraging ranges into areas previously unused by them to make up for the loss of foraging habitat. The impact of shifting flight patterns and foraging areas will vary from bat to bat. However, considering the relatively small amount of habitat that will be lost with respect to the forest habitat that is available, we do not anticipate that these adjustments in foraging ranges will result in physiological responses sufficient to cause death or injury, or to impair reproduction.

Habitat Connectivity

Site preparation for the road network, transmission line, staging area, and turbine pads will occur in the midst of foraging and roosting habitat. While no known roost trees will be lost, tree clearing for this project is likely to bisect the foraging areas of multiple bats and also bisect travel corridors between roosting and foraging areas. For example, tree clearing for the eastern turbine string will not only bisect the foraging area of one of the tracked Indiana bats, but will also occur between its roosting and foraging areas (Figure 9). The extensive road network and transmission line corridor is expected to cross through and between the foraging and roosting areas for other Indiana bats as well, which are likely have home ranges dispersed throughout the action area. However, the loss of forest habitat within the narrow road and transmission line corridors is not expected, in and of itself, to reduce habitat connectivity. Where cleared areas are maintained as herbaceous or shrubby habitat (*i.e.*, the transmission line corridor), they are expected to continue to serve as Indiana bat foraging habitat, particularly where they abut forest. As discussed above, where cleared areas are converted to roads, we anticipate bats will cross the roadways to move between and within roosting and foraging areas.

Duration of the Effect

Tree cutting will occur over a single winter, when Indiana bats are hibernating. If the project solely involved tree cutting as described above, we would expect the effects on Indiana bats to occur primarily during the spring and summer immediately following the habitat loss. However, as discussed below, the effects of habitat loss will not occur in isolation – they will be exacerbated by project construction and operation, resulting in effects that last over the life of the project.

Habitat Conservation

To partially offset the short- and long-term effects of habitat loss on Indiana bats, the applicant will permanently protect 145 acres of forest habitat for an Indiana bat maternity colony. This habitat conservation would benefit either the on-site maternity colony or the maternity colony in the valley adjacent to the action area, so the local Indiana bat population would benefit. The particular conservation parcel(s) has not been identified yet, but it will be subject to review and approval by the Service, as detailed in the Adaptive Management Plan.

While permanent protection of existing forest will not fully offset the loss of 145 acres of forest and extensive fragmentation of forest within the action area, it will prevent the loss of the conserved forest stands, thereby maintaining roosting/foraging habitat for Indiana bats associated with a maternity colony in or near the action area. Given the risk of forest loss and fragmentation in the action area and adjacent valley (*e.g.*, due to mining, timber harvesting, oil and gas development, agriculture), the permanent protection of forest habitat for a maternity colony will contribute to the long-term conservation of the local Indiana bat population.

Project Construction

After trees have been cut and cleared from the project area, the transmission line will be installed, and the areas associated with the roadway, turbine pads, and staging area will be graded as necessary. Roadways and turbine pads will be constructed using a variety of heavy equipment, and then turbines will be erected. All of this construction activity is expected to occur over a 9-month period, running from early April through late December.

Construction Noise

In addition to the actual habitat removal in the project footprint (which occurs during site preparation) and the indirect effects associated with that removal, the proposed project may also decrease the quality of habitat, especially near the project footprint. Indiana bats in the action area during construction will be subject to noise disturbance from clearing, grading, and construction activities carried out by heavy equipment (*e.g.*, bulldozers, graders, cranes, dump trucks). As a result, Indiana bats will be exposed to noise levels, or intensity of noise and vibrations, that they have probably not experienced in the past. Considering the remote nature of the project site, including its low density of rural roads, construction noise is expected to greatly exceed ambient noise levels.

Noise impacts associated with the project are anticipated to be greatest during the construction period, which will coincide with a full season of bat activity. No construction is anticipated on the site at night, so construction noise and activities will not interfere with bat foraging activities. However, the noise and vibrations generated by heavy equipment during site grading, road construction, transmission line construction, turbine pad construction, and turbine erection could disturb roosting bats during the day and thereby temporarily lower the suitability of habitat adjacent to the project footprint.

It is reasonable to assume that some Indiana bats may be temporarily disturbed by noise and vibrations from construction activities within or directly adjacent to roosting habitat. This disturbance is expected to be localized around the footprint of project features (*e.g.*, roads, turbine pads) and may affect one or more bats during the construction period. While the location of all roost trees for this colony is not known, the cluster of four known roost trees is approximately 1000 feet from the nearest proposed road, and 2000 feet from the staging area. Noise attenuation within the forested buffer that exists between construction areas and the known roost trees will reduce the likelihood of disturbing bats that roost in these particular trees. Where construction activities are close to other occupied roost trees, we would expect bats to respond by shifting their roosting away from active construction areas. Most of the remaining, surrounding habitat is heavily forested and provides an abundant supply of potential roost trees. Therefore, while noise may disturb roosting bats, we do not expect it to lead to death or injury by excluding bats from other nearby roosting areas.

Construction Lighting

Construction activities will only occur between sunrise and sunset, so lighting is not anticipated during construction. Consequently, foraging bats will not be exposed to construction lighting.

Construction Dust

The creation of airborne dust by construction equipment is likely to occur in all earth moving projects, but the magnitude is dependent on many factors, including humidity, wind velocities and direction, and location of soil disturbances. Dust will be created during the spring, summer, and autumn when Indiana bats are roosting and foraging in adjacent forest.

Airborne dust from earth moving activities is a short-term effect, occurring primarily during activities in the daytime, and abating at night when relative humidity increases, causing dust to settle. Suspended dust could interfere with roosting bats if it causes respiratory distress or coats their fur, causing them to relocate to roosts farther from the work area. Any potential effects from dust would be very local within and immediately adjacent to the project footprint. The presence of adjacent vegetation will greatly reduce the settling distance. It is very unlikely that dust created from construction would drift underneath the bark where an Indiana bat is roosting, or reach levels that would result in injury, physiological impairment, or death.

Water Quality Impacts

There will likely be temporary water quality impacts during construction due to earth disturbance, associated runoff, and use of construction vehicles. However, the applicant will implement several measures to reduce the risk of sediment and contaminants reaching action area wetlands and waterbodies pursuant to their Erosion and Sediment Control Plan and NPDES permit. Best management practices (BMPs) and erosion and sediment control measures will include aerial crossings of wetlands, use of timber mats and pipe bundles for temporary wetland and stream crossings, water bars, diversion berms, sediment traps, vegetative buffers, and level spreaders.

The use of BMPs and erosion and sedimentation control measures is expected to significantly reduce the potential for water quality impacts during construction. However, it is still possible to have periods where erosion and sedimentation cause short-term declines in aquatic insect populations in adjacent wetlands and waterways. This would result in a localized reduction in prey base and drinking resources for the Indiana bat. Potential impacts from sedimentation are expected to remain near the source of sedimentation (*e.g.*, roadway), so Indiana bats would be able to relocate upstream or downstream to forage. Moreover, the diet of Indiana bats is not restricted to aquatic insects, since they also forage on terrestrial insects. The surrounding landscape will continue to provide an abundant prey base of both terrestrial and aquatic insects during project construction, operation, and maintenance. Therefore, any potential effects on Indiana bats from localized reductions in water quality are anticipated to be insignificant.

Project Maintenance

Project maintenance is expected to include periodic maintenance of transmission lines, roads, turbines, turbine pads, transmission line rights-of-way, and road rights-of-way.

No tree removal is expected to occur during project maintenance activities, because ongoing

maintenance will retain previously-cleared areas (e.g., adjacent to roads, within transmission line rights-of-way) in an herbaceous or shrubby condition. Road, turbine, and turbine pad maintenance will occur in areas that were cleared of all vegetation during site preparation and construction activities, so no further vegetation disturbance is anticipated. Any tree cutting within transmission line rights-of-way and along roadways would have been done during site preparation and construction. The resulting herbaceous vegetation within transmission line rights-of-way, along roadways, and in the vicinity of turbine pads will be periodically mown to keep it in an herbaceous or shrubby state. Mowing is expected to occur during the day when Indiana bats are roosting in forest habitat, so they are not expected to be harmed or disturbed due to the maintenance of herbaceous/shrubby vegetation.

Periodic road maintenance will be needed as gravel roads and their associated culverts and roadside drainage ditches degrade through use, erosion, and weather events. Heavy equipment (e.g., dump trucks, graders, backhoes) would be used to repair and maintain the road system, and this maintenance would most likely occur during the daylight hours when Indiana bats are roosting in forest habitat. While road maintenance is occurring, it will probably generate less noise than road construction, because maintenance activities are expected to occur over shorter periods of time and in more localized areas than the original project road construction. In addition, maintenance activities may require the use of fewer vehicles.

The known roost tree cluster is approximately 1000 feet from the nearest road, a distance that is probably sufficient to preclude any harm or harassment due to road maintenance activities. However, it is likely that Indiana bats are using additional roost trees whose location is not known at this time. Furthermore, the location of roost trees will change over time as individual roost trees lose bark and fall to the ground, and bats shift their roosting to other suitable trees. If roost trees are close to the road system, roosting Indiana bats may be disturbed during road maintenance activities. However, we expect that within any particular road reach the disturbance would be short-term (a day or potentially a few days), and that bats would shift to alternate roosts farther from the road if noise reaches a level that disturbs them. Regardless, we would not expect noise to reach a level that would result in take in the form of harm, although short-term disturbance of roosting bats is possible, depending on the distance between occupied roost trees and road maintenance activities.

Project Operation

Project operation is expected to include vehicle traffic (road use), lighting, and turbine operation. The effects of each are discussed below.

Road Use

Indiana bats are vulnerable to mortality from vehicle strikes, especially when traffic volume and speed are relatively high and the road occurs within established foraging areas (Russell *et al.* 2009). In the case of the Shaffer Mountain wind project, both traffic volume and speed are expected to be quite low on the rural, unpaved roads that will be constructed to access and maintain the wind project. Furthermore, vehicle traffic will be restricted to between sunrise and sunset, when Indiana bats are roosting. Consequently, there is no risk of road kills or disturbance

of foraging bats.

Should bats roost near the road, they may be disturbed by road use. However, the potential for disturbance is low because traffic volume, frequency, speed, and noise levels are all expected to be low during project operation. In addition, the applicant will establish speed limits for operations vehicles. If roosting bats are disturbed by periodic traffic on the gravel roads, we anticipate they will move to potential roost trees elsewhere in the heavily-forested action area. As discussed above (see “Site Preparation”), we do not expect the presence of roads or their use to preclude use of foraging habitat in the action area.

The degree to which roads influence the availability of potential roosting habitat is not clearly understood. Garner and Gardner (1992) report that Indiana bats select roosts near intermittent streams and far from paved roads, particularly adult females (pregnant, lactating, post-lactating) who rarely roosted less than 500 meters from a paved road in Illinois, as compared to juveniles and males. However, in Michigan, Kurta *et al.* (2002) found no difference between roost trees and random points in distance to roads of any type. In central Pennsylvania, Indiana bats have been observed actively moving along and over S.R. 22, although the primary maternity roost structure for the Canoe Creek maternity colony is located approximately 650 meters (0.4 mile) from the roadway, and alternate day roosts were found 300 to 1000 meters from the nearest road. In the action area, the four identified roost trees are 400 to 500 meters from an existing road, and will be 350 to 450 meters from the new proposed roads. Indiana bats appear able to become habituated to the nearby presence of traffic in settings where avoiding roadway activity is not possible. In the case of the Shaffer Mountain project, the presence of roosting habitat throughout the action area will allow Indiana bats to select roosting areas away from roads, if the roads are perceived as a source of disturbance.

Lighting

Thirteen of the 30 turbines will be lit with medium-intensity, red synchronized flashing LED obstruction lights with a flash frequency of 20 flashes per minute. While some bat species congregate and feed near lights, there is no indication that lights on wind turbines contribute to bat mortality. Studies indicate there is no statistical difference in bat mortality rates between turbines lit with FAA lights and unlit turbines, or between turbines lit with different types of FAA lighting (Arnett *et al.* 2008, Horn *et al.* 2008, Jain *et al.* 2007).

Turbine Operation

The project involves the operation of 30 turbines in two parallel strings that are 4.2 and 2.5 miles long. The two strings are approximately one mile apart and generally run north-south through an area that is predominantly forested. Forested stream valleys occur between the turbine strings, as well as to their west and east. The wind farm is situated in an area that provides high-quality foraging and roosting habitat for bats, evidenced by the mist-net survey results.

Mortality Risk – Operational wind turbines pose a risk of killing and injuring bats, including Indiana bats. Risk appears to be a complex interplay between turbine characteristics, environmental conditions, operational parameters such as cut-in speed, and bat behavior. Due to

post-construction mortality monitoring at several wind facilities over the past few years, we have a better understanding of the factors that influence this mortality risk. However, it is not possible to precisely quantify that risk for individual bats that are resident to an area or migrating through an area where wind turbines are located.

Turbine characteristics that influence risk include turbine height and rotor diameter⁶, both of which are positively correlated with bat mortality (Arnett *et al.* 2008). It is the spinning turbine blades that pose the mortality risk; no bat fatalities have been reported due to non-operational turbines (Arnett 2005, Kerns *et al.* 2005). Environmental factors that appear to influence risk include geographic location, wind speed, weather patterns, surrounding habitat, and insect activity (Arnett *et al.* 2008, Horn *et al.* 2008). Mortality rates are significantly higher on the forested ridges of the Appalachian Mountains than elsewhere in the United States (Arnett *et al.* 2008). Also, mortality appears to be highest on low wind nights, after storms, and during periods of higher barometric pressure (Kerns *et al.* 2005). At the Meyersdale and Mountaineer wind facilities, 82% and 85% of the bat fatalities, respectively, occurred when median wind speeds were less than 6 m/sec, and the highest numbers of bats were found following nights with median wind speeds of 4.1 to 4.2 m/sec (Arnett *et al.* 2008, Kerns *et al.* 2005). On 81% of the nights when median wind speed exceeded 6 m/sec, no bat fatalities were observed (Kerns *et al.* 2005). It is not clear why bat fatalities are lower in high wind speeds. It may be that during high wind speeds fewer bats migrate or that they migrate at higher elevations (Baerwald *et al.* 2009). On a local scale, strong winds can reduce the abundance and activity of insects, which in turn influences bat activity (Arnett *et al.* 2010).

Based on the observations of high bat mortality during low wind conditions (Arnett *et al.* 2008, Kerns *et al.* 2005), studies have been conducted to assess the potential effectiveness of adjusting turbine cut-in speeds to reduce bat mortality. “Cut-in speed” refers to the minimum wind speed at which the wind turbine will generate usable power. A study at a wind facility in Canada documented a 57.5 to 60% reduction in bat fatalities when cut-in speeds were increased from 4.0 m/s to 5.5 m/s during the fall migration period (Baerwald *et al.* 2009). A similar study in Pennsylvania documented a 44 to 93% reduction in bat fatalities when cut-in speeds were increased from 3.5 m/s to 5.0 and 6.5 m/s (Arnett *et al.* 2010). Total fatalities at fully operational turbines in the Pennsylvania study were 3.6 to 5.4 times greater than at curtailed turbines. At the Fowler Ridge Wind Farm in Indiana, 50% and 78% reductions in overall bat mortality were realized during the fall migration period by raising the turbine cut-in speeds from 3.5 m/s (“control”) to 5.0 m/s and 6.5 m/s (“treatments”), respectively (Good *et al.* 2011).

Bat behavior also has a significant influence on mortality risk. While it would seem intuitively obvious that bats would be able to use echo-location to both detect and avoid collisions with wind turbines, this does not appear to be the case. During studies at the Mountaineer wind facility in August, bats were frequently observed near operating wind turbines (mean of 99 bats per turbine per night), with the majority of bats foraging and flying at the range of altitudes at which the turbine blades were operating (Horn *et al.* 2008). Bats flying within the rotor swept zone (29 to 111 meters above ground level) outnumbered bats flying below the rotor swept zone by a factor of 6:1. Bats were observed to investigate moving blades with repeated fly-bys, take

⁶ Rotor diameter is directly related to rotor swept area, which is the area through which the rotor blades of a wind turbine spin.

evasive maneuvers near moving blades, succumb to being stricken by moving blades, and investigate and alight on turbine monopoles and stationary blades. Investigators noted that “many of the instances of avoidance behavior involved multiple passes. Bats often appeared to investigate the turbine blades after a near miss, rather than fly off quickly. This often resulted in several additional near misses in a row, with the bat appearing to be repeatedly buffeted by turbulence close to the blade surface” (Horn *et al.* 2008).

This tendency of bats to forage and fly within the rotor swept area, and to investigate monopoles and moving turbine blades, makes the bats highly susceptible to mortality through a direct strike by a moving blade or through the indirect, but fatal effects of barotrauma. Studies have found that the pressure differential near spinning turbine blades is so significant that it causes pulmonary hemorrhaging (barotrauma) in bats (Baerwald *et al.* 2008). While direct contact with turbine blades was evident in about half of the examined bats, over 90% of the fatalities involved internal hemorrhaging consistent with barotrauma. Approximately 57% of the bats had internal hemorrhaging, but no external signs of injury (Baerwald *et al.* 2008). While bats may perceive spinning blades as a potential threat, there is apparently no perceived danger from the invisible threat of wind vortices capable of inducing barotrauma. As with direct collisions with the spinning blades, if bats are close enough to experience the effects of barotrauma, they will die from those effects rather than learn to avoid them.

The mortality risk appears to vary by species and potentially also by the species’ flight mode at the time of exposure. In North America, most documented fatalities are migratory tree-roosting bats, including hoary bats (*Lasiurus cinereus*), eastern red bats (*Lasiurus borealis*), and silver-haired bats (*Lasionycteris noctivagans*), with the highest fatality rates being observed in late summer and fall (Arnett *et al.* 2008). However, fatalities also occur during the summer, presumably affecting resident bats and their young. The observations of bats routinely flying and foraging around operating turbines at the Mountaineer facility in August could represent summer residents, migratory bats, or both. While migratory bats would presumably only be exposed to the effects of an operating turbine for a short period of time (*i.e.*, while passing through a wind facility or stopping over for a night to forage and roost), summer residents would be exposed to turbines within their home ranges for many months. It is not known to what degree short-term vs. long-term exposure to operating turbines influences mortality risk, or to what degree flight mode (migratory travel vs. foraging) influences mortality risk. However, it is reasonable to assume that the risk of mortality increases with increasing exposure, especially if bats are unable to perceive and avoid the risk of death by collision and barotrauma (Baerwald *et al.* 2008, Horn *et al.* 2008).

The proposed wind farm represents a substantial change in the landscape used by the resident maternity colony, and poses a significant mortality risk to bats due to its location and characteristics. The wind turbines are located on a forested Appalachian ridge, a geographic and topographic area associated with the highest mortality risk. The wind turbines are among the tallest and largest used by the industry. The turbines are designed to operate in low wind speeds (cut-in speed of 3 m/s), when the risk of bat mortality has been reported to be highest. Most significantly, the turbines are positioned in a forested landscape in the midst of an Indiana bat maternity colony, where mortality of the resident members is very likely to occur while bats are foraging, moving between foraging areas, moving between roosting areas, and moving between

foraging and roosting areas. Four wind turbines are within 0.5 mile of known roost trees, and all of the turbines are in and between known and potential foraging areas (Figures 2 and 9). Indiana bats are known to use edge habitat and small non-forested openings, but the distance that they will travel from the forest edge into non-wooded habitat is unknown. Data garnered thus far by Stanec (2010) on 21 radio-tagged Indiana bats show that 75% of foraging telemetry points were within 400 feet of forest edge and 97% were within 1000 feet of forest edge. Considering forest clearing for the Shaffer Mountain wind project is only expected to occur in the immediate vicinity of the turbines, each turbine will be within a few hundred feet of and surrounded by forest that is suitable for Indiana bat foraging and roosting, exposing these bats to the risk of turbine-related mortality.

Due to the species' site fidelity, members of the maternity colony are expected to continue to use their home ranges despite the presence of operating wind turbines. Consequently, the wind farm will pose a mortality risk to Indiana bats throughout the 30-year life of the project. Although the primary roost area for the colony will probably shift over 30 years, we would not expect it to shift substantially because roosting habitat remains abundant surrounding the turbines. Therefore, we would expect the maternity colony's range to continue to overlap the action area (Figures 1 and 2), subjecting the colony to the effects of operating wind turbines throughout the life of the project. Indiana bats are not known to shift primary roost locations in response to such a disturbance, and as discussed previously, will probably not learn to recognize the turbines as a risk without fatal consequences.

Because turbines are positioned throughout the range of the maternity colony (Figure 2), we would expect many of the maternity colony's members to be exposed to operating turbines. While maternity colony members typically congregate at primary colonial roosts, their foraging ranges tend to be scattered throughout the maternity colony's range. As discussed above, the maternity colony's range is typically encompassed by a 2.5-mile radius centered on the primary roost tree or roosting area. This radius is chosen because 2.5 miles is the maximum distance that females typically travel from their roosting area to forage. We would expect maternity colony members to have individual foraging ranges of 200 to 400 typically non-overlapping acres (USFWS 2007) scattered throughout the maternity colony's range. Each night, an individual may have to travel through the foraging areas of one to several bats as it moves from the colonial roosting area to its individual foraging area(s). Therefore, maternity colony members would not only be exposed to the risk of operating turbines in their own foraging areas, but also along travel routes between their foraging areas and the colonial roosting area. When mortality occurs, it is likely that the bat's foraging area will be taken over in that year or subsequent years by another colony member, particularly one familiar with the foraging area due to its travel through it. Operating turbines in the newly-occupied foraging range will pose a risk of mortality to the new occupant, as they did to the former one. As discussed above, bats are not expected to perceive and avoid the risk posed by air pressure differentials near spinning turbine blades (Baerwald *et al.* 2008), so they will be vulnerable to mortality from barotrauma throughout the summer due to the constant presence of operating turbines within their habitat. Each year, juvenile bats will also be exposed to operating turbines for the first time while they are learning to fly. Their limited flight experience is expected to substantially increase their risk of mortality from direct turbine blade strikes and from barotrauma.

To reduce the risk of turbine-related mortality, the applicant will implement an Adaptive Management Plan (Appendix A). The objective of the Adaptive Management Plan (AMP) is to ensure the wind farm is operated in a manner that results in a fatality rate that is low enough to allow the maternity colony to survive and grow over the life of the project, albeit at a reduced rate from what would be expected in the absence of additive mortality. To achieve this objective, the AMP starts with turbine cut-in speeds of at least 5.5 m/s for all turbines from dusk to dawn between April 1 and October 15. The three turbines closest to the identified roost tree cluster would not be operational at all during this period. Turbine cut-in speeds will be increased as necessary to ensure mortality levels are in compliance with the objective of the Adaptive Management Plan. While the position of the wind farm places it in an area of high risk to Indiana bats, the implementation of the Adaptive Management Plan is expected to substantially reduce the risk of turbine-related fatalities, as discussed below.

Estimating Mortality – Post-construction mortality monitoring indicates that wind turbines present a unique risk to several species of bats. Fatality rates associated with facilities in the eastern United States have ranged from 20.8 to 69.6 bats/turbine/year (Arnett *et al.* 2008). As discussed above, there are several factors that influence risk, and therefore fatality rates. Those factors were considered when estimating Indiana bat mortality due to operation of the Shaffer Mountain Wind Farm.

It has recently been documented that operating wind turbines have led to Indiana bat fatalities. In September 2009, a dead Indiana bat was found in an agricultural area at the Fowler Ridge Wind Farm in Indiana. Another Indiana bat fatality occurred at the same facility in September 2010 while wind turbines were operating at a cut-in speed of 5.0 m/sec (Good *et al.* 2011). These Indiana bats were presumably migratory bats, as they were not found near any known hibernacula or maternity colonies.

Because Indiana bats are at risk of mortality, but mortality data are sparse for this rare species, Indiana bat mortality will be estimated based on the mortality of a surrogate species, the little brown bat. Although foraging and roosting behaviors differ somewhat (*e.g.*, little brown bats are more likely to roost in artificial structures, and more likely to forage in open areas), we believe it is reasonable to use little brown bats as a surrogate due to several important similarities between these two species. The Indiana bat and little brown bat are closely related, use similar foraging habitats, have overlapping ranges, hibernate in the same caves, have similar physical characteristics (USFWS 2007), and are found in the same action area (Chenger and Papenbrock 2007, Chenger 2008). In light of these similarities, Indiana bats and little brown bats may be equally vulnerable to the risk of turbine-related mortality. While it is possible that one species is slightly more or less vulnerable than the other, the two species are similar enough that it seems reasonable to use little brown bats as a “surrogate mortality indicator” for the Indiana bat, especially due to the rarity of Indiana bats on the landscape. To use the little brown bat as a mortality surrogate for the Indiana bat, it is necessary to determine 1) the relative abundance of each species (preferably in the action area), and 2) the anticipated number of little brown bat fatalities per wind turbine.

The relative abundance of little brown bats and Indiana bats was calculated using available data for on-site and nearby bat populations. Mist-net surveys in the project area resulted in the

capture of both Indiana bats and little brown bats with ratios of 0.01 Indiana bats/little brown bats in 2007 (Chenger and Papenbrock 2007), 0.03 Indiana bats/little brown bats in 2008 (Chenger 2008), and 0.016 Indiana bats/little brown bats overall. The relative abundance of these species in summer habitat in the project area is similar to that which has been observed at 14 Pennsylvania hibernacula where both species are known to occur (mean = 0.014 Indiana bats/little brown bats).

Bat mortality data have only been collected at a few wind farms, and this has occurred over a relatively short period of time (a few years). Mortality rates are often reported on a per turbine basis (*i.e.*, X bats/turbine/year). As discussed above, several variables are likely to influence mortality rates, including location relative to bat usage, turbine height, rotor swept area, turbine cut-in speed, geographic location, elevation, topographic location, surrounding habitat types, time of year, and weather conditions. Due to the influence of these variables on mortality rates, it is important to consider which data most closely represent the proposed project area.

Two data sets were considered in estimating bat mortality for the Shaffer Mountain project – a local data set provided by the Pennsylvania Game Commission and a data set compiled by Arnett *et al.* (2008). From those data sets, wind facilities were selected that were in the same geographic area (Pennsylvania/West Virginia) and in similar landscapes (deciduous forested ridge) as the Shaffer Mountain wind project (Table 2). In addition, monitoring studies were selected that covered the full bat activity period (April through November) to ensure sampling captured impacts to resident bats entering, occupying, and departing from their summer habitat. Based on spring telemetry studies conducted in Pennsylvania, Indiana bats emerge from hibernation from early to late April and move quickly from their hibernacula to their summer maternity areas (Butchkoski and Turner 2005, Butchkoski and Turner 2007, Chenger and Sanders 2007). In light of this, we expect Indiana bats to be migrating into summer habitat within the action area in April, and considered members of the Shaffer Mountain maternity colony to be at risk of turbine-related mortality beginning in April both as migrating bats and summer residents. We would expect Indiana bats to remain in their summer habitat from April through September, and be vulnerable to turbine-related mortality as residents within that summer habitat. Beginning in late August, some bats may begin to migrate back to their hibernacula, but others are expected to remain in their summer habitat as late as September or mid-October (Humphrey *et al.* 1977, Kurta and Rice 2002). Therefore, from August through mid-October, Indiana bats may be subject to turbine-related mortality as both summer residents and fall migrants. Due to the Indiana bat's vulnerability to turbine-related mortality in the action area from April through October, we used full-season bat mortality data sets to estimate mortality.

Table 2. Bat mortality data from wind facilities similar to Shaffer Mountain

Wind Facility ⁷	Location	Estimated mean fatality/turbine/year ⁸	Little brown bat fatalities as a % of total bat fatalities	Estimated little brown bat fatalities/turbine/year
Mountaineer 1	West Virginia	48.0	12.6	6.0
Site 1 (2007)	Pennsylvania	42.7	4.5	1.9
Site 1 (2008)	Pennsylvania	34.3	6.4	2.2
Site 2 (2008)	Pennsylvania	18.9	9.5	1.8
Site 2 (2009)	Pennsylvania	12.9	16.8	2.2
Site 3 (2009)	Pennsylvania	6.8	9.4	0.6
Site 5 (2009)	Pennsylvania	28.5	10.7	3.0
Site 8 (2009)	Pennsylvania	28.2	24.3	6.9
Mean Value		27.5	11.8	3.2

The average fatality rate from these combined data sets is 27.5 bats/turbine/year of which 11.8% are little brown bats. Therefore, little brown bat fatalities would be expected to average 3.2 bats/turbine/year (range = 0.6 to 6.9) in the absence of turbine curtailment measures and in the absence of white-nose syndrome. For the 30-turbine Shaffer Mountain project, little brown bat fatalities would be expected to range from 18 to 207 bats annually (mean = 96). Considering an observed Indiana bat/little brown bat ratio of 0.01 to 0.03 in the action area (Chenger and Papenbrock 2007, Chenger 2008), Indiana bat fatalities would be expected to range from 1 to 3 bats annually⁹, with a mean fatality rate of 1.5 Indiana bats annually¹⁰. However, if the little brown bat fatality rate is 6.0 to 6.9 per turbine as observed at some West Virginia and Pennsylvania sites, Indiana bat fatalities would be expected to range from 2 to 6 bats annually, with a mean fatality rate of 2.9 to 3.3 Indiana bats annually.

Under a scenario of no curtailment and no WNS impacts, modeling indicated that starting fatality rates of 3 to 6 Indiana bats would cause a substantial decline in the size of the maternity colony, and probably lead to its extirpation. A starting fatality rate of 2 Indiana bats would prevent the colony from experiencing any growth, while a starting fatality rate of 1 would considerably limit

⁷ Mortality data in Pennsylvania were collected under the Pennsylvania Game Commission's *Wind Energy Voluntary Cooperation Agreement*, which maintains the confidentiality of companies that supply data to the PGC. Consequently, only site numbers are provided. All Pennsylvania sites in Table 2 are located on ridgetops in the Appalachian Mountains Ridge and Valley Physiographic Province (Tracy Librandi-Mumma, Pennsylvania Game Commission, personal communication).

⁸ Mortality data are adjusted for searcher efficiency and scavenger removal (Capouillez and Librandi-Mumma 2008, Kerns and Kerlinger 2004).

⁹ Mean LBB fatality estimate (3.2 x 30 = 96) x observed IBAT/LBB ratios in 2007 and 2008. (96 x .01 = 1 IBAT and 96 x 0.03 = 3 IBATS).

¹⁰ Mean LBB fatality estimate x mean IBAT/LBB ratio (96 x 0.016 = 1.5 IBATS)

the colony's grow potential¹¹.

In light of the risk that turbine-related fatality rates could lead to maternity colony extirpation, the applicant has proposed to implement an Adaptive Management Plan that incorporates increased turbine cut-in speeds to reduce the risk of mortality. Under the AMP, all turbines will operate with a cut-in speed of at least 5.5 m/s from dusk to dawn from April 1 to October 15, and the three turbines closest to the identified roost tree cluster will not operate during the same period. The AMP calls for further increases in cut-in speeds should surrogate species fatality levels suggest the Indiana bat fatality rate would not allow for maternity colony growth. Under the AMP, an annual AMP-compliant fatality rate of 2% of the Indiana bat maternity colony cannot be exceeded.

To date, curtailment studies have focused on the effectiveness of reducing fatalities primarily during the fall migration period. The effectiveness of increased cut-in speeds in reducing fatalities of summer residents has not been studied or demonstrated, and we acknowledge there may be differences in exposure risk between migratory and summer resident bats, even within the same species. This exposure risk may vary not only due to the amount of time individual bats are exposed to operating turbines, but also due to potential differences in the way they use habitat and travel across the landscape. Summer residents would be exposed to turbines in their summer habitat for several months, while migratory bats would be exposed to turbines along migratory routes for one to a few nights during each spring and fall migration period. The exposure risk of summer residents may be reduced if they consistently fly at lower heights than migratory bats. Within summer habitat, foraging Indiana bats tend to fly at or below tree canopy level (Humphrey *et al.* 1977, LaVal and LaVal 1980), but some studies suggest they may fly higher while commuting between foraging and roosting habitat (Brack *et al.* unpublished data). Data regarding the height Indiana bats fly during migration are severely lacking, but there are two emerging viewpoints: they fly at or below tree canopy height or they fly considerably higher than tree canopy height. The documented mortality of two Indiana bats at the Fowler Ridge wind facility in Benton County, Indiana (Good *et al.* 2011), and the documented mortality of many other myotis at other wind facilities primarily during late summer and fall (USFWS unpublished data) indicate that at least a portion of myotis bats are flying at rotor-swept height (well above the tree canopy) during migration.

Despite uncertainties regarding the exposure risk of migratory versus summer resident bats, it does appear that increased turbine cut-in speeds reduce the risk of exposure, evidenced by reduced bat fatalities. Therefore, it seems reasonable to assume that benefits to summer residents would be similar to those experienced by migrating bats. Cut-in speeds of 5.5 m/s (as proposed in the Adaptive Management Plan) are expected to reduce overall bat fatalities by approximately 60%, assuming the benefits to summer resident bats are similar to those experienced by migrating bats (Arnett *et al.* 2010, Baerwald *et al.* 2009, Good *et al.* 2011). A 60% overall reduction in bat fatalities would be expected to reduce little brown bat fatalities as well – from an average of 3.2/turbine/year to 1.3/turbine/year. In the absence of WNS, little brown bat fatalities

¹¹ With no additive mortality from wind turbine operation, the colony would be expected to increase to 118 bats over 30 years, while a starting mortality rate of 1 (additive mortality from turbine operation) would be expected to limit this growth to 80 bats over the same period.

would average 35 annually for the Shaffer Mountain wind project¹² if fatality rates at this site are consistent with the estimated mean fatality rate for little brown bats in this geographic region. Based on the pre-WNS ratio of Indiana bats to little brown bats, Indiana bat fatalities would average 0.6 annually¹³ which is approximately 1.3% of the maternity colony. However, under the Adaptive Management Plan, the annual fatality rate may be as high as 2% of the maternity colony (1.0 Indiana bat annually, assuming a maternity colony size of 50 adult females).

Maternity Colony Effects – The effects of bat fatalities are relevant at the level of both the individual and the population unit. In the case of the subject project, one of the population units under consideration is the maternity colony. In considering the effects of the project, the estimated fatalities due to wind turbine operation must be considered in light of maternity colony effects. The applicant initially modeled the resident Indiana bat population (maternity colony) over a 30-year period under various wind mortality projections that did *not* include increased cut-in speeds, including no mortality, low mortality, medium mortality, and high mortality¹⁴. The effect of each of these mortality projections on the population was modeled using estimates of biological variables, including adult survivorship (0.76), fecundity (0.45 or 0.5 female young per female), juvenile survivorship (0.6 or 0.7), rate of population growth (0.95 to 1.01), and dependency of young at the time adult females are killed. Using a starting colony size of 50 and 80 female bats, 14% and 7% (respectively) of the model iterations predicted the loss of the colony after 30 years of project operation.

When attempting to model a population, it is important to know the initial rate of population growth. Biological factors, such as adult survivorship, juvenile survivorship, fecundity, sex ratio at birth, immigration, and emigration all work in concert to influence lambda (λ), the rate of population growth. A population is considered stable when $\lambda=1$, declining when $\lambda<1$, and increasing when $\lambda>1$. With respect to the subject maternity colony, none of these variables are known. However, it is important to note that hibernaculum counts at the nearby South Penn Tunnel suggest the presence of a local population that appears to have increased, at least over the short term. This hibernating population appears to be an important source population for the Shawnee maternity colony in the valley east of the project area (Chenger and Sanders 2007), and is likely to be one of the source populations for the Shaffer Mountain maternity colony. From 1999 (when the population was first found) to 2007, the Indiana bat hibernating population at the South Penn Tunnel increased from 23 to 139 bats. An increase of this magnitude is probably due to a combination of factors, including immigration and high survivorship of adults and young. Bats that migrate to high-quality summer habitat close to their hibernacula are exposed to less migration stress and mortality risk than long-distance migrants would be exposed to, and this probably contributes to higher survival and reproductive rates.

In light of what appears to be a possibly increasing local population (at the South Penn Tunnel hibernaculum), it seems reasonable to conclude that the baseline condition can be described as an on-site maternity colony that would gradually increase over time as well ($\lambda>1$). This baseline

¹² 27 turbines x 1.3 LBB/turbine/year = 35 LBB/year. (Three of the 30 turbines will not be operating.)

¹³ LBB fatality estimate x mean IBAT/LBB ratio (35 x 0.016 = 0.6 IBATS)

¹⁴ Low, medium, and high Indiana bat mortality estimates were derived from low, medium, and high estimates of the proportion of Indiana bats to little brown bats (see Table 4 in the biological assessment).

condition was modeled using a simple, deterministic model (Figure 11). Published values for fecundity and survivorship were used, because values for this particular colony are not known. Using a limited data set, Humphrey *et al.* (1977) observed that juvenile survival up to weaning was approximately 0.8 to 0.9. Therefore, we estimated that the number of young born per adult female colony member was 0.9. However, if one were to factor in stochastic events, fecundity would likely be lower in some years, as discussed below. Annual adult female survival was estimated to be 0.76, although this is thought to decline to 0.66 between 6 and 10 years, and 0.041 after 10 years (Humphrey and Cope 1977). First year survival of young was estimated to be 0.6, less than that of adult females (Humphrey and Cope 1977). A 1:1 male to female sex ratio was used (Humphrey *et al.* 1977). The rates reported for Indiana bats are similar to those reported for little brown bats, a closely-related species that we are using as a surrogate for estimating Indiana bat mortality. A long-term study of a little brown bat maternity colony found that the adult female survival rate ranges from 0.63 to 0.9, the first-year survival rate ranges from 0.23 to 0.46, and the reproductive rate ranges from 0.92 to 0.99 (Frick *et al.* 2010b).

Emigration and immigration rates for the maternity colony are unknown, and one cannot necessarily assume those rates are the same for the maternity colony and the hibernating population. Indiana bats have a strong fidelity to their summer habitat, so it is unlikely that a female will abandon its maternity colony to immigrate to another colony, unless perhaps it is nearby. In light of this fidelity to maternity habitat, it seems reasonable to assume that immigration and emigration rates are low, and that for the purposes of modeling they balance each other out. Therefore, the model assumes that females exhibit fidelity to, and recruit back into, their natal maternity colony rather than immigrate to or emigrate from another colony.

As discussed above (see “Estimating Mortality”), Indiana bat fatalities are expected to average 0.6 bat per year with turbine cut-in speeds of 5.5 m/s, although the AMP-compliant fatality rate may be as high as 1.0 per year¹⁵. We modeled the effects of turbine operation using the AMP-compliant fatality rate, as this represents the fatality rate which may occur during project operation. As the colony size changes, the number of Indiana bats killed annually will change. However, because the turbine-related mortality risk (*i.e.*, exposure risk) for each individual bat remains the same, mortality would affect the same proportion of the colony annually. If the number of fatalities remained constant as the colony increased, it would suggest that the risk for each individual bat decreased with increasing colony size, and that is not a reasonable assumption. Therefore, the model incorporates a constant fatality rate based on the proportion of the colony that is initially affected, rather than a constant number of fatalities each year throughout the operational life of the project. In other words, exposure risk remains constant, but the number of Indiana bats exposed decreases as the population decreases and increases as the population increases. For example, if we estimated that five adult females from a 100-member maternity colony would be killed during the first year of turbine operation, the adult female fatality rate would be 5%. If the colony declined to 20 adult females, we would expect the fatality rate to continue at 5%, which would be one female.

In determining how to allocate these estimated fatalities, we considered the presence of an on-site maternity colony and the vulnerabilities of adults vs. volant juveniles and males vs. females.

¹⁵ This assumes a maternity colony size of 50 adult females, in which case fatality rates of 0.6 and 1.0 represent 1.3% and 2% of the maternity colony, respectively. Under the AMP, 2% is the maximum allowable fatality rate.

Few wind mortality studies report age and sex composition of killed bats, and those that do suggest species-specific factors may influence these vulnerabilities (Arnett *et al.* 2008). In reviewing a road mortality data set for little brown bats in the vicinity of Canoe Creek (Blair County, Pennsylvania), we noted that adult female bats were more susceptible than adult males to fatal vehicle strikes (3:1), and juvenile bats were as susceptible as adult females (1:1). A similar number of fatalities among adult females and juveniles may mean that while females have a longer exposure period (the full maternity season), juveniles are at increased risk during the portion of the season when they are both capable of flight and exposed to the risk, probably due to less flight experience. In light of these considerations, we divided the anticipated Indiana bat fatalities equally between adult females and juveniles, and assumed juvenile male and juvenile female bats would be equally vulnerable. We are not discounting the possibility of adult male fatalities, but due to the presence of an on-site maternity colony, the density of adult females and juveniles is expected to be much higher than that of adult males. Consequently, the likelihood of adult female and juvenile fatalities is much higher.

With respect to adult female fatalities, we considered the fact that mortality could occur anytime during the maternity season, including the periods when the females are pregnant (April-June), lactating (June-July), or post-lactating (July-August). However, in the model we assumed that the adult female fatalities would occur when these females had fetal or dependent young (between April and July), so the loss of an adult female would automatically result in the loss of her offspring. This was a reasonable assumption because 1) females have fetal or dependent young during most of the maternity season; 2) females will be exposed to operating turbines throughout all or most of the action area during the maternity season; 3) females may be more vulnerable to fatalities early in the season when we assume they are less maneuverable while pregnant; and 4) females will likely experience reduced physical condition and reduced flight agility early in the maternity season, when WNS-related wing damage is most evident.

Using the available life history parameters discussed above, we modeled the baseline condition for a maternity colony with a starting size of 50 adult females. A colony of this size was a reasonable starting point (see “Life History”), and was consistent with the maximum exit count (50) for the nearby Shawnee maternity colony (Chenger and Sanders 2007). The modeling effort was based on the following assumptions, which were discussed in the preceding paragraphs.

- Fecundity rate = 0.9
- Sex ratio at birth = 1:1
- Annual adult female survival rate = 0.76
- Juvenile survival rate (1st year) = 0.6
- All surviving females return to the same maternity colony (*i.e.*, no immigration or emigration, or immigration = emigration).
- Females reach sexual maturity and reproduce their first year.
- Adult female mortality occurs when their young are dependent.
- Adult female mortality results in the death of dependent young.
- Adult females and volant juveniles are equally vulnerable to mortality.
- Juvenile males and juvenile females are equally vulnerable to mortality.
- Mortality from wind turbines is additive mortality.

- Fatality rates are a proportion of the adult females and juveniles within the maternity colony population unit, and these rates remain constant. The first-year fatality of 1.0 Indiana bat establishes adult female and juvenile fatality rates of 0.01 and 0.01¹⁶, respectively in the model. Consequently, 2% of the colony is subject to turbine-related fatalities annually under the AMP.

The model predicted that a maternity colony of 50 bats would increase to 118 bats in 30 years in the absence of WNS and any additive (turbine-related) mortality. This does not necessarily mean the colony would retain all of this recruitment and continue to grow to this number of bats. It is more likely that this growth would be absorbed by adverse stochastic events that we were not able to model, or that it would contribute to the formation of one or more new maternity colonies consistent with the fission-fusion theory of colony dynamics (Barclay and Kurta 2007, Kurta 2005).

The model predicted the maternity colony would increase to 93 bats in 30 years when subject to a turbine-related fatality rate of 1.3%, as was projected with cut-in speeds of 5.5 m/s (see “Estimating Mortality”). This reduction in the growth potential of the colony results from the mortality of 34 Indiana bats over that period, including adult females, fetal and dependent young, and volant juveniles. However, if the maximum fatality rate occurs during project operation (*i.e.*, the 2% fatality rate under the AMP), the model predicted the maternity colony would increase to only 80 bats in 30 years. This reduction in growth potential results from the mortality of 57 Indiana bats over that period, including adult females, fetal and dependent young, and volant juveniles (Figure 11). Under either fatality rate scenario (1.3% or 2%), the colony may

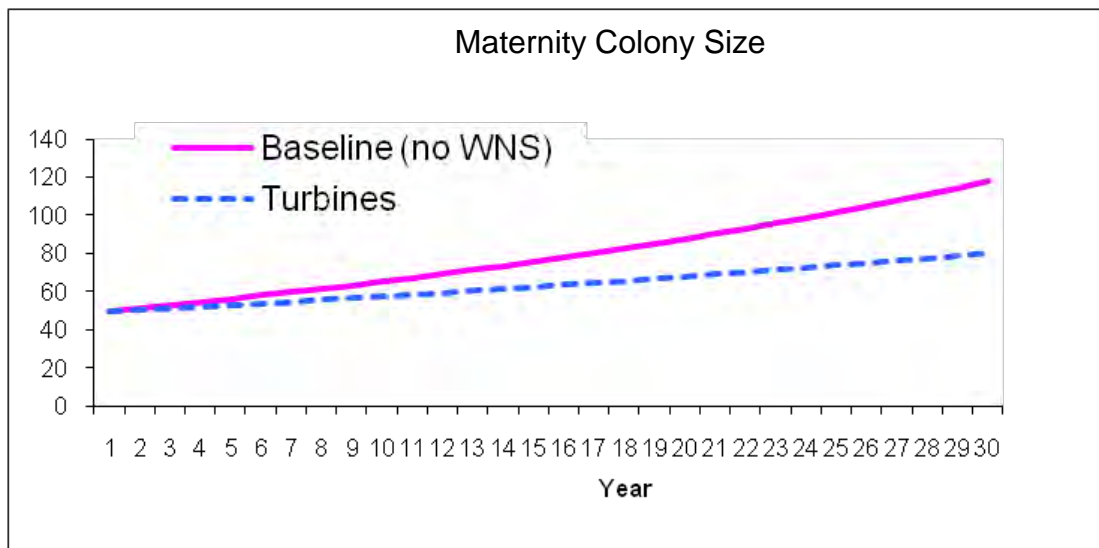


Figure 11. Effects of additive mortality on a maternity colony that is unaffected by WNS. Predicted trends in the number of adult female Indiana bats (vertical axis) are shown, assuming a starting population of 50 adult females. Baseline depicts a population with an annual adult female survival rate of 0.76, annual juvenile (first year) survival rate of 0.6, and female fecundity rate of 0.9. The turbine scenario depicts the effects of annual turbine-related mortality (additive mortality), using a constant 2% fatality rate.

¹⁶ 1% of the adult females and 1% of the volant juveniles

continue to grow in the face of turbine-related mortality, but at a substantially slower rate than that which would be expected to occur without this source of additive mortality. As with the baseline scenario, much of the estimated increase in the maternity colony may be mitigated by stochastic events, leading to a stable rather than increasing maternity colony. Turbine-related mortality would remove much of the colony's growth and recovery potential, and reduce its contribution to associated hibernating populations over time.

A small percentage of the predicted fatalities would likely be adult males, which have been documented to occur in the action area. It is difficult to predict how many adult males will be killed over the life of the project because their number and distribution within the action area are not fully known. Foraging and roosting areas for two adult males have been identified in the southeastern part of the action area, in the immediate vicinity of turbines. This will place these particular males at a significant risk of turbine-related mortality. The extent to which other males may be at risk of mortality will depend upon their distribution with respect to the proposed turbines. We anticipate that adult male fatalities over the life of the project will be much lower than those of adult females and juveniles because adult males tend to occur solitarily in widely-dispersed home ranges across the landscape.

We were not able to incorporate stochasticity into the model, although yearly and seasonal variations in fecundity, survival, and turbine-related mortality are anticipated. For example, unseasonably cool or rainy springs have been found to affect adult reproductive and juvenile survival rates in some myotis species (Humphrey *et al.* 1977; Grindal *et al.* 1992). Grindal *et al.* (1992) found that in a year with below-average springtime precipitation, 80 to 95 percent of female little brown bats and Yuma myotis (*Myotis yumanensis*) reproduced, but in a year with significantly higher than normal springtime precipitation, the percent of reproductive females decreased to around 30 percent. They believe that above-average rainfall in May and June increased the amount of time pregnant females had to enter torpor (lower body temperature to reduce energy expenditures) in order to compensate for reduced insect abundance, reduced foraging opportunities (many bats do not forage in the rain), and increased costs of homeothermy due to wet fur. The data collected by Grindal *et al.* (1992) support their supposition that during the high-precipitation year, embryo resorption or abortion occurred in many little brown bats and Yuma myotis and delayed parturition by approximately one month in others. Delayed parturition is expected to decrease adult female and juvenile survival rates by reducing the amount of time available to regain body condition, grow, and store up fat reserves in preparation for hibernation. A similar effect would be expected for Indiana bats, which are closely related to little brown bats.

Due to the simple design of the model, the inputs used, and the inability to incorporate stochasticity, the results obtained were conservative. The use of a more complex model that incorporated the effects of stochasticity and a wider range of variables would have resulted in a more biologically realistic projection. For example, a more complex model that accounted for the loss of some adult females when their young were no longer dependent would have slightly increased the rate of maternity colony growth. Conversely, the incorporation of reduced adult female survival rates for older age classes, and reduced fecundity and survival rates during stochastic events would have served to significantly reduce the growth rate of the maternity colony. All of these factors are operating in the real world, but at this time, it would be

extremely difficult to identify a numerical range of estimates to include in a model for each of these variables, let alone predict their timing and frequency.

Using the model inputs and assumptions described above, the maternity colony would gradually increase over time under the curtailment scheme detailed in the Adaptive Management Plan, albeit at a much slower rate than would be expected in the absence of additive mortality. Juvenile and adult female fatalities, when added to natural mortality factors, would be expected to reduce the potential for colony growth because the females cannot offset an increase in mortality with a concomitant increase in fecundity.

The population effects described above are based on closed populations and do not consider the effect of immigration of animals into the maternity colony. Colonizing (or re-colonizing) of suitable habitats within a species' range is a biological need of most populations, although the mechanism by which this occurs in Indiana bat populations is poorly understood. If females from the nearby hibernaculum occasionally immigrate to the maternity colony, the colony would grow faster. However, due to the documented fidelity of females to their maternity habitat, it does not seem plausible that more than a few, if any females from the hibernating population would join the maternity colony each year. The effect of immigration on the maternity colony would be to fully or partially mask the effects of turbine-related mortality, and cause the colony to stabilize or grow at a rate similar to that which would be expected in the absence of such mortality. However, if the colony is supported by immigration of a few adult females per year, which are subsequently subjected to the risk of turbine-related mortality, the site could function as a population sink, and fatalities at the wind farm could be higher than predicted.

None of the above modeling scenarios reflect the anticipated effects of WNS on bat populations, including the local Indiana bat population. By 2011, WNS had been documented at the South Penn Tunnel and throughout much of Pennsylvania (Figure 7), so bats in this geographic area will begin to suffer from the effects of WNS before turbines are put into operation in 2012. While the effects of WNS vary from hibernaculum to hibernaculum, it does not appear that any sites are completely spared from the effects of WNS once it has become well-established in an area. We do not have estimates of adult survivorship, juvenile survivorship, and fecundity for Indiana bat populations affected by WNS. However, based on regional survey data, Indiana bat populations have declined by approximately 72%, with declines at individual hibernacula ranging from 21% to 100% (Turner *et al.* 2011). Because WNS has such a detrimental effect on body condition, these population declines probably reflect substantial declines in several demographic parameters, including adult survivorship, fecundity, juvenile survivorship, and consequently recruitment.

In anticipation of WNS affecting this maternity colony before turbines are put in operation, we attempted to model a WNS baseline condition, and then add in the effects of turbine-related fatalities on the population unit. All model assumptions and inputs remained the same as those detailed above, with the exception of adult survivorship, juvenile survivorship, and fecundity. Based on WNS declines averaging 72% (Good *et al.* 2011), we reduced adult and juvenile survivorship rates in an attempt to reflect this level of baseline impact resulting from WNS. Adult and juvenile survivorship rates of 0.5 and 0.4, respectively, approximate the 74% population decline noted at the Williams Hotel hibernaculum. Due to a reduction in body

condition as surviving bats come out of hibernation, the female fecundity rate was decreased to 0.8. A drop in fecundity from 0.9 to 0.8 for Indiana bats is consistent with the degree of drop recently noted in a closely monitored little brown bat population (0.95 to 0.87) in New Hampshire, within the realm of WNS influence (Frick *et al.* 2010b).

Using the demographic parameters detailed above, a maternity colony that is affected by WNS may face extirpation in eight to ten years in the absence of any turbine-related fatalities. Due to the highly social nature of Indiana bats, the maternity colony could be functionally extirpated prior to this. If only a few bats return to their summer habitat, they may not find each other. Even if they do, they may be too few in number to enjoy the survival benefits of communal roosting. Individual females would be more likely to roost solitarily, and experience lower survival and fecundity rates, further accelerating the colony's decline. There is probably a critical threshold below which the maternity colony disintegrates and ceases to function as a colony. Although we do not know what this threshold is, it seems reasonable to assume that a maternity colony consisting of very few adult females will cease to function as a colony.

In the WNS baseline scenario above, maternity colony extirpation is projected to occur. Operation of the Shaffer Mountain wind farm in accordance with the AMP does not appear to accelerate maternity colony extirpation because the additive mortality from turbine operation is masked by the magnitude of the WNS-related effects on survivorship and fecundity. However, it is important to note that this simplistic modeling effort is subject to far greater uncertainty and variability than the non-WNS baseline model (Figure 11). With only three to five years of post-WNS population monitoring in the northeastern United States, it is premature to conclude that all affected Indiana bat population units will have low, fixed survivorship and fecundity rates over the next several years and eventually face extirpation. There may be surviving population units that have some level of resistance to WNS considering 1) many hibernacula have been affected by WNS for multiple years, 2) bats exhibit a high degree of fidelity to their hibernacula, 3) bats using these hibernacula are presumed to have been exposed to WNS, and 4) bats that have presumably been exposed to WNS are returning to the same hibernacula. It is noteworthy that researchers have observed a progressive lessening of mortality rates at some New York hibernacula (Langwig *et al.* 2010), which suggests some resistance to WNS may be developing.

Within the action area, it is possible that WNS will have a moderate rather than severe effect on Indiana bats. Some of the maternity colony members in the action area are probably hibernating in a tunnel whose environment may be slightly less conducive to WNS and its effects. Spring telemetry studies at the South Penn Tunnel found that at least 86% of the tracked males and 63% of the tracked females dispersed to summer habitat within 13.3 miles of the hibernaculum (Chenger and Sanders 2007). Assuming the 15 tracked bats were a representative sample of the population, one would expect 60 male and 44 female bats from the hibernating population to use summer habitat in the vicinity of the hibernaculum. The action area associated with the Shaffer Mountain project occurs within this 13-mile dispersal distance, so it is reasonable to assume that some of the male and female Indiana bats in the action area over-winter in the South Penn Tunnel. Indiana bats within the South Penn Tunnel are hibernating in temperatures of 50-51° F (10.3° C), temperatures that are well above those typically noted for this species. While this is within the 5-10° C range of optimal growth for *Geomyces destructans* (Blehert *et al.* 2009), the higher temperature range may be advantageous to hibernating bats if it allows them to retain

additional fat reserves. If this is the case, it may make them less vulnerable to the effects of WNS. They would also have the additional survival advantage of a very short migration to nearby summer habitat.

If resistance to WNS develops, or if recovery efforts are able to mitigate the effects of WNS, we would expect survivorship and fecundity rates to increase over time, resulting in populations that may persist, stabilize, and gradually increase. Should that occur in the action area, the additive mortality from wind turbine operation would reduce the maternity colony's potential for survival and growth by removing some of the individuals who had survived WNS and may be resistant to it. Implementation of the AMP would significantly reduce the risk of turbine-related fatalities, but this reduction in fatalities may not be sufficient to allow for maternity colony persistence and growth if baseline survivorship and fecundity rates do not return to pre-WNS levels.

Maternity colony extirpation and maternity colony persistence are both plausible outcomes in a landscape affected by WNS. Without knowing how and to what degree demographic parameters may change over time, to what degree WNS-resistance may develop, and to what degree recovery efforts may mitigate the effects of WNS, the results of modeling efforts would be highly speculative. While AMP implementation would probably allow for maternity colony persistence and growth in the absence of WNS, the effects of AMP implementation in conjunction with WNS are much more difficult to predict. Therefore, monitoring over the life of the project is proposed to ensure turbine-related mortality is low enough to allow for maternity colony survival and recovery.

Based on available information, it is reasonable to integrate WNS recovery efforts and potential WNS resistance into our effects analysis. Efforts are ongoing in North America and Europe to slow the spread of WNS, and to investigate its cause, transmission, effects and potential treatment. The goal of these studies is to decrease bat vulnerability to WNS and prevent species extinctions. Also, based on the documented resistance of European myotis species to *G. destructans*, it is plausible that immunological or behavioral resistance to WNS exists or will develop in North American myotis species, including the Indiana bat. If there is resistance to WNS or if ongoing research efforts are successful in identifying ways to lessen the effects of WNS, any modeling efforts would have to incorporate initially low survivorship rates followed by higher survivorship rates. At this time, there is no way of knowing how or to what degree recovery interventions will influence survivorship rates, so it is not possible to model these scenarios. However, if the surviving population in the action area is resistant to WNS, absent the turbines we would expect the population to stabilize and then gradually increase as survivorship rates increase, potentially to pre-WNS levels. Additive mortality from wind turbines would remove some of the individuals that would have stabilized and rebuilt the population over time, reducing the maternity colony's potential for persistence and growth. The objective of the AMP is to ensure turbine-related mortality is low enough that it does not compromise the maternity colony's ability to persist and recover.

Effects on Migrating Bats – Due to the presence of a maternity colony and adult male Indiana bats in the action area, it logically follows that Indiana bats migrate to the action area in the spring and from the action area in the fall. This makes the adults and juveniles of both sexes vulnerable to mortality from wind turbines in the spring, summer, and fall. In our evaluation of

the effects of turbine operation on the maternity colony (see “Estimating Mortality” and “Maternity Colony Effects”), we used full-season bat mortality data sets. Consequently, the maternity colony effects analysis captured the effects of turbine-related mortality on colony members not only during the summer, but also as they migrate to and from the action area in the spring and fall. As discussed below (see “Effects on Hibernacula and Hibernating Bats”), the loss of Indiana bats during the summer and during migration will affect the hibernating populations to which they belong.

At this time, available data do not suggest that other Indiana bats are migrating *through* the action area (other than those which migrate to and from the action area), although only a small number of Indiana bats have been tracked during migration. During the spring telemetry study at the South Penn Tunnel hibernaculum, none of the bats migrated over or in the direction of the action area; all of the tracked male and female bats migrated to the east, southeast, or northeast of the hibernaculum (Chenger and Sanders 2007) and many of the tracked females ended up in the Shawnee maternity colony (Figure 10). During a spring telemetry study at the Hartman Mine hibernaculum, the six radio-tracked females migrated to the east and southeast (away from the action area), and two were ultimately tracked to summer habitat in Maryland (Butchkoski and Turner 2005). While these studies do not discount the possibility of additional Indiana bats migrating through the project area as they move between their hibernacula and summer habitat, it appears that migratory movements from the two closest hibernacula tend to pass over areas other than the project area.

Effects on Hibernacula and Hibernating Bats – The project will result in no direct or indirect impacts on any known Indiana bat hibernacula, the closest of which is the South Penn Tunnel. However, the hibernating population at the South Penn Tunnel, as well as other hibernating populations, will be affected by the turbine-related mortality of Indiana bats. The fatalities of maternity colony members and adult males (see “Maternity Colony Effects” and “Effects on Migrating Bats”) due to turbine operation will “feed back” to the hibernating populations to which these bats belonged. As discussed above, these fatalities are expected to occur not only during the summer, but also during the spring and fall migration period.

It is reasonable to assume that many of the bats that spend the summer in the action area originate from the South Penn Tunnel and Hartman Mine, which occur within 10 and 32 miles (respectively) and together support 88% of Pennsylvania’s hibernating population. This assumption is further supported by telemetry studies, which indicate that a significant proportion of the Indiana bats which hibernate at the South Penn Tunnel stay in this local geographic area during the summer. At least 86% of the tracked males and 63% of the tracked females dispersed to summer habitat within 13.3 miles of the hibernaculum (Chenger and Sanders 2007). Although no Indiana bats from the South Penn Tunnel were tracked to the project area, the Shaffer Mountain roost trees are the same distance from the hibernaculum as are some of the Shawnee maternity colony’s roost trees. Therefore, it seems likely that many of the males and females that occupy summer habitat in the action area hibernate in the South Penn Tunnel.

The loss of Indiana bats in the action area, particularly females, will deprive their hibernating populations of the recruitment they would have had available had the females survived to contribute their full reproductive potential to the population. Turbine-related mortality is expected to remove Indiana bats (including adult females, fetal and dependent young, and volant

juveniles) from the maternity colony over the 30-year life of the project. The loss of females, along with their lifetime reproductive potential, cannot be offset. At best, females produce only one offspring per year; they cannot increase this reproductive rate in response to either advantageous or unfavorable environmental conditions. Because Indiana bats do not have a high reproductive potential, they cannot easily recover from increased mortality, decreased fecundity, or stochastic events. Mortality that results from environmental phenomena to which the species has not adapted (*e.g.*, pesticides, roads, wind turbines, cave entrance obstructions) is likely to have an additive effect that contributes to, rather than fully replaces, the effects of natural causes of mortality (*e.g.*, seasonal variation in insect abundance, adverse weather conditions, injuries and disease, predation). This is the case because the natural causes of mortality continue to operate, and survivors of those events will be further compromised by additional sources of mortality.

Over the 30-year life of the project, the South Penn Tunnel and other hibernating populations will be affected by the loss of maternity colony members and adult males in the action area. Without knowing how many Indiana bats from the action area hibernate in the South Penn Tunnel, it would be challenging to model the effects of their mortality on this particular hibernating population. However, if all of the Indiana bat mortality associated with the Shaffer Mountain wind project affects bats that hibernate at the South Penn Tunnel (a reasonable, worst-case scenario), we would expect the hibernating population (which has been growing over the past several years) to be affected by turbine-related mortality in much the same way as the maternity colony was (*e.g.*, see Figure 11). That is, in the absence of WNS, turbine-related mortality would be expected to reduce the ability of the hibernating population to grow and contribute to the regional Indiana bat population. The magnitude of the effect would be less than that on the maternity colony because unlike the maternity colony, not all of the hibernating population would be vulnerable to the effects of turbine-related mortality. That is, even if all of the Shaffer Mountain maternity colony members hibernate at the South Penn Tunnel, the hibernating population would also include bats from other maternity colonies that would presumably be unaffected by turbine-related mortality (*e.g.*, the Shawnee maternity colony).

In the presence of WNS, turbine-related mortality would be expected to remove some of the individuals that would have sustained the hibernating population and allowed it to recover. At best, the maternity colony would not be able to contribute fully to rebuilding the hibernating population, and at worse it would not contribute at all. In light of the lessening of mortality rates at some WNS-affected hibernacula in New York (Langwig *et al.* 2010), we think it is certainly possible that resistance will develop over time, allowing the hibernating population at the South Penn Tunnel to persist. The additive mortality from turbine operation would somewhat reduce the ability of the hibernating population to recover from the effects of WNS.

Summary

The proposed wind project occurs within swarming habitat associated with an Indiana bat hibernaculum, and within summer habitat occupied by an Indiana bat maternity colony and adult males. Tree removal within swarming habitat may harm Indiana bats, and tree removal within summer foraging and roosting habitat may harm maternity colony members, particularly if primary maternity roost trees are cut. Turbine operation over the 30-year life of the project is

expected to kill Indiana bats during spring and fall migration, and to kill adult male, adult female, and juvenile Indiana bats occupying summer habitat in the project area. The Adaptive Management Plan provides for increasingly restrictive turbine cut-in speeds to reduce Indiana bat fatalities to a level that is expected to not only prevent maternity colony extirpation, but also allow the colony to grow over time. Monitoring will occur over the life of the project to ensure turbine-related fatalities do not compromise the maternity colony's ability to persist or grow.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Two types of non-federal actions are reasonably likely to occur in the action area over the 30-year life of this wind project – timber harvesting and oil and gas development. Occasionally these activities result in wetland or stream encroachments, necessitating a Corps permit. Nevertheless, because there is often no federal action associated with these types of resource extraction activities necessitating future consultations, they have been included as cumulative effects.

The action area is primarily forested, and according to the BA, lands in the action area are held and managed for timber production. The Service is not aware of any specific harvest plans on these privately owned lands, so it is not possible to assess in detail the potential impacts from future timber harvesting. If timber harvesting is done without consideration for Indiana bats, it is very likely that the species will be harmed and harassed, primarily through the felling and loss of roost trees and foraging habitat. However, lands in the vicinity of the identified Indiana bat roost trees are recorded in the Pennsylvania Natural Heritage Program's online environmental review web tool, increasing the likelihood that projects planned in this area will undergo coordination with the Service to incorporate measures to avoid or minimize potential adverse effects on Indiana bats.

The BA also states that some portion of the action area is leased for potential oil and gas exploration and development, although neither the Corps nor the applicant is aware of any specific development plans. As with timber harvesting, oil and gas development has the potential to harm and harass Indiana bats, especially if it is done without consideration for the species. Oil and gas development results in the permanent loss of forest cover due to the construction of roads, pipelines, well pads, and storage tanks for oil and waste water. Because a state permit is necessary to develop oil wells, it is likely that most oil and gas development in the action area will be referred to the Service for consultation as part of the required environmental review associated with these activities. During the environmental review process, measures would be incorporated to avoid or minimize potential adverse effects on Indiana bats and their habitat.

CONCLUSION

After reviewing the current status of the Indiana bat, the environmental baseline, the effects of the action, and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Indiana bat. There is no critical habitat for the Indiana bat in or near the action area. Therefore, this action will not affect any federally designated critical habitat.

The implementing regulations for section 7 define "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402). This definition directs us to assess whether an *appreciable decrease* in the *probability* of survival and recovery is expected. Appreciable means noticeable, perceivable, or measurable. Therefore, our jeopardy analysis focuses on determining whether the anticipated reductions in the species' reproduction, numbers, or distribution would reasonably be expected to noticeably, perceivably, or measurably decrease the species' probability of survival and recovery.

An action would jeopardize a species if it appreciably reduced the species' ability to survive and retain sufficient resilience to allow recovery from endangerment. Survival is a condition characterized by a species with a sufficiently large population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter. Recovery would be compromised if an action made it difficult for a species to retain sufficient resilience to allow recovery from endangerment or if an action impeded the removal of threats to the species so self-sustaining and self-regulating populations can be supported as persistent members of native biotic communities (USFWS 1998, p. 4-35).

In the "Effects Analysis" we evaluated impacts to individual bats and the population units to which they belong. Those population units included the on-site maternity colony, as well as the associated hibernating populations. We concluded that turbine operation over the 30-year life of the project would kill adult female and juvenile Indiana bats, but that fatality levels would be significantly reduced when turbines are operated in accordance with the Adaptive Management Plan. Implementation of the AMP would probably allow for maternity colony persistence and growth in the absence of WNS, but its effects in conjunction with WNS are much more difficult to predict. If no resistance to WNS develops and recovery efforts cannot stem the decline of Indiana bats, operation of the Shaffer Mountain wind farm in accordance with the AMP is not likely to accelerate maternity colony extirpation because the additive mortality from turbine operation will be masked by the magnitude of the WNS-related effects on survivorship and fecundity. However, if resistance to WNS develops, or if recovery efforts are able to mitigate the effects of WNS, we would expect the additive mortality from wind turbine operation to reduce the maternity colony's potential for survival and growth by removing some of the individuals who had survived WNS and may be resistant to it. Implementation of the AMP would significantly reduce the risk of turbine-related fatalities, but this reduction in fatalities may

not be sufficient to allow for maternity colony persistence and growth if baseline survivorship and fecundity rates do not return to pre-WNS levels.

There is a great deal of uncertainty about the manner in which the maternity colony will be affected by WNS over the 30-year life of the project. However, the overarching objective of the AMP is to reduce the risk of maternity colony extirpation in light of the threat of WNS. This objective will be met by ensuring the turbine-related fatality rate is low enough that it is not likely to impair the maternity colony's ability to persist and grow. Various types of monitoring are proposed to fulfill this objective, including not only post-construction mortality monitoring, but also monitoring of the maternity colony. To ensure the objective of maternity colony persistence is met, the AMP provides for increasingly restrictive turbine operation measures to ensure fatality rates are AMP-compliant. The applicant's commitment to ongoing monitoring and curtailment measures to reduce bat fatalities is important, particularly due to uncertainties related to the effects of WNS. Provided the wind project is operated in accordance with the AMP, we do not expect turbine-related mortality to result in the extirpation of the maternity colony or its associated hibernating populations. We acknowledge the increased risk of maternity colony extirpation due to WNS, but it appears that turbine-related mortality under the AMP will not appreciably increase the risk of maternity colony extirpation.

Given the steep rate of population decline due to WNS, the loss of any maternity colonies and their associated contribution to the reproduction, numbers, and distribution of the species takes on a higher level of significance than it would if the population were stable or increasing. In recognition of this, the applicant has agreed to implement an Adaptive Management Plan that is intended to retain the maternity colony as a functional population unit on the landscape. While there will be a reduction in the numbers and reproductive potential of Indiana bats due to turbine-related mortality, this reduction is not expected to appreciably reduce the likelihood of the species' survival and recovery, as the project is not likely to appreciably impair the maternity colony's ability to persist or contribute to hibernating populations.

In summary, while the proposed project will introduce a persistent source of additive mortality to a landscape occupied by an Indiana bat maternity colony, implementation of the Adaptive Management Plan is likely to keep additive mortality levels low enough to preclude maternity colony extirpation due to the project. Ongoing monitoring and restrictive turbine operation are vital project components to ensuring turbine-related mortality does not change the biological trajectory of the maternity colony, or increase the risk of its extirpation. The proposed action is not expected to result in mortality at a level that would reduce appreciably the reproduction and numbers of the Indiana bat, or compromise the survival of Indiana bat population units (*e.g.*, maternity colonies). Therefore, the Service has concluded the proposed project is not likely to jeopardize the continued existence of the species.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations under Section 4(d) of the ESA prohibit the taking 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 attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat

modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as 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 that 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 under the ESA, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Because incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity, this Incidental Take Statement is valid only upon receipt by the applicant of all appropriate authorizations and permits from federal, State and local permitting authorities. These permits/authorizations may include, but are not limited to, permits under section 404 of the Clean Water Act from the Corps of Engineers; section 401 Water Quality Certification and Chapter 105 Dam Safety and Encroachment Permit from the Pennsylvania Department of Environmental Protection; and an approved Erosion and Sedimentation Control Plan from the County Conservation District. Again, this incidental take statement (along with its exemption from the section 9 prohibitions of the Endangered Species Act) is valid only upon receipt of all required permits and authorizations.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any permits, and/or approvals, as appropriate, for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps 1) fails to require the applicant or contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit, authorization, or funding document; and/or 2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the applicant must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement (50 CFR §402.14(I)(3)).

AMOUNT OR EXTENT OF TAKE

Construction and operation of the Shaffer Mountain Wind Farm in accordance with the Adaptive Management Plan is expected to result in the incidental take of Indiana bats, as described in the “Effects Analysis”. Turbine operation in accordance with the Adaptive Management Plan will reduce Indiana bat fatalities, but not eliminate them. The incidental take that occurs over the life of the project is not expected to compromise the maternity colony’s ability to persist.

As discussed in the Effects Analysis (see “Site Preparation”), one or two males may be harmed due to the loss of foraging and roosting habitat within the swarming radius of the South Penn Tunnel hibernaculum. In addition, the survival or reproduction of one or more females associated with the Shaffer Mountain maternity colony may be reduced if a primary maternity roost is cut during site preparation. The location of the primary roost(s) is not known, so the likelihood of this happening cannot be predicted with any degree of certainty. Considering the

applicant will implement a seasonal restriction on tree clearing to avoid the direct take of bats while trees are being felled, take is most likely to occur as a reduction in the reproductive rate of affected females, which may range from no affected females to several. This take is expected to occur in the first year or two following tree clearing.

Most of the project-related incidental take will occur due to wind turbine operation. As discussed in the Effects Analysis, the adult females and juveniles associated with the maternity colony will be most vulnerable to turbine-related mortality, but some adult males may also be killed. Because Indiana bats make up a small percentage of the overall bat community, and because a significant number of bats are missed during post-construction mortality monitoring due to scavengers and searcher inefficiency, the Service anticipates that incidental take of Indiana bats due to turbine operation will be very difficult to detect. Therefore, the little brown bat will be used as a surrogate mortality indicator to estimate take of Indiana bats. Take resulting from turbine operation is expected to occur annually between April 1 and October 15.

Implementation of the Adaptive Management Plan will reduce the risk of turbine-related bat mortality. Level 1 of the Adaptive Management Plan includes a 5.5 m/s turbine cut-in speed during times of the year when Indiana bats are or may be present to ensure the estimated annual fatality rate does not exceed 2% of the maternity colony. Increasingly restrictive turbine operation measures (levels of curtailment) will be implemented to ensure this AMP-compliant fatality rate is not exceeded. To measure the effectiveness of the AMP in meeting its objective, the results of post-construction mortality monitoring will be used to estimate little brown bat and Indiana bat fatalities. Table 3 includes the estimated little brown bat and Indiana bat fatalities under Level 1 of the Adaptive Management Plan, and also includes the maximum, AMP-compliant fatality rates.

The last column in Table 3 illustrates the manner in which the AMP-compliant fatality rate will be adjusted due to WNS, which has reduced the Indiana bat and little brown bat populations in the eastern United States by 72% and 91%, respectively (Turner *et al.* 2011). To ensure Indiana bat fatalities are AMP-compliant, fatality estimates for its surrogate indicator species have to be reduced to reflect reduced population levels due to WNS. A 91% overall reduction in the little brown bat population should mean a 91% reduction in little brown bat fatalities at wind facilities, assuming WNS does not increase or decrease the species vulnerability to operational turbines. At this time, the best available information on the degree to which WNS has affected Indiana bat and little brown bat populations is summarized by Turner *et al.* (2011). Consequently, fatality estimates for the Shaffer Mountain wind project were adjusted to reflect bat populations that have been reduced to these levels. The differential reductions in Indiana bat and little brown bat populations (72% versus 91%) will also affect the relative abundance of these species on the landscape. Accordingly, the Indiana bat to little brown bat ratio was adjusted from 0.016 (pre-WNS ratio) to 0.05 (post-WNS ratio). This ratio may require further adjustments as additional population data become available on both species. Further adjustments in the fatality estimates in Table 3 may also be necessary pending new information. The adjusted AMP-compliant fatality rates are indicated in bold type in the last column, and these are the levels within which the project must operate to be in compliance with this biological opinion.

Table 3. Annual fatality estimates for the Shaffer Mountain Wind Farm

Turbine Operation	Species ¹⁷	Estimated Fatalities with no WNS ¹⁸	Estimated Fatalities with WNS ¹⁹
Fully Operational (3.0 m/s cut-in speed)	LBB	96	9
	IBAT	1.5	0.45
Adaptive Management – Level 1 (5.5 m/s cut-in speed) ²⁰	LBB	35	3
	IBAT	0.6	0.15
AMP-Compliant Fatality Rate²¹	LBB	≤ 62	≤ 6
	IBAT	≤ 1	≤ 0.3

It is important to note that the fatality estimates in Table 3 only include adults and volant juveniles. Adult fatalities will be primarily females due to the presence of an on-site maternity colony. As discussed under “Maternity Colony Effects”, the death of an adult female is expected to result in the loss of her fetal or dependent young, so incidental take of Indiana bats will actually be 50% higher than the AMP-compliant fatality estimate in Table 3.

The AMP-compliant fatality estimates are based on a proportion of the maternity colony. If the colony remained at 50 adult females and was unaffected by WNS throughout the life of the project, the estimated fatality of one Indiana bat annually would stay within the AMP-compliant fatality rate. However, for a maternity colony that is reduced due to WNS, the estimated fatality of 0.3 Indiana bat annually (approximately one bat every three years) would likely remain within the AMP-compliant fatality rate. Because we cannot predict the effects of WNS on maternity colony size over a 30-year period, we have not attempted to project cumulative incidental take levels due to project operation. Instead, we have identified annual fatality levels (*i.e.*, 2% of maternity colony size) that will not be exceeded. Table 3 includes the annual Indiana bat fatality estimate (≤ 0.3) based on the most recent scientific data available, which documents an overall 72% decline in Indiana bat populations and 91% decline in the surrogate mortality indicator species (little brown bat). In addition to turbine curtailment, annual monitoring and reporting will be critical to ensuring the project is operated in a manner that does not exceed these incidental take estimates.

¹⁷ LBB = little brown bat (*Myotis lucifugus*). IBAT = Indiana bat (*Myotis sodalis*)

¹⁸ These are estimated fatalities in a landscape unaffected by WNS, consistent with baseline conditions at sites where post-construction mortality monitoring was conducted (see Table 2). IBAT estimates are obtained by multiplying the LBB estimate by the pre-WNS IBAT/LBB ratio of 0.016.

¹⁹ These estimates are based on reduced IBAT and LBB populations and an adjusted IBAT/LBB ratio of 0.05 resulting from a 91% population decline in little brown bats and 72% population decline in Indiana bats (Turner *et al.* 2011). IBAT estimates are obtained by multiplying the LBB estimate by the post-WNS IBAT/LBB ratio of 0.05.

²⁰ A cut-in speed of 5.5 m/s is estimated to reduce bat fatalities by 60%, as compared to fully operational turbines. Estimates are based on the operation of 27 turbines from April 1 to October 15 annually. Three turbines will not be operated from dusk to dawn from April 1 to October 15, so no fatalities are projected to occur from these turbines.

²¹ The AMP-compliant fatality rate cannot exceed 2% of the maternity colony. For a maternity colony of 50 adult females, the AMP-compliant fatality rate is 1 Indiana bat.

Due to the sparse distribution of adult males on the landscape during the summer, no more than two adult males are expected to be killed or injured due to turbine operation over the life of the project. While male fatalities will not affect the 2% annual limit on maternity colony fatalities, they will be counted against the annual Indiana bat fatality estimate and the cumulative male fatality estimate of two.

This incidental take statement only authorizes take of Indiana bats resulting from construction and operation of the Shaffer Mountain Wind Farm in accordance with the Adaptive Management Plan, provided there is compliance with the reasonable and prudent measures and terms and conditions to minimize, monitor, and report such take.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the Indiana bat.

1. Implement measures to reduce the risk of taking Indiana bats, such that incidental take due to project construction and operation will not appreciably reduce the likelihood of maternity colony persistence and growth.
2. Monitor and report take.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of Section 9 of the ESA, the Corps must ensure that the applicant complies with the following terms and conditions, which implement the reasonable and prudent measures described above and outline monitoring/reporting requirements. These terms and conditions are non-discretionary.

1. Fully implement all project minimization measures (see pages 10-11 of this biological opinion).
2. Fully implement the Adaptive Management Plan (see Appendix A) to reduce the risk of Indiana bat mortality when maternity colony members and adult males may be present in the action area. The objective of the Adaptive Management Plan is to ensure turbine-related mortality of Indiana bats is low enough that it is not expected to reduce the likelihood of maternity colony persistence and growth. The Adaptive Management Plan is an integral part of the proposed project, and as such was considered in the Service's effects analysis, non-jeopardy conclusion, and incidental take statement.
 - a. To ensure the project is operated in a manner that minimizes the risk of take,

turbine operation will not go below Level 1 of the Adaptive Management Plan, regardless of monitoring results.

- b. Both little brown bat and Indiana bat fatalities and fatality estimates will be used to determine whether take is within the limits described in the Incidental Take Statement. The little brown bat will serve as a surrogate mortality indicator for the Indiana bat, as indicated in Table 3 of the Incidental Take Statement. When little brown bat fatalities are used to estimate Indiana bat fatalities, the little brown bat fatalities that occur from April 1 to October 15 will be considered.
 - c. As additional data on Indiana bat and little brown bat populations becomes available, the Service will determine whether and to what degree the fatality estimates in Table 3 will be adjusted to ensure incidental take is consistent with the Adaptive Management Plan and the Incidental Take Statement. These adjustments do not require re-initiation of formal consultation as this represents ongoing project implementation (including implementation of the Adaptive Management Plan), rather than a change in the project. Any revisions to Table 3 will be provided to the Corps and applicant as an addendum to this biological opinion.
3. Monitor and report take, consistent with the Adaptive Management Plan and the terms of this biological opinion.
- a. If mist-net surveys in the project area do not result in the capture of Indiana bats, negative capture data will not be interpreted as species absence. The effectiveness of mist-net surveys in detecting and capturing Indiana bats may be compromised due to the effects of white-nose syndrome.
 - b. Bat fatality data and bat fatality estimates from the project area will be assessed annually (or more frequently if necessary) to determine compliance with the Incidental Take Statement. In addition, maternity colony monitoring data and hibernaculum data from affected and potentially affected Indiana bat population units will be evaluated. Where appropriate, best available scientific information from other sources will be considered to inform decisions regarding the effectiveness of Adaptive Management Plan implementation.

CONSERVATION RECOMMENDATIONS

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

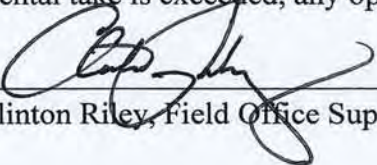
The Service has identified the following actions that, if undertaken by the applicant or Corps, would further the conservation and assist in the recovery of the Indiana bat.

1. Assist with white-nose syndrome investigations. For example, provide funding for WNS research activities, allow staff to participate in research projects, or monitor the health and status of bat colonies on Corps lands.
2. Develop and test techniques to reduce bat mortality at wind farms.
3. Work with the Service to develop best management practices and programmatic consultation approaches (or programmatic HCPs) to ensure wind power development is compatible with the conservation and recovery of federally-listed bats.
4. Manage Corps lands in a manner that is compatible with Indiana bat conservation.
5. Permanently protect Indiana bat habitat through fee-simple land donations to conservation entities, the establishment of conservation banks, and other mechanisms.

To be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed species or their habitats, the Service requests notification of the implementation of the conservation recommendations carried out.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the U.S. Army Corps of Engineers, February 5, 2010, request for initiation of formal consultation. As written 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 the agency action may affect listed species or critical habitat in a manner or to an extent not considered in this BO; (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 BO; 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.


Clinton Riley, Field Office Supervisor

9/27/11
Date

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Appendix A

Shaffer Mountain Wind Farm Adaptive Management Plan

Shaffer Mountain Wind Farm – Adaptive Management Plan

Shaffer Mountain Wind, LLC (the applicant) will reduce the risk of turbine-related Indiana bat mortality due to operation of the Shaffer Mountain Wind Farm. The wind farm will be operated in a manner that significantly reduces the likelihood of Indiana bat fatalities and avoids maternity colony extirpation by using the best available biological information, post-construction monitoring, and an adaptive management strategy that includes turbine curtailment and/or other methods demonstrated through scientific study to reduce bat fatalities.

This Adaptive Management Plan was developed to reduce the risk of maternity colony extirpation, particularly in light of the threat of white-nose syndrome (WNS). In the absence of WNS, the maternity colony population model predicted that a beginning fatality rate of three to six Indiana bats per year (*i.e.*, additive mortality from normal turbine operation) would lead to maternity colony extirpation over time. A beginning fatality rate of two bats per year would result in a stable population, but this scenario allows for no adverse stochastic events and allows for no population growth. Therefore, even this fatality rate would make the colony highly vulnerable to extirpation, and WNS would further exacerbate the risk of extirpation.

The Adaptive Management Plan (AMP) was formulated on the premise that the fatality rate would have to be low enough (\leq one bat) to allow the maternity colony to not only survive, but also grow, albeit at a reduced rate from what would be expected in the absence of additive mortality due to turbine operation. Consequently, the objective of the Adaptive Management Plan is to ensure the wind farm is operated in a manner that results in a fatality rate that is low enough to allow the maternity colony to survive and grow over the life of the project, albeit at a reduced rate from what would be expected in the absence of additive mortality. This “AMP-compliant fatality rate” will not exceed 2% of the Indiana bat maternity colony annually²².

The elements of the Adaptive Management Plan (AMP) are detailed below.

1. Minimization Measures

In addition to implementing all of the project avoidance and minimization measures detailed in the Biological Assessment, the following measures will be implemented.

- a. Most of the transmission line corridor occurs within the swarming habitat radius of a known Indiana bat hibernaculum (South Penn Tunnel). To avoid the direct take of Indiana bats when trees are felled, all tree cutting within the 11.1-mile swarming radius of this hibernaculum will occur between November 15 and March 31, when bats are hibernating. Within the remainder of the project area (*i.e.*, the part of the project area that occurs outside this swarming radius), all tree cutting will occur between October 15 and March 31.
- b. Project specifications and project minimization measures will be included in contracts for work conducted at the project site.

²² The 2% fatality rate equates to the estimated fatality of one Indiana bat, assuming a maternity colony size of 50 adult females.

- c. The applicant will regularly monitor the project area during site preparation activities and during construction activities to ensure work is done consistent with the project description, and to ensure all minimization measures are carried out.
- d. Prior to placing turbines in operation, the applicant will provide a report to the Fish and Wildlife Service on site preparation activities (*i.e.*, tree cutting) and project construction activities.

2. Habitat Conservation Measure

Prior to placing wind turbines in operation, the applicant will permanently protect and place in conservation ownership (see below) 145 acres of suitable forest habitat for an Indiana bat maternity colony (*Biological Assessment*, Section 2.4, p. 7).

- a. The conservation acreage, including its location and quality, are subject to review and approval by the Fish and Wildlife Service's Pennsylvania Field Office.
- b. The conservation acreage will be placed in the ownership of a conservation entity (*e.g.*, Pennsylvania Game Commission, conservation organization) that is both able and willing to protect and manage the habitat in perpetuity for Indiana bats. The recipient (proposed owner) of the conservation acreage is subject to Fish and Wildlife Service review and approval.
- c. The Fish and Wildlife Service and Pennsylvania Game Commission, and their representatives, will have access to conservation lands for future research and monitoring.

3. Adaptive Management Strategy to Reduce Take due to Turbine Operation

To reduce the risk of turbine-related Indiana bat mortality, the applicant will implement the following measures.

a. Adaptive Management Strategy – Level 1

Level 1 of the Adaptive Management Strategy will be implemented as soon as turbines go into operation (*i.e.*, the first year of project operation).

Curtailment – Use a cut-in speed of at least 5.5 m/s for all turbines from sunset to sunrise from April 1²³ to October 15²⁴. Alternatively, change the pitch angle of the blades and lower the required generator speed for electricity production. In either case, ensure all turbine blades are idle and motionless during low wind speeds (<5.5 m/s) from sunset to sunrise from April 1 to October 15. This restriction coincides with the period when Indiana bats are moving into, established within, or dispersing from their summer habitat.

Limited Turbine Operation –Turbines D9, D10 and D11 (*i.e.*, the southernmost

²³ Early April coincides with Indiana bat emergence from the nearby South Penn Railroad Tunnel (Chenger and Sanders 2007), the closest known hibernaculum to the project area.

²⁴ The period of late September through mid-October coincides with the latest Indiana bats are thought to remain in their summer habitat before migrating to their hibernacula (Humphrey *et al.* 1977, Kurta *et al.* 1993, Kurta and Rice 2002).

turbines in the eastern turbine string) will not be operated from sunset to sunrise from April 1 to October 15. These turbines are closest to the known roost tree cluster, and based on current information, present the greatest risk of killing Indiana bats. Should the primary maternity roost shift, this restriction will apply to the three turbines closest to the primary roost tree (or roosting area), as reviewed and approved by the Fish and Wildlife Service.

b. Adaptive Management Strategy – Level 2

If Level 1 of the adaptive management strategy does not reduce fatalities to a level that is AMP-compliant, turbine cut-in speeds will be increased to at least 6.5 m/s for all turbines. The three turbines closest to the maternity colony's primary roost tree (or roosting area) will continue to operate under "limited turbine operation" (see Level 1 of the Adaptive Management Strategy).

c. Adaptive Management Strategy – Level 3

If Level 2 of the adaptive management strategy does not reduce fatalities to a level that is AMP-compliant, increase turbine cut-in speeds (≥ 6.5 m/s) and/or place additional turbines into the category of "limited turbine operation" described in Level 1. This will be subject to Fish and Wildlife Service review and approval.

d. Other methods that have been demonstrated to reduce bat fatalities may be substituted for Adaptive Management Strategy Levels 1-3 upon Fish and Wildlife Service approval, provided they are expected to reduce Indiana bat fatalities to those that are AMP-compliant. "Demonstrated" means the method has been scientifically tested and study results have been published in a scientific, peer-reviewed publication.

4. Monitoring and Reporting

It is anticipated that foraging and roosting habitat will be affected by tree removal during site preparation activities, and that Indiana bats will have to adjust to these habitat losses. In addition, Indiana bats are expected to suffer mortality due to turbine operation. Monitoring studies have the potential to identify the extent of these effects, and serve as a means to determine whether the effects of the project on Indiana bats and their habitat are consistent with those anticipated. A plan for surveying, monitoring, and reporting on the Indiana bat within and adjacent to the project area will be developed and implemented by the applicant in coordination with the Fish and Wildlife Service. The purpose of the monitoring plan is to 1) ensure incidental take levels are AMP-compliant; 2) assess the effectiveness of the Adaptive Management Plan over time; 3) evaluate the response of bats to the disturbance that will occur in the project area; and 4) determine the need for adjustments to turbine operations in accordance with the Adaptive Management Plan. The monitoring plan will be designed to meet these minimum specifications and include mist-netting, telemetry, emergence counts, hibernaculum counts, post-construction mortality monitoring, and reporting of results.

a. The applicant will conduct additional mist-netting and radio-telemetry studies to determine to what extent the project affects Indiana bats (*e.g.*, maternity colony size, use of roost trees, use of foraging habitat, *etc.*).

- i. Annual monitoring will occur for at least five consecutive years, beginning with the year of turbine construction. After five years, monitoring frequency may be reduced based on results obtained during the first five years.
- ii. Surveys and studies will be performed by Fish and Wildlife Service-approved, qualified personnel.
- iii. Because monitoring must be geared to evaluating the response of bats to the project at both the individual and colony level, mist-netting and telemetry work will be designed to track as many different bats as possible. Mist-netting and tracking will be conducted during three sampling periods within the maternity season: pregnancy (May 15 to June 15); lactation (June 15 to July 15); and post-lactation or juvenile volancy (July 15 to August 15).
- iv. The most current Fish and Wildlife Service Indiana bat mist-netting protocols will be followed, although mist-net density may be increased as discussed below. The scope of the mist-netting will be similar to previous project area studies, but with additional mist-netting near the most recently documented roosting or foraging areas to increase the likelihood of capture success.
- v. All captured Indiana bats will be banded and fitted with radio transmitters, (provided body weights are sufficient) and tracked for the life of the transmitter to obtain information about the use of roosting and foraging habitat. Roost trees will be identified for all radio-tracked bats for the life of the transmitter. In addition, exit counts (*i.e.*, emergence counts) will be conducted for each occupied roost tree (*e.g.*, tree in which a radio-tagged bat roosts) and each identified roost tree for at least five consecutive days. The purpose of obtaining emergence counts is to determine which roost trees are primary vs. alternate roosts, and whether the maternity colony is stable, increasing or decreasing. Indiana bats will be banded to facilitate future identification, following the most current banding procedures approved by the Pennsylvania Game Commission.
- vi. Upon identification of a roost tree, document its location (latitude and longitude), and record site-specific data relative to the roost tree and roosting area. For each tree containing a roost used by an Indiana bat, record the tree species, height, diameter at breast height (d.b.h.), condition (alive or dead), aspect, elevation, and percentage of exfoliating bark. Also include distances from the roost tree to other roosts used by the bat(s), distance to the nearest perennial and intermittent stream, distance to the edge of tree-clearing, and distance from turbines and roads. Percent canopy closure above roost trees and habitat cover type near each roost will also be recorded. Roost trees will be marked in a manner sufficient to identify the trees in the field, but not obvious enough that the mark is conspicuous to passers-by.
- vii. Reports documenting the above efforts will be prepared and submitted to the Fish and Wildlife Service's Pennsylvania Field Office and the Pennsylvania Game Commission by December 31 of each year. The report will include an introduction, methods section, results section, conclusion and/or summary, and

any relevant supplementary information (*e.g.*, names and qualifications of surveyors). The methods section will describe the survey protocol used. The results section will include the total number of individuals of each bat species found; date found; total number of Indiana bats found; sex, reproductive condition, and health of each captured Indiana bat; data regarding non-endangered bats, particularly those species such as the little brown bat that have similar behaviors; maps or figures showing project features; maps of mist-net locations, and Indiana bat capture locations, roost trees, roosting habitat, foraging habitat, and travel corridors; GPS locations of mist-net sites and roost trees; dates of surveys; and names of surveyors.

- b. Post-construction mortality monitoring will occur over the life of the project to monitor take, and determine the effectiveness of the Adaptive Management Plan in reducing take to a level that is AMP-compliant.
 - i. All monitoring and reporting will be done in accordance with a monitoring protocol that is subject to review and approval by the Fish and Wildlife Service²⁵. The proposed monitoring protocol will be submitted to the Service for review at least six months prior to placing turbines in operation. Monitoring will be overseen by a Service-approved, qualified Indiana bat surveyor. Fatality estimates will be adjusted to consider site-specific data regarding both searcher efficiency and scavenger removal.
 - ii. During the first two years of turbine operation, bat mortality monitoring will occur daily at all turbines from April 1 to November 15. After the first two years, bat mortality monitoring will reduced to a subset of the turbines, contingent upon Fish and Wildlife Service review and approval.
 - iii. Annual mortality monitoring reports will be submitted to the Fish and Wildlife Service by December 31st of each year.
- c. Any dead Indiana bats located in the action area will be reported the Fish and Wildlife Service's Pennsylvania Field Office (315 South Allen Street, Suite 322, State College, PA 16801; telephone 814-234-4090) and Region 5 Division of Law Enforcement (300 Westgate Center Drive, Hadley, MA 01035-9589; telephone 413-253-8343) within 48 hours. Notification will include the date, time, and location of the carcass, and any other pertinent information. Indiana bats that are dead or moribund will be preserved in a cold location until properly identified (date of collection, complete scientific and common name, latitude and longitude of collection site, description of collection site). Specimens will be transferred to the Fish and Wildlife Service or a Service-approved facility.

²⁵ To the extent possible, post-construction mortality monitoring will complement and attempt to avoid duplicating the bat mortality monitoring requirements of other agencies (*e.g.*, the Pennsylvania Game Commission).