United States Department of the Interior

FISH AND WILDLIFE SERVICE
3761 Georgetown Road
Frankfort, Kentucky 40601

June 9, 2006

Mr. Jose Sepulveda
Division Administrator
Federal Highway Administration
330 West Broadway
Frankfort, Kentucky 40601

Subject: FWS #06-0466; Final Programmatic Biological Opinion on minor road construction projects in Kentucky and their effects on the Indiana Bat.

Dear Mr. Sepulveda:

This document sends the U.S. Fish and Wildlife Service's (Service) informal consultation and programmatic biological opinion based on our review of the U.S. Federal Highway Administration's (FHWA) proposed construction of minor road construction projects in Kentucky, implementation of the April 2006 Indiana Bat Habitat Assessment Manual (HAM), and their related effects on the Indiana bat (*Myotis sodalis*) under section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your May 8, 2006, request for formal consultation was received on May 9, 2006.

This informal consultation and biological opinion is based on information provided in the April 2006 Biological Assessment (BA) and the April 2006 HAM for the Kentucky Transportation Cabinet (KYTC), meetings (see consultation history), other available literature, personal communications with experts on the federally listed species considered in this biological opinion, and other sources of information available to us and/or in our files. A complete administrative record of this consultation is on file at the Service's Kentucky Field Office in Frankfort, Kentucky.

Introduction

The FHWA and KYTC are proposing to address section 7 consultation issues related to the Indiana bat for minor road construction projects through the use of a 2-tiered programmatic approach. Tier 1 involves the use of the HAM to determine if habitat for Indiana bats is present within a proposed project site. If habitat is not present within a proposed project site (as determined by the process contained in Sections II, III, and Appendix A of the HAM), the project would be considered to have "no effect" on Indiana bats (Table 1). If potential summer roosting habitat is present within the proposed project site, but the habitat is marginal, project effects are discountable, or the habitat is unlikely to be occupied by Indiana bats (as determined by the process contained in Section IV and Appendix B of the HAM), the project effects would be considered "not likely to adversely effect" Indiana bats (Table 2). The process for making the

Table 1. Species that were evaluated where a "no effect" determination was made for the proposed action.

Scientific Name	Common Name	Listing Status	In Action Area	Not in Action Area
Myotis sodalis	Indiana bat	endangered	+	

Table 2. Species that were evaluated where a "not likely to adversely affect" determination was made for the proposed action.

Scientific Name	Common Name	Listing Status	In Action Area	Not in Action Area
Myotis sodalis	Indiana bat	endangered	+	

determinations in Tier 1 are provided in the HAM and are supported by information contained in the BA and HAM developed by the FHWA and KYTC. Tier 2 involves the use of this programmatic biological opinion to account for adverse effects to Indiana bats that may occur in association with proposed minor highway development projects where a "no effect" or "not likely to adversely effect" determination cannot be made during the project evaluations outlined in the Tier 1 analyses. This biological opinion would, thus, provide KYTC with a streamlined option for proceeding with the specific types of minor highway projects identified in the BA where it is probable that adverse effects are unavoidable.

The Service has reviewed the BA, HAM, and all of the supporting and supplemental information that evaluates the effects of the proposed action on the Indiana bat. This document represents our (a) concurrence with the effects determinations stated in the BA for the Indiana bat associated with the Tier 1 analysis; and (b) biological opinion on the effects of the proposed action on the Indiana bat associated with the Tier 2 analysis in accordance with Section 7 of the Act. The Indiana bat was the only species for which the FHWA made a "may affect - likely to adversely affect" determination.

According to the BA, Tier 1 review involves trained KYTC personnel utilizing the HAM to determine if any habitat for Indiana bats is present within a proposed project site. Sections I, II, and III of the HAM, respectively, provide: a) suitable Indiana bat habitat descriptions and examples; b) a specific list of projects that do not require alteration of Indiana habitat; and c) procedures for determining if a project requires the alteration of Indiana bat habitat. As determined by the aforementioned Tier 1 process, only those projects where no Indiana bat habitat was identified within the project site will be considered to have "no effect" on the Indiana bat. Upon this determination, KYTC personnel will document their finding by completing Appendix A of the HAM. Therefore, the Service concurs that projects that (a) are reviewed according to Sections II and III of the HAM and (b) lead to a documented "no effect" finding in Appendix A of the HAM will have no effect on the Indiana bat, because these projects will not involve the removal of Indiana bat habitat or result in other potential adverse effects. As a result, further consultation on these "no effect" projects is not necessary.

For those projects that do not meet the criteria for a "no effect", further analysis by trained KYTC personnel utilizing the HAM would be conducted to determine (a) if the habitat present within the project area is marginal and/or isolated and unlikely to be occupied by Indiana bats or (b) if project effects would be discountable or insignificant. This analysis would be conducted using Section IV and Appendix B of the HAM and was developed to identify those situations where the Service considers effects to not be reasonably likely to occur. As determined by the process in Tier 1, only those projects that meet the specific criteria in Section IV and Appendix B of the HAM will be considered to be "not likely to adversely affect" the Indiana bat. Upon this determination, KYTC personnel will document their finding by completing Appendix B of the HAM.

The Service has reviewed the process for making and documenting a "not likely to adversely affect" determination. Based on the information contained in the BA, HAM, and the other information on the Indiana bat that is available to the Service, the Service concurs with FHWA's determination for projects that are reviewed in accordance with Section IV of the HAM and that lead to a documented "not likely to adversely affect" finding for the Indiana bat in Appendix B of the HAM, because the potential adverse effects of these projects have been evaluated and meet the criteria of Section IV of the HAM. As a result, further consultation on these "not likely to adversely affect" projects is not necessary.

Based on this, the Service believes that the FHWA has fulfilled its section 7 consultation requirements relating to the implementation of the Tier 1 process. However, the FHWA's obligations under section 7 of the Act relative to the Indiana bat must be reconsidered for any "no effect" or "not likely to adversely affect determination" made under the HAM if (1) new information reveals impacts of the proposed action that may affect listed species or critical habitat in a manner not previously considered, (2) the proposed action is subsequently modified to include activities which were not considered during this consultation, or (3) new species are listed or critical habitat designated that might be affected by the proposed action.

Consultation History

January 2005	A meeting was held between the Service, FHWA, and KYTC to discuss Indiana bat issues and other options of satisfying Section 7 for small projects.
March 4, 2005	A meeting was held between the Service, FHWA, and KYTC to discuss Section 7 consultation process and the ability of action agencies to make "No Effect" determinations with consulting with the Service.
December 15, 2005	A meeting was held between the Service, FHWA, and KYTC. Discussions included ways to streamline the Section 7 process regarding Indiana bats and what would be required during a programmatic consultation process.
January 4, 2006	The Service sent a letter to KYTC and FHWA providing technical assistance on what information would be needed in a programmatic

	biological assessment that would support an Indiana bat programmatic biological opinion for transportation projects
March 23, 2006	A meeting was held between the Service, FHWA, and KYTC to discuss the need and development of a programmatic consultation to address Indiana bat issues.
March 31 thru May 8, 2006	The Service, FHWA, and KYTC worked to develop a Habitat Assessment Manual and Programmatic Biological Assessment. Several meetings were held in order to comment on the documents' contents, implementation, and provide revisions. Specific meeting dates and draft documents are on file in the administrative file located in the Service's Kentucky Field Office.
May 9, 2006	The Service receives a request from the FHWA, dated May 8, 2006, to initiate formal consultation on the proposed action. The FHWA's request includes the final BA dated March 31, 2005.
May 9, 2006	The Service sent a letter to the FHWA acknowledging that the FHWA's May 8, 2006, request for initiation of formal consultation was received, that the information contained in the BA and HAM was complete, and that formal consultation had been initiated.
May 25, 2006	The Service sent a Draft Biological Opinion (BO) to the FHWA for review via electronic mail.
June 6 & 7, 2006	The Service received comments regarding the draft BO from KYTC and FHWA.
June 7, 2006	The Service receives a request from KYTC via electronic mail to amend the formal initiation package to amend the HAM. This amendment was noted and has been reflected in this biological opinion.
June 9, 2006	The Service provided the FHWA with the Final Biological Opinion on the proposed action.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

As defined in the Service's section 7 regulations (50 CFR 402.02), "action" means "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas." The "action area" is defined as "all areas to

be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The direct and indirect effects of the actions and activities must be considered in conjunction with the effects of other past and present Federal, State, or private activities, as well as the cumulative effects of reasonably certain future State or private activities within the action area. This biological opinion addresses only those actions for which the Service believes adverse effects may occur. In their BA, the FHWA outlined those activities associated with minor road construction projects that may result in adverse effects on the Indiana bat. This biological opinion addresses whether minor road construction projects and the implementation of Tier 2 of the programmatic analysis for these projects is likely to jeopardize the continued existence of the Indiana bat.

Project Area

The KYTC maintains and constructs a wide variety of transportation infrastructure needs within 120 counties in Kentucky that are identified and scheduled in a master plan occurring in six year increments. Project priorities and time schedules, within the six year plan, vary pending several factors (i.e., purpose, safety, funding, etc.). However, one factor remains consistant in that the proposed action area is located within the Commonwealth of Kentucky.

Kentucky is divided into six distinctive physiographic regions that include the Appalachian or Cumberland Plateau, Knobs, Bluegrass, Pennyroyal, Shawnee Hills, and the Coastal Plain. Mountain forests of the eastern Cumberland Plateau extend westward to the Knobs, Bluegrass and karst areas of the Pennyroyal of central Kentucky. The geography then turns into the hilly uplands of the Shawnee Hills, which finally reach the coastal plain of the Mississippi River known as the Jackson Purchase region of west Kentucky. A wide range of habitat types are found in Kentucky, including numerous wetlands and streams, deciduous and evergreen forests, karst and cave features, and prairie habitat.

Land use in Kentucky varies across the state and includes: agricultural farmland, livestock farmland, forest, streams and wetlands, residential, industrial, mining for natural resources, infrastructure, urban development, and others. Today, much of Kentucky's natural habitat has been disturbed; however, about 2,070,434 acres land has been conserved to be publicly managed fish and wildlife habitat. The remaining 95 percent of Kentucky remains privately owned and plays an important role in the overall landscape of Kentucky providing natural and semi-natural habitats to support wildlife diversity.

Proposed Action

The proposed action involves the construction of minor road projects within the Commonwealth of Kentucky. Appendix B of the BA includes a specific list and description of project types that are being considered as part of this action. Various steps are involved in the development of these types of projects, and these projects are conducted in phases that are tied directly to funding authorization. The phases used for project development are: Planning (P), Preliminary Design and Environmental (D), Right-of-Way (ROW), Utilities (U), and Construction (C). The type of funding source (state or federal) does not affect these phases of project development.

Project development phases do not necessarily apply to every project. For example, a Planning phase is typically reserved for those projects where a large number of solutions for a transportation need may be feasible. The Right-of-Way phase is only programmed where additional land acquisition or easements would be required to complete the work. Utilities phase is only necessary where relocation of existing utilities is required for construction. A complete description of each project phase is provided in the BA and is considered to be incorporated as part of the proposed action.

As stated previously, FHWA and KYTC have developed an Indiana bat HAM to support a two-tiered programmatic review process in order to address potential adverse effects on the Indiana bat that result from specific types and levels of transportation projects. A description of each tier of this process relating to the proposed action is provided below.

Tier 1 of the Programmatic Review Process

Tier 1 involves the use of the HAM during the preliminary design and environmental phase to determine if habitat for Indiana bats is present within a proposed project site. This process involves a Division of Environmental Analysis (DEA) biologist or District Environmental Coordinator(DEC) utilizing information available to them to determine if any Indiana bat summer or winter habitat exists within a proposed project area. If the DEA biologist or DEC determines that habitat is not present within a proposed project site (as determined by the process contained in Section II and III of the HAM), then the appropriate documentation would be prepared and the project would be considered to have "no effect" on Indiana bats. However, if habitat is present within the proposed project site, a DEA biologist or DEC would use the information necessary to conduct a further review. This additional review of the project by the DEA biologist or DEC would include the data used previously during the analysis in Section III of the HAM and the analysis contained in Section IV of the HAM. If the DEA biologist or DEC (whomever conducts the review) determines that the habitat is marginal, project effects are determined to be discountable, or the habitat is unlikely to be occupied by Indiana bats (as determined by the process contained in Section IV and Appendix B of the HAM), then the project is considered to "not likely to adversely effect" Indiana bats. The Service has reviewed and concurred with these effects determinations previously in this biological opinion; therefore, further consultation with the Service would not be required and section 7(a)(2) responsibilities for those projects would be fulfilled.

Two criteria within the Tier 1 review process would trigger additional informal consultation with the Service. These criteria are described in the HAM and involve situations where the proposed project may impact: a) occupied and/or potential Indiana bat wintering habitat (i.e., caves, mine adits, or other karst features exhibiting cave like characteristics) or b) a known Indiana bat maternity colony. If any of these two criteria exist during the review of a road construction project, then KYTC would follow the process contained in Section V of the HAM. The only exceptions would be for those projects found to have "no effect" on the Indiana bat. If it is determined by KYTC, as defined in Section V of the HAM, that a species survey is needed in order to determine if the project would result in adverse effects to the Indiana bat, then KYTC will coordinate the findings and effects determination for concurrence with the Service.

Tier 2 of the Programmatic Review Process

Tier 2 involves the use of this programmatic biological opinion to account for adverse effects to Indiana bats that are likely to occur and that do not result in a "no effect" or "not likely to adversely affect" determination under Tier 1. If KYTC determines that a species survey or other minimization factors are impractical for a project where it is probable that adverse effects to the Indiana bat could occur, then KYTC would use the incidental take provided in this biological opinion's incidental take statement to account for adverse affects to the Indiana bat. However, if a proposed project may impact Indiana bat wintering habitat (i.e., caves, mine adits, or other karst features exhibiting cave like characteristics) then a species survey and BA must be prepared for coordination with the Service. In other words, Tier 2 would only apply on specific projects that could affect Indiana bat summer habitat outside of the range of a known maternity colony and where no potential or occupied winter habitat occurs.

As discussed previously, if it is determined that a specific road project listed in Appendix B of the BA does not meet the criteria of Tier 1, then KYTC may account for adverse effects to Indiana bats by utilizing the incidental take provided in this programmatic biological opinion. However, impacts for road projects in Appendix B of the BA that exceed 25 acres of summer habitat removal would not be considered for authorization of incidental take. Projects of this scope would undergo analysis in Section V of the HAM and would be coordinated with the Service.

KYTC has analyzed project impacts from previous years to estimate Indiana bat summer habitat losses. There are about 1,500 projects in the KYTC Six Year Plan, an average of 250 projects per year. Of these projects, about 80 percent (200) are considered "small" projects that are sufficiently documented with a Categorical Exclusion during the NEPA process. It is estimated that as many as half of these projects will result in "no effect" or "not likely to adversely affect" determinations. Of the remaining projects (100), it is estimated that an average of five (5) acres of habitat removal may occur, resulting in a net habitat loss estimate of 500 acres in 2006. Based on this analysis, KYTC estimates that the amount of Indiana bat summer habitat loss in 2006 would not exceed 500 acres. It is anticipated that this projection would increase 20 percent each year for the remaining duration of the current six-year plan. At the end of the current six-year plan (FY 2010), KYTC's estimate of summer habitat losses would be reevaluated. Therefore, the amount of incidental take requested for the current six-year plan is 500 acres of Indiana bat summer habitat in FY 2006, 600 acres in FY 2007, 720 acres in FY 2008, 864 acres in FY 2009, 1,037 acres in FY 2010. The aforementioned figures will be based upon KYTC's Fiscal Year beginning July 1 through June 30.

In order to ensure the consideration of all direct, indirect, and cumulative effects of the proposed actions on the Indiana bat, the action area under consideration in this Biological Opinion will include those areas within the right-of-way disturbance limits for each proposed project, as described in Appendix B of the BA, within the Commonwealth of Kentucky. The Service has described the action area to include the previously described area for reasons that will be explained and discussed in the "EFFECTS OF THE ACTION" section of this consultation.

STATUS OF THE SPECIES/CRITICAL HABITAT

The Indiana bat was listed as an endangered species on March 11, 1967 (32 FR 4001), under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U.S.C. 668aa(c)). It is currently included as an endangered species under the Endangered Species Act of 1973, as amended. Critical habitat was designated on September 24, 1976 (41 FR 41914), and included caves in Kentucky, Tennessee, Illinois, Indiana, Missouri, and West Virginia. At the time of critical habitat designation, the Service estimated that about 75 percent of the known population of Indiana bats hibernated at the 13 sites that were designated as critical habitat. Since routine surveys began in 1980, populations of Indiana bats at hibernacula, including many of the previously designated critical habitat caves, have witnessed a significant decrease in numbers followed by recent stabilization and an increase over the last decade. No summer roosting habitat has been designated as critical habitat for the Indiana bat.

The primary objective of the 1980 Indiana Bat Recovery Plan is to remove the Indiana bat from endangered status. The important features of the recovery plan are: (A) to determine the cause(s) of observed declines during both non-hibernation and hibernation seasons, and (B) to control access to important Indiana bat hibernacula, thus protecting the bats from human disturbance. In addition, summer foraging habitat must be maintained, protected, and restored. Lastly, in order to evaluate the success of protection efforts, a monitoring program is needed to document changes in Indiana bat populations.

Criteria for reclassification from endangered to threatened status will be based upon the status of the Indiana bat throughout its range, as determined through a 12 year, two-stage process. The species will be evaluated for reclassification following documentation of stable or increasing populations for three consecutive census periods (six years) and permanent protection [i.e., public ownership or long- term easement/lease, and gate/fence (where necessary and feasible)] at all Priority One hibernacula. To delist, the above criteria must be met, in addition to protection and documentation of stable or increasing populations for three consecutive census periods at 50% of the Priority Two hibernacula in each state, and the overall population level must be restored to that of 1980. This level is believed to be sufficient to maintain enough genetic diversity to enable the species to persist over a large geographic area and avoid extinction.

The Service (USFWS 1999) completed an agency draft of a revised recovery plan for the Indiana bat. The recovery plan is being revised to: (A) update information on the life history and ecology of the Indiana bat, especially information on summer ecology gathered since 1983; (B) highlight the continued and accelerated decline of the species; (C) continue site protection and monitoring efforts at hibernacula; and (D) focus new recovery efforts toward research in determining the factor or factors causing population declines. The main recovery actions identified in the revised recovery plan are to:

1. Conduct research necessary for the survival and recovery of the Indiana bat.
2. Obtain information on population distribution, status, and trends for the Indiana bat.
3. Protect and maintain Indiana bat populations.
4. Provide information and technical assistance outreach.
5. Coordinate and implement the conservation and recovery of the Indiana bat.

To date, conservation efforts have concentrated on protection of winter habitat, although there has been some research into the life history of the Indiana bat. Active programs by state and federal agencies have led to the acquisition and protection of a number of Indiana bat hibernation caves. Of 127 caves/mines with populations greater than 100 bats, 54 (43%) are in public ownership or control. Most of the 46 (36%) that are gated or fenced are on public land. Given the divergent population trends throughout the range of the Indiana bat, however, it is evident that these measures have not yet produced the desired result of recovery of the species, although there has been some improvement in population numbers.

Threats

Indiana bats have been described as "once one of the most common mammals in the Eastern United States" (Tuttle et al 2004). Between 1960 and 2002, a 56 percent population decline has been documented (Clawson 2002; see below). A variety of factors have contributed to rangewide Indiana bat population decline including flooding and ceiling collapse in winter hibernacula (Service 1983). This often resulted in the adverse changes to the hibernaculum microclimate by affecting temperature and humidity. Other documented cases of Indiana bat declines include: (1) blocking cave entrances or installation of gates that do not allow for bat ingress and egress, or disrupt cave air flow; and (2) human disturbance during hibernation. These changes resulted in either die-off during hibernation due to freezing, or starvation as the higher temperatures increases the bats metabolism. This can result in the utilization of limited fat reserves that are required to survive hibernation and emergence in the spring. In this situation, the Indiana bat does not have the ability to awake from hibernation, leave the cave, forage for additional sustenance, and return to the cave to complete its hibernation cycle. It simply starves.

Because many known threats are associated with hibernation, protection of hibernacula has always been a management priority; however, disturbance to hibernacula continues to be a threat to the Indiana bat. For example, the largest hibernacula in Indiana (50,941 Indiana bats in 2003) is not gated, and based on electronic monitors in the cave, unauthorized visits to this cave occur. Also, at the only large hibernacula in Ohio (9,436 Indiana bats in 2004 – a decrease from the previous two counts), there are still tours, as well as other commercial and residential activities, taking place in and adjacent to the Lewisburg Limestone Mine during the hibernation period.

Despite the protection of about half of the known major hibernacula (Currie 2002), range-wide population declines continued until recent years when numbers of hibernating Indiana bats stabilized and then began showing an increase in numbers over the last few years. In the last fifteen years, appropriately constructed bat gates have been correctly installed in caves, allowing for protection of hibernating bats and restoration of the microclimate. Although most of these efforts were completed by 1990 and resulted in some recolonization of traditional hibernacula, there have not been corresponding overall population increases (Clawson 2002). Possible reasons for this are that the species' reproductive capacity will take much longer than 10-20 years to show population gains and/or other environmental factors continue to negatively affect the species.

Because of the migratory behavior of this species and other reasons described below, it is not prudent to differentiate between different geographical ranges with regard to wintering populations. The range-wide declines have led some to conclude that additional information on Indiana bat summer habitat is needed (3D/E 1995).

Land use practices have been identified as a suspected cause in the decline of the Indiana bat, particularly because habitat in the Indiana bats' maternity range has been changed dramatically from pre-settlement conditions in the following ways: the vast majority of mature forests have been harvested and remaining forests are fragmented to varying degrees; fires have been suppressed; prairies have been replaced with agricultural systems; native plants have been replaced with exotics; and diverse plant communities have been simplified. These changes can have profound effects through factors such as loss of suitable roosting habitat caused by the removal of large trees, and by a reduction of the diversity and abundance of insects on which the Indiana bats prey (Service 1983; Kurta and Murray 2002; Kurta et al. 2002; McCracken 1988; Racey and Entwistle 2003).

In addition to an increased focus on Indiana bat summer habitat, attention has also being directed to pesticide contamination (Clark et al. 1987; Clawson 1987; Garner and Gardner 1992; Callahan et al. 1997; 3D/E 1995; O'Shea and Clark 2002; Kurta and Murray 2002). Insecticides have been known or suspected as the cause of a number of bat die-offs in North America, including endangered gray bats in Missouri (Mohr 1972; Reidinger 1972; Clark and Prouty 1976; Clark et al. 1978). The insect diet and longevity of bats also exposes them to persistent organochlorine chemicals that may bioaccumulate in body tissue; however the use of organochlorine insecticides has decreased over the last 20 years (O'Shea and Clark 2002).

Summary - In general terms, the overall population decline of the Indiana bat is the result of mortality exceeding recruitment (i.e., deaths are outpacing recruitment). The specific reasons for this dynamic remain unknown. However, it is likely that higher mortality rates occur during migration and hibernation due to the energy demands of these events than during routine foraging and roosting activities in summer habitat.

Loss of breeding females can occur at any point in the annual cycle of hibernation, spring migration, parturition, lactation, fall migration, mating, and hibernation. Healthy females are capable of producing only one pup per year. At some point(s) in this annual cycle, the species experienced higher mortality rates or lower recruitment than it did historically, causing the species' population to decline steadily (i.e., a 19 percent decline was noted between 1990 and 2000). The vulnerable point(s) in this cycle may very well differ by geographic area, and even within the same area. Ransome (1990) further identifies the limiting factors that control overall bat population as the number of maternity colonies and the proximity and quality of foraging areas surrounding each maternity site. He also concludes that a reduction in the number of maternity colonies contributing to a hibernaculum is a prime factor that should be considered when evaluating the causes of population declines in bats. The number of bats found in individual caves is regulated by the number and sizes of maternity colonies that contribute to those caves (Ransome 1990). MacGregor (Service 2005) clarifies that many other factors affect cave populations. Unless a change in these environments occurs to allow recruitment to exceed mortality, the species will decline.

Distribution

The Indiana bat is a migratory species whose range encompasses much of the eastern half of the United States. As of January 2001, the Indiana bat had been recorded in 311 counties, scattered across 27 states (Gardner and Cook 2002). Preliminary genetic studies indicate that, the species appears genetically uniform throughout its range with the exception of New York and Vermont (Bob Currie, personal communication, Service). The winter/summer populations in Vermont and New York appear to be isolated in that the majority of individuals followed from hibernacula appear to be migrating short distances to establish maternity colonies in close proximity to the hibernacula. Elsewhere throughout the range, rather than one large meta-population, the Indiana bat functions as hundreds or thousands of smaller sub-populations. Because mating takes place randomly at the hibernaculum during fall swarming, genetic exchange is a result of the contribution of many smaller populations, or maternity colonies, congregating at one hibernaculum (Service 1999b).

The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range.

Indiana Bat Population Status

Due to the colonial nature of Indiana bats, conducting censuses of hibernating bats is the most reliable method of tracking population/distribution trends range-wide, and provides a good representation of the overall population status and distribution. As such, winter distribution of the Indiana bat is well documented.

For several reasons, interpretation of the census data must be made with caution. First, winter census data is broken down 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. 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, little is known as to the size, location and number of maternity colonies for the Indiana bat. As described below, it is estimated that the location of about 90 percent of the maternity colonies are 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 come from one to many different hibernacula, the source (hibernacula) of most, if any, of the individuals in a maternity colony is not known. As discussed in the "Spring Emergence/Migration" section, Indiana bats have been documented to travel up to 300 miles from their hibernaculum to their maternity areas (Gardner and Cook 2002).

Range-wide Hibernacula Censuses

Based on the 2005 winter census, Indiana has four Priority I hibernacula and Kentucky and Missouri each contain three Priority I hibernacula. Priority II hibernacula are known from the

aforementioned states, in addition to Arkansas, Illinois, New York, Ohio, Tennessee, Virginia, and West Virginia. Priority III hibernacula have been reported in 17 states, including all of the aforementioned states. In the 2005 hibernacula census, the total known Indiana bat population was 458,332, down from about 880,000 bats in 1960 (Table 3), and about half of these hibernated in eight Priority I hibernacula (excluding Dixon Cave, Kentucky, which did not reach the Priority I threshold) (King, personal communication, 2005). Censuses began in the late 1950s, and since then many winter counts have decreased, especially in Kentucky and Missouri. Overall, the population has declined 48 percent since the 1960s (King, personal communication 2005). Caves in Kentucky suffered dramatic losses because of changes in microclimate due to poor cave gate design in two of the three most important hibernacula (Humphrey 1978), and Indiana bat numbers in Kentucky hibernacula continued to decline until 2005 when a increase was observed (King, personal communication 2005). Despite recovery efforts, Indiana bats in Missouri caves have declined with a loss of more than 80 percent of the population (Clawson 2002). The ten-year population trend of the Indiana bat has steadily declined (Table 3). It should be noted that the results of winter hibernacula censuses completed in 2001, 2003, and 2005 all have shown population increases. Therefore, the 2000-2010 trend may represent an improvement in the range-wide population.

Table 3. Ten-year, range-wide population trend for the Indiana bat.

Approximate Time Period	Population Estimate	Approximate Percent Change
1960 – 1970	883,300	N/A
1980	678,750	-23
1980 – 1990	473,350	-30
1990 – 2000	382,350	-19

Although slight increases in 2001 and 2003, as well as the more substantial 2005 increase was seen in the range-wide population, we are hesitant, at this time, to extrapolate long-term trends from changes between individual survey periods, because the species' reproductive capacity may take longer than 10-20 years to show sustained population gains. Also, small fluctuations from year-to-year may be attributed to such factors as weather affecting the success of reproduction for a given year (Humphrey et al. 1977; Ransome 1990).

One known major cause of Indiana bat decline has been human disturbance and vandalism of hibernating bats during the decades of the 1960s through 1980s. Some hibernacula have been rendered unavailable to Indiana bats by erection of solid gates in the entrances (Humphrey 1978). Although some hibernacula have been restored in order to support future wintering populations, and Indiana bats have returned to traditional hibernation sites, in some cases, population gains have not yet materialized. It appears that by the 1990s, vandalism and improper installation of cave gates had been reduced. Despite these efforts to reduce threats and restore traditional hibernacula, the range-wide population of Indiana bats continues to be well-below historic levels with only recent signs of stabilization or population increases. A hypothesis for documented early population declines is that warmer winter temperatures have resulted in less conducive microhabitat conditions (warmer temperatures) at hibernacula, particularly in the

southern part of the species range (Rick Clawson, personal communication, Missouri Department of Conservation).

Range-wide Maternity Colony Information
Early researchers considered floodplain and riparian forest to be the primary maternity roosting and foraging habitats for the Indiana bat, and these forest types unquestionably are important (Humphrey et al. 1977). More recently, Indiana bats have been shown to use upland forests for maternity roosting (Clark et al. 1987; Gardner et al. 1991b; Callahan et al. 1997; Kiser et al. 2002; Apogee 2003); and upland forest, old fields, and pastures with scattered trees have been shown to provide maternity foraging habitat (Gardner et al.1991b).

The first Indiana bat maternity colony found was in the Midwest region. As a result, the majority of studies of maternity colonies and their associated habitats have been conducted in glaciated regions of the Midwest region (southern Iowa, northern Missouri, northern Illinois, northern Indiana, and southern Michigan). Remaining woodlands in this glaciated region are mostly fragmented with small bottomland and upland forested tracts of predominantly oak-hickory forest types and riparian/bottomland forests of elm-ash-cottonwood associations. These forested areas exist in an otherwise agricultural dominated (non-forested) landscape (Forest Service 1997). Nevertheless, the small amount of forested area in this region appears to have a relatively high density of maternity colonies, especially when compared to the unglaciated forested landscapes similar to the action area. While the majority of maternity colonies have been discovered in the glaciated areas of the Midwest, some have been discovered as far northeast as Vermont's Lake Champlain valley and as far south as the Cherokee and Nantahala National Forests in eastern Tennessee and western North Carolina, respectively.

Despite the large expanse of forested habitat in the unglaciated portions of the Midwest (southern Missouri, southern Illinois, southern Indiana, and southern Ohio), Kentucky and most of the eastern and southern portions of the species' range (including Pennsylvania and West Virginia) appears to have fewer maternity colonies per unit area of forest. However, such conclusions may be premature, given the lack of search effort and large areas of forested habitat in these areas. The recent discovery of maternity colonies in these areas has led to expanded search efforts and habitat studies.

Based on published literature and correspondence with Service or State biologists throughout the range of the Indiana bat, maternity activity has been documented at about 225-250 locations throughout the species' range (Table 4) (Service 2004). The majority of confirmed maternity areas are in the "core" of the range, in the glaciated Midwest in pockets of remaining forested habitat within a predominantly agricultural landscape in close proximity to known hibernacula. Because the Indiana bat is philopatric, there is no evidence to suggest that maternity colonies are located in optimal foraging and roosting habitat. A possible explanation for the species' decline is that existing maternity colonies are senescent (i.e. recruitment < death). This could be caused by pups being produced but not surviving their first hibernation period; or maternity areas are no longer providing a sufficient supply of suitable prey, resulting in an increase in the age of first reproduction and increasing fecundity schedules. Proof of at least several years of successful reproduction and recruitment would be needed to verify long-term survival of the Indiana bat in these highly altered and fragmented landscapes. Although data at a few maternity sites indicate

Table 4. Documented Indiana bat maternity areas (or maternity activity).

STATE	NUMBER OF MATERNITY COLONIES[1]
Illinois	38
Indiana	83
Iowa	21
Kentucky	31
Michigan	10
Missouri	17
Ohio	9
Pennsylvania	1
New Jersey	1
North Carolina / Tennessee	5
Vermont / New York	7
Virginia	1
West Virginia	2
TOTAL	**218 (227-252)**

[1] Estimates are based on the capture of a reproductive female or juveniles in a discrete area during the maternity season (15 May – 15 August), or telemetry tracking reproductive females from hibernacula to maternity roost sites. This number is based on correspondence through the 2003 field season. In order to allow for new maternity colonies discovered in 2004, it is assumed that approximately 227-252 maternity colonies have been discovered.

that reproduction is occurring (exit counts nearly double a month after birth), long term monitoring of maternity sites is limited. Long term monitoring has been conducted at a maternity colony located near the Indianapolis Airport (Indianapolis Airport Authority 2003; Indianapolis Airport Authority 2004). This colony continues to persist, and shows evidence of reproduction, although additional monitoring is needed to make a determination regarding whether the colony is stable, increasing, or decreasing at this site.

Monitoring data, including extensive exit counts to estimate maternity colony population size and structure over more than one-year, is available for only a few of the maternity colonies discovered (Humphrey et al. 1977; Garner and Gardner 1992; Callahan 1993; Gardner et al. 1991b; Kurta et al. 1996; Indianapolis Airport Authority 2003; Indianapolis Airport Authority 2004). Additionally, because the vast majority of the Indiana bat maternity colonies have not been discovered, let alone studied, what little demographic data that is available, represent a fraction of the range-wide maternity activity.

Because so little is known regarding the population size and structure of maternity colonies, the Service used the same assumption as Whitaker and Brack (2002) to determine the average maternity colony size to give an approximation of the number of potential maternity colonies range-wide for the Indiana bat. The Service recognizes that maternity colonies are not static in size, and the numbers of individuals that comprise a maternity colony likely vary widely as a colony adjusts to current conditions, including the availability and quality of roosting and foraging habitat, and variable climatic conditions. Therefore, these figures should not be used to