



United States Department of the Interior



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IN REPLY REFER
TO:

FWS/RIFO

Memorandum

To: Lisa Mandell, Acting Chief, Endangered Species USFWS R3, Bloomington, MN

From: Richard Nelson, Field Supervisor, Rock Island Field Office, Moline, IL

Date: July 17, 2013

Subject: Final Biological Opinion for Section 10(a)(1)(A) permitted activities associated with acoustic deterrent and curtailment speed research at the California Ridge Wind Energy Project, Champaign and Vermillion Counties, Illinois

Summary

This document transmits the biological opinion of the Fish and Wildlife Service (Service) prepared under the authority of and in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). This opinion is based on our review of the proposed issuance of a Section 10(a)(1)(A) permit by the Service's Region 3 Regional Office and the information provided in the recovery permit application and supplemental information documents provided by Invenergy (hereafter referred to as the applicant), dated April 11, 2013.

This action would permit the take of the federally endangered Indiana bat in conjunction with wind-bat interaction research in Champaign and Vermillion Counties, Illinois. The Service has determined in this opinion that permitting of the activities described in the permit application and associated documents will not jeopardize the continued existence of the Indiana bat but will result in incidental take of this species. Other species listed for Champaign and Vermillion Counties include the eastern prairie fringed orchid (*Platanthera leucophaea*), prairie bush clover (*Lespedeza leptostachya*), clubshell mussel (*Pleurobema clava*), and rabbitsfoot mussel (*Quadrula cylindrica*). However, this action will have no effect on these species, and therefore they are not subsequently addressed in this biological opinion.

Consultation History

A notice of the availability of permit applications and request for comments on the subject project (and others) was published in the Federal Register on April 26, 2013. The Service received comments and decided to move forward with the processing of the permit application.

On June 11, 2013, the Regional Office requested that the Rock Island Field Office conduct an intra-Service consultation and prepare a biological opinion on the action. A draft biological opinion was submitted to Lisa Mandell of the Regional Office on July 9, 2013. After the incorporation of comments, this final draft is being submitted.

1. Description of the Proposed Action

The Service proposes to issue a Section 10(a)(1)(A) permit to authorize take of the Indiana bat associated with acoustic deterrent and experimental wind turbine cut-in speed research at Phase I of the California Ridge Wind Energy Project (CRWE) in Champaign and Vermillion Counties, Illinois. The research will build on the work initiated by Bat Conservation International in 2010 (Arnett et al. 2011) to assess the possible use of auditory deterrent devices to reduce impacts of wind projects on all bats, including the Indiana bat. It will also complement numerous existing and ongoing research efforts related to the effects of wind turbine cut-in speeds on bat species, including the Indiana bat.

The proposed acoustic deterrent research will be conducted over a ten-week period from July 15 through September 30 during 2013, 2014, and 2015. The acoustic deterrent will be affixed to 20 randomly selected turbines. At any given time, 10 of these turbines will have operating acoustic deterrent devices and 10 turbines will be “silent.” Acoustic and “silent” turbines will be rotated randomly among those turbines outfitted with deterrents in order to minimize unknown but unavoidable biases.

Depending on the results of the acoustic deterrent, a curtailment study will also be conducted from July 15 through September 30 in 2014 and 2015. More specifically, the curtailment study will occur if the acoustic deterrent is functioning such that the permitted take of Indiana bats is not expected to be exceeded by the addition of the curtailment study turbines. The curtailment study will consist of treatments of 4.5 and 6.9 meters per second (m/s) that will be applied to 40 turbines (20 turbines per treatment). The treatment groups will be rotated randomly among curtailment study turbines on a periodic basis to control for potentially inherent but unknown environmental or systematic biases.

To determine the effectiveness of the research, mortality monitoring will be conducted to (1) estimate facility-wide bat mortality rates under various turbine operation strategies; (2) determine species-specific fatality rates for bats to the extent possible; (3) provide a general understanding of the factors associated with the timing, extent, distribution, and location of fatalities; (4) determine if the treatments reduce all bat fatality rates and avoid take of listed species; and (5) provide a baseline estimate of bat fatalities for comparison with the results of future follow-up studies conducted throughout the life of the project.

1.1 Conservation Measures

Curtailment of the remaining turbines at the CRWE facility will continue to be fully feathered until a wind speed of 6.9 m/s is reached, per the existing operational protocol previously coordinated with the Service in the Technical Assistance letter dated November 18, 2010. It is

also expected that the operation of the acoustic deterrent will serve as a conservation measure to minimize all bat mortality at the site. This permit is intended to explore the viability of acoustic deterrent devices as a conservation measure for all bat species in the region.

2. Status of the Species

This section presents the biological or ecological information relevant to formulating this Biological Opinion. Appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival are included to provide background for analysis in later sections. This analysis documents the effects of past human and natural activities or events that have led to the current range-wide status of the species. Portions of this information are also presented in listing documents, the recovery plan (USFWS 1983), and the draft revised recovery plan (USFWS 1999), and are referenced accordingly.

2.1 Species Description and Life History

The Indiana bat is an insectivorous, temperate, medium-sized bat that migrates annually from winter hibernacula to summer habitat in forested areas. The bat has a head and body length that ranges from 41 to 49 mm, with a forearm length of 35 to 41 mm. The fur is described as dull pinkish-brown on the back but somewhat lighter on the chest and belly, and the ears and wing membranes do not contrast with the fur (Barbour and Davis 1969). Although the bat resembles the little brown bat and the northern long-eared bat, it is distinguished by its distinctly keeled calcar and a long, pointed, symmetrical tragus.

The key stages in the annual cycle of Indiana bats are: hibernation, spring staging, pregnancy, lactation, volancy/weaning, migration and swarming. Figure 1 provides a depiction of the annual cycle. While there is variation based on weather and latitude, generally bats begin winter torpor in mid-September through late-October and begin emerging in April. Females depart shortly after emerging and are pregnant when they reach their summer area. Birth of young occurs between mid-June and early July and then nursing continues until weaning, which is shortly after young become volant (able to fly) in mid- to late-July. Migration back to the hibernaculum may begin in August and continue through September.

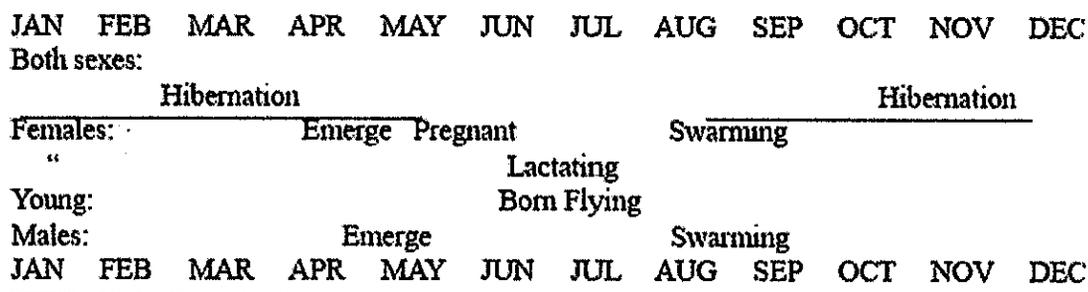


Figure 1. Indiana Bat Annual Chronology

Winter Hibernation

Generally, Indiana bats hibernate from October through April (Hall 1962, LaVal and LaVal 1980), depending upon local weather conditions. They hibernate in large, dense clusters, ranging from 300 bats per square foot to 484 bats per square foot (Clawson et al. 1980, Clawson, pers. observ. October 1996 in USFWS 2000). Upon arrival at hibernating caves in August-September, Indiana bats "swarm," a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, with relatively few roosting in the caves during the day (Cope and Humphrey 1977). Swarming continues for several weeks and mating occurs during the latter part of the period. Fat supplies are replenished as the bats forage prior to hibernation.

Females emerge from hibernation ahead of males; most winter populations leave by early May. Some males spend the summer near hibernacula in Missouri (LaVal and LaVal 1980) and West Virginia (Stihler, pers. observ. October 1996, in USFWS 2000). In spring when fat reserves and food supplies are low, migration is probably hazardous (Tuttle and Stevenson 1977). Consequently, mortality may be higher in the early spring, immediately following emergence.

Summer Roosting

After hibernation ends in late March or early April, most Indiana bats migrate to summer roosts. Females emerge from hibernation ahead of males. Reproductively active females store sperm from autumn copulations through winter, and ovulation takes place after the bats emerge from hibernation. The period after hibernation and just before spring migration is typically referred to as "staging," a time when bats forage and a limited amount of mating occurs (Service 2007).

Most winter populations leave hibernacula by late April or early May. In spring when fat reserves and food supplies are low and females are pregnant, migration is probably hazardous (Tuttle and Stevenson 1977). Consequently, mortality may be higher in the early spring, immediately following emergence. Once en route to their summer destination, females move quickly across the landscape. Radio-telemetry studies in New York documented females flying between 10 and 30 miles (mi) in one night after release from their hibernaculum, arriving at their maternity sites within one night. Indiana bats can migrate hundreds of miles from their hibernacula. Observed migration distances range from just 34.1 mi to 356.5 mi (Service 2007).

Females seek suitable habitat for maternity colonies, which is a requisite behavior for reproductive success. They exhibit strong site fidelity to summer roosting and foraging areas, generally returning to the same summer range annually to bear their young (Garner and Gardner 1992). Females arrive in their summer habitats as early as April 15 in Illinois (Gardner et al. 1991, Brack 1979), and usually start grouping into larger maternity colonies by mid-May. Humphrey et al. (1977) reported that Indiana bats first arrived at their maternity roost in early May in Indiana, with substantial numbers arriving in mid-May. During this early spring period, a number of roosts may be used temporarily, until a roost with larger numbers of bats is established.

After the summer maternity period, Indiana bats migrate back to traditional winter hibernacula. Some male bats may begin to arrive at hibernacula as early as July. Females typically arrive later and by September the number of males and females are almost equal. Autumn “swarming” occurs prior to hibernation. During swarming, bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day. By late September many females have entered hibernation, but males may continue swarming well into October in what is believed to be an attempt to breed with late arriving females.

Male Indiana bats may be found throughout the entire range of the species. Some males spend the summer near hibernacula, as has been observed in Missouri (LaVal and LaVal 1980) and West Virginia (Stihler, pers. observ. October 1996, in USFWS 2000). Males appear to roost singly or in small groups, except during brief summer visits to hibernacula. Males have been observed roosting in trees as small as 3 inches dbh, but the average roost diameter for male Indiana bats is 13 inches (USFWS 2007).

2.2 Diet and Foraging

Indiana bats forage over a variety of habitat types but prefer to forage in and around the tree canopy of both upland and bottomland forest or along the corridors of small streams. Bats forage at a height of approximately 2-30 meters under riparian and floodplain trees (Humphrey et al. 1977). They forage between dusk and dawn and feed exclusively on flying insects, primarily moths, beetles, and aquatic insects. Females in Illinois were found to forage most frequently in areas with canopy cover of greater than 80%, and typically utilize larger foraging ranges than males (Garner and Gardner 1992).

2.3 Population Dynamics

The population of the Indiana bat has decreased significantly from an estimated 808,000 in the 1950s (USFWS 2007). Based on censuses taken at all hibernacula, the current total known Indiana bat population in 2013 is estimated to number about 536,362 bats (Figure 2). Population trend data showed a steady increase from 2001 to 2007, a drop in 2009, and then an increase in 2011.

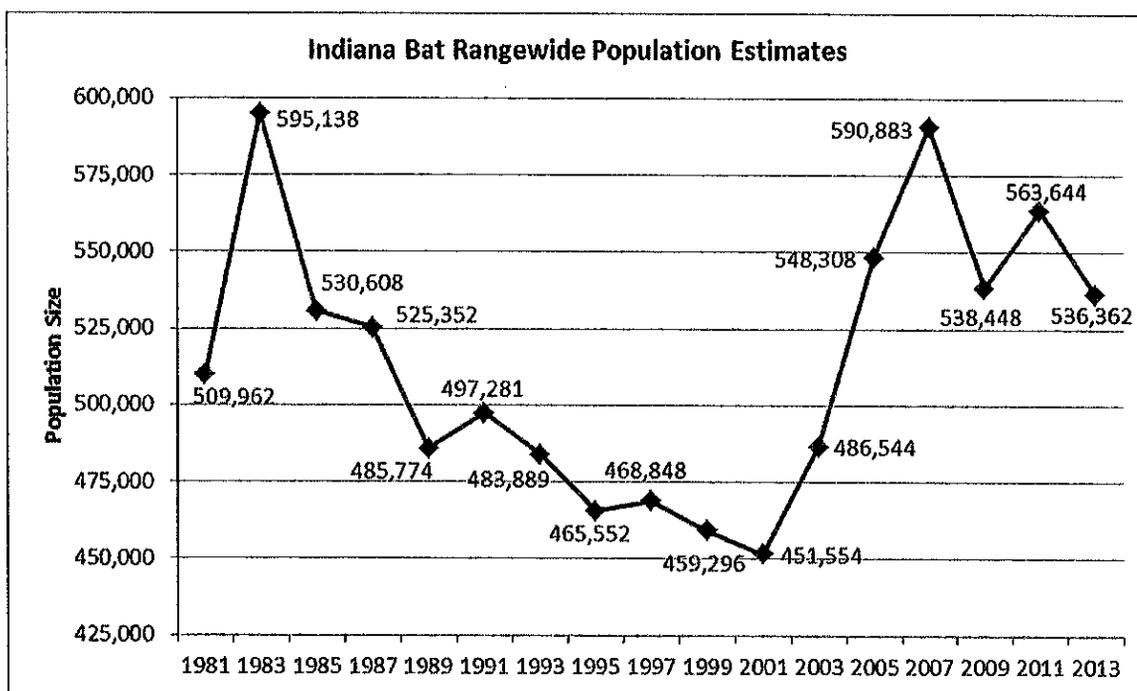


Figure 2. Indiana bat rangewide population estimates from 1981 – 2013 (www.fws.gov/midwest/Endangered/mammals/inba/pdf/2011inbaPopEstimate04Jan12.pdf) (*2013 estimate does not include most recent survey data from all states in the range. Where the most recent data were lacking, 2011 data were substituted.)

2.4 Status

The current species range includes much of the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. The species has disappeared from, or greatly declined, in most of its former range in the northeastern United States. The current revised recovery plan (USFWS 2007) delineates recovery units based on population discreteness, differences in population trends, and broad level differences in land-use and macrohabitats. There are currently four recovery units for the Indiana bat: Ozark-Central, Midwest, Appalachian Mountains, and Northeast.

The reasons for listing the Indiana bat were summarized in the original Recovery Plan (USFWS 1983) including: declines in populations at major hibernacula despite efforts to implement cave protection measures, the threat of mine collapse and the potential loss of largest known hibernating population at Pilot Knob Mine, Missouri, and other hibernacula throughout the species range were not adequately protected. Although several known human-related factors have caused declines in the past, they may not solely be responsible for recent declines. Documented causes of Indiana bat population decline include: 1) human disturbance of hibernating bats; 2) improper cave gates and structures rendering them unavailable or unsuitable as hibernacula; and 3) natural hazards like cave flooding and freezing. Suspected causes of Indiana bat declines include: 1) changes in the microclimate of caves and mines; 2) dramatic changes in

land use and forest composition; and 3) chemical contamination from pesticides and agricultural chemicals. Current threats from changes in land use and forest composition include forest clearing by private industry within the summer range, woodlot management and wetland drainage by landowners, and other private and municipal land management activities that affect the structure and abundance of forest resources.

Climate change is also an emerging threat to the Indiana bat, primarily because temperature is an essential feature of both hibernacula and maternity roosts. Potential impacts of climate change on temperatures within Indiana bat hibernacula were reviewed by V. Meretsky (pers. comm., 2006). Climate change may be implicated in the disparity of population trends in southern versus northern hibernating populations of Indiana bats (Clawson 2002), but Meretsky noted that confounding factors are clearly involved. Humphries et al. (2002) used climate change models to predict a northern expansion of the hibernation range of the little brown bat; such modeling would likely result in predictions of range shifts for Indiana bats as well. Potential impacts of climate change on hibernacula can be compounded by mismatched phenology in food chains (e.g., changes in insect availability relative to peak energy demands of bats) (V. Meretsky, pers. comm., 2006). Changes in maternity roost temperatures may also result from climate change, and such changes may have negative or positive effects on development of Indiana bats, depending on the location of the maternity colony. The effect of climate change on Indiana bat populations is a topic deserving additional consideration.

The greatest current threat to Indiana bats is white nose syndrome (WNS). WNS was first documented in New York in February of 2006 and has since been confirmed in 20 states and 4 Canadian Provinces (www.whitenosesyndrome.org/resources/map). It is currently unknown if WNS is the primary cause or a secondary indicator of another pathogen, but it has been correlated with erratic behavior such as early or mid-hibernation arousal that leads to emaciation and mortality in several species of bats, including the Indiana bat (<http://whitenosesyndrome.org/>; www.fws.gov).

3. Environmental Baseline

The purpose of the environmental baseline is to describe past and ongoing human and natural factors that have contributed to the current status of the species and its habitat in the project vicinity. Range-wide factors affecting the species include those listed previously under Section 2.4 Status. Other factors with the potential to adversely affect the species in the area include forest clearing by private industry within the summer range in Illinois, woodlot management and wetland drainage by landowners, and other private and municipal land management activities that affect the structure and abundance of forest resources in the area.

3.1 Status of the Indiana Bat within the Action Area

The action area includes the entire 33,500 acres associated with the wind energy project. The project area and surrounding landscape consists almost entirely of row-crop agricultural fields, with the occasional farmstead on field edges. A few grass waterways with sparse trees do extend into the project area, but all turbines are located at least 1000 feet from those waterways that may

function as bat foraging corridors. The project is approximately 3 miles from the Middle Fork of the Vermillion River and approximately 10 miles from the nearest known maternity colony of the Indiana bat, which is located along that river corridor to the north.

The nearest winter hibernacula are in Crawford County, Indiana, but multiple other Priority 1 Hibernacula are within a 200 mile radius of the project site. These are well within the maximum known migration distance of an Indiana bat. Because turbines in the project area have been sited at least 1000 feet away from potential summer foraging corridors or roosting habitat, and no Indiana bats have been documented as killed by wind farms during the spring migration, to date, it is expected that only fall migrating bats are at risk of deleterious interaction with the project area. Currently, this risk is minimized through the implementation of a 6.9 m/s per second cut-in speed operational protocol in the project area, and fall-migrating Indiana bats are expected to pass through the project area unharmed at lower wind speeds. .

3.2 Factors Affecting the Indiana Bat Environment within and adjacent to the Action Area

The action area is expected to produce agricultural crops as normal, and no land use changes are expected during the term of the action. The Middle Fork of the Vermillion River, adjacent to the project area, contains potential roosting and foraging habitat for the Indiana bat. Ongoing or future expected effects to the river corridor are uncertain, but could include timber harvests or other tree removal, storm damage, and/or regeneration of forested areas through natural regeneration or conservation practices. No Federal actions that would affect the Indiana bat in the immediate vicinity of the area are known to be proposed at the time of this Biological Opinion. However, two other wind farms in the general area are pursuing incidental take authorization through Section 10 of the Endangered Species Act.

4. Effects of the Action

This section includes an analysis of the direct and indirect effects of the proposed action and associated interrelated and interdependent activities on the Indiana bat and its potential and critical habitat.

4.1 Federally Permitted Actions

The federally permitted action is the permitting of the take of up to four Indiana bats, two per year, as a result of the proposed research project. The take would be most likely involve killing, harming, or harassing of Indiana bats by any turbines operating at wind speeds less than 6.9m/s. Because the project action area does not contain suitable summer habitat for Indiana bats, it is expected that any Indiana bats taken would be migrating bats. These bats could be either male, female, adult, or juvenile Indiana bats passing through the project area from summer to winter habitat.

4.2 Interrelated Activities, Interdependent Activities, and Indirect Effects

Indirect effects could be a minor shift in the route of migrating Indiana bats in order to avoid the

areas with operating acoustic deterrents. No other indirect effects to the species are expected as a result of the project.

5. Cumulative Effects

Cumulative effects include the effects of State, local or private actions that may occur in the action area. 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. The Service is unaware of any other Federal or non-Federal actions that are reasonably certain to occur which may adversely affect the Indiana bat in the 33,500 acre action area.

6. Conclusion

After reviewing the current status of the Indiana bat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed project, interdependent, and interrelated actions are not likely to jeopardize the continued existence of the Indiana bat. There is no critical habitat for the Indiana bat in the project area, and therefore, destruction or adverse modification of critical habitat as a result of the project is not foreseen.

7. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA, prohibits the take of endangered and threatened species 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 behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

7.1 Extent of Take Anticipated

The applicant is seeking a Section 10(a)(1)(A) permit from the Service for the taking of two Indiana bats per year for three years, which is a total of six Indiana bats. The project will cease when the two bat-maximum per year is reached, and therefore this take number is not expected to be exceeded.

7.2 Effect of the Take

The take of two Indiana bats in any given study year, should it occur, would happen at random. Therefore, it is not possible to predict if these bats would be male, female, adult, or juvenile. Because take is expected to occur during the fall migration season, if females are taken, the take should not result in the loss of offspring for that year, but only the removal of the individual(s) from the population, and the loss of their remaining reproductive potential. Given the project location, it is difficult to predict if the taken bats would come from a single or multiple maternity colonies. However, the greater population from which the bats would be removed is expected to be the Ozark-Central Recovery Unit. It is our opinion that the level of expected take by the project is not likely to affect the survival or recovery of the species, nor is it expected to result in jeopardy to the species, destruction, or adverse modification of critical habitat.

7.3 Reasonable and Prudent Measures

The Service has identified the following reasonable and prudent measures to minimize impacts of incidental take of the Indiana bat.

- After the first year of the study, the applicant should discuss the results with the Service to evaluate the observed effectiveness of the acoustic deterrent devices.
- If take was realized or calculated as a result of the acoustic deterrent portion of the study in the first year, the study design should be reexamined and preference should be given to the acoustic deterrent portion of the study in the second and (if practical) third years.
- After the first year, if adjusted mortality calculations indicate that two or more Indiana bats were likely to have been killed as a result of the project, further coordination with the Service should be conducted.

8. Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the lead agency for an action must comply with the following terms and conditions. These terms and conditions are non-discretionary.

- If take is realized or calculated for the 2013 study year, but the acoustic deterrent continues to hold promise for bat conservation, the study design should be reexamined and preference given to the acoustic deterrent portion of the study in subsequent years. Modifications to the study to ensure take is not exceeded could include, but are not limited to increasing the cut-in speeds of the acoustic deterred and control turbines or increasing the curtailment study turbine cut-in speed. Alternately, a second possible scenario could be that should the first Indiana bat be taken by the curtailment study in 2014 or 2015, the curtailment treatments should cease, and all curtailed turbines should be returned to 6.9m/s cut-in speeds.
- In order to ensure that the permitted take is not exceeded, the applicant should estimate (using currently accepted rare event detection statistical methods) the probability that the take of two Indiana bats was exceeded, regardless of whether or not actual Indiana bat carcasses were found.

- Results of the research, including statistical analyses, calculated mortality estimates, summaries of monitoring efforts, searcher efficiency calculations, and carcass removal times should be provided to the Service within a reasonable time period after the 2013 and 2015 monitoring seasons (not to exceed one year). In addition, permission must be granted for the Service to disseminate this information among Service personnel to facilitate the recommendation of either the tested cut-in speeds or the acoustic deterrent device installation in conjunction with other research or projects, should they prove to have conservation value to the Indiana bat or other wildlife.

Closing

The reasonable and prudent measures and terms and conditions are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the monitoring period, the level of incidental take described above is exceeded, reinitiation of consultation and review of the reasonable and prudent measures is required. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Reinitiation Notice

This concludes formal consultation on the actions to be permitted by the Service, associated with the issuance of a Section 10(a)(1)(A) permit to the applicant. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Literature Cited

- Barbour, R.W. and W.H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington. 286 pp.
- Brack, V., Jr. 1979. Determination of presence and habitat suitability for the Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*) for portions of three ditches, Big Five Levee and Drainage District, Union and Alexander Counties, Illinois. U.S. Army Corps of Engineers, St. Louis, MO. 23 pp.
- Clawson, R.L., R K. LaVal, M.L. LaVal, and W. Caire. 1980. Clustering behavior of hibernating *Myotis sodalis* in Missouri. *Journal of Mammalogy*, 61:245-253.
- Clawson, R.L. 2002. Trends in population size and current status. *In* The Indiana bat: biology

- and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas. 253 pp.
- Cope, J. B., and S. R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana bat, *Myotis sodalis*. *Journal of Mammalogy*, 58:93-95.
- Gardner, J. E., J. D. Garner, and J. E. Hofmann 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Final report. Illinois Natural History Survey, Illinois Dept. of Conservation, Champaign, IL. 56 pp.
- Garner, J.D. and J.E. Gardner. 1992. Determinations of summer distribution and habitat utilization of the Indiana bat (*Myotis sodalis*) in Illinois. Final Report: Project E-3. End. Sp. Act Sec. 6 Rpt. Illinois. Dept. of Conservation, Springfield, IL.
- Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Public Museum and Art Gallery. Scientific Publication No. 12, 68pp, Reading, PA.
- Humphrey, S.R., A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. *Journal of Mammalogy*, 58:334-346.
- Humphries MM, D.W. Thomas, J. R. Speakman. 2002. Climate mediated energetic constraints on the distribution of hibernating mammals. *Nature*, 418:313–316
- LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Dept. of Conservation Terrestrial Series 8:1-53.
- Tuttle, M.D. and D.E. Stevenson. 1977. An analysis of migration as a mortality factor in the gray bat based on public recoveries of banded bats. *American Midland Naturalist*. 97:235-240.
- USFWS (U.S. Fish and Wildlife Service). 1983. Recovery Plan for the Indiana Bat. Twin Cities, MN. 23 pp.
- USFWS (U.S. Fish and Wildlife Service). 1999. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. Fort Snelling, MN. 53 pp.
- USFWS (US Fish and Wildlife Service) 2000. Biological Opinion for the Nantahala and Pisgah National Forests Land and Resource Management Plan, Amendment 5, on the Indiana bat. Asheville Ecological Services Field Office, Asheville, North Carolina.89 pp.