# BIOLOGICAL OPINION

**for the**

## FEDERALLY ENDANGERED INDIANA BAT (*Myotis sodalis*)

**for the**

## HOOSIER NATIONAL FOREST'S PROPOSED TELL CITY WINDTHROW 2004 SALVAGE TIMBER HARVEST

**on the**

## TELL CITY RANGER DISTRICT CRAWFORD AND PERRY COUNTIES, INDIANA

**Submitted to the**
**U.S. Department of Agriculture, Forest Service,**
**Hoosier National Forest**

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# INTRODUCTION

This document transmits the U.S. Fish and Wildlife Service's (Service or USFWS) Biological Opinion (BO) based on our review of the Biological Assessment for Threatened and Endangered Species, Tell City Windthrow 2004, Hoosier National Forest (dated March 18, 2005)(hereafter referred to as the Windthrow BA) and other supplemental materials. The Windthrow BA was originally submitted by The USDA Forest Service, Hoosier National Forest (HNF) and was received at the Service's Bloomington, Indiana Field Office (BFO) on March 21, 2005 along with a letter requesting us to initiate formal consultation on the proposed Windthrow 2004 salvage timber harvest and its effects on the Federally endangered Indiana bat (*Myotis sodalis*).

This BO is prepared in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). This biological opinion is the culmination of formal section 7 consultation under the Act. The purpose of formal section 7 consultation is to insure that any action authorized, funded, or carried out by the Federal government is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat of such species. This BO covers the actions of the HNF, as this federal agency will authorize, contract, and oversee the salvage timber harvest and related activities associated with this project.

This BO is based on information provided from the following sources:
1) the Biological Assessment for Threatened and Endangered Species, Tell City Windthrow 2004, Hoosier National Forest (dated March 18, 2005), 2) the HNF's Land and Resource Management Plans (1985 and 2005 Draft Plan) and the 1991 Plan Amendment, 3) the Hoosier-Shawnee Ecological Assessment (2004), 4) maps, reports and scientific literature on Indiana bat research conducted in the action area and elsewhere, and 5) meetings, phone calls, and written correspondence with the HNF staff. BFO Biologist, Andy King, also observed some of the wind damaged areas of the HNF during a ground and helicopter tour in July 2004. An administrative record of this consultation is on file at the BFO.

# CONSULTATION HISTORY

After the wind/storm damage occurred during July 2004, HNF wildlife biologists contacted BFO biologists and began informally consulting on the potential for conducting salvage timber harvests in some of the most heavily damaged areas. BFO biologist, Andy King, conducted a ground and helicopter tour of the proposed project area and provided technical assistance. Because the HNF desired to conduct the salvage operations during the summertime when Indiana bats are roosting in trees, it was concluded that incidental take of some roosting bats may occur and that this possibility would necessitate the completion of a formal section 7 consultation. The scope of this salvage timber harvest project was not considered under the current Forest Plan Biological Opinion (July 2001) and therefore would require a separate formal section 7 consultation. The HNF biologists prepared a biological assessment for this project with the aid of the USDI Fish and Wildlife Service's Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act (USFWS 1998), USDA Forest Service Manual 2670 direction (USDA Forest Service 1995), and the Hoosier National Forest Land and Resource Management Plan (USDA Forest Service 1991, 2000a). The BFO received the

Windthrow 2004 BA and a written request to initiate formal consultation with the HNF on 21 March 2005. On 25 April 2005, HNF biologists, Gary Dinkle and Jason Engle, met at BFO to discuss the proposed project with BFO Field Office Supervisor, Scott Pruitt, and BFO consultation biologist, Andy King. During this meeting, the HNF provided the Service with a wall-sized map the Windthrow 2004 project area that contained detailed information that had not been provided in the Windthrow BA itself. For example, the map included locations of all proposed road activity: maintenance, reconstruction, new construction, and obliteration. The BFO acknowledged during this meeting that they now had the information they anticipated needing for conducting their required analyses and that formal consultation would begin on that day. The 90-day consultation period would extend through July and the 45-day BO preparation period would conclude in early September. The Service's BO would be issued within the standard 135-day period or by 7 September 2005. However, on 5 August 2005, HNF biologist, Clark McCreedy, e-mailed BFO biologist, Andy King, and others a memo (and photograph) stating that he had just identified what appeared to be a "maternal roost of the Indiana bat" within the Celina North Campground, which is within the proposed Windthow 2004 project area. Mr. McCreedy observed 30 bats emerge from beneath sheaths of loose bark on upper branches of a dead American elm (*Ulmus americana*) shortly after sunset on the evening of 4 August 2005. If these were Indiana bats, then this would be the second documented maternity colony on the HNF. On October 21 2005, prior to issuance of the BO, HNF and BFO staff members discovered that this newly found (and later confirmed) Indiana bat maternity roost tree had been felled on September 22 by recreation maintenance workers, who believed the dead tree was a safety hazard and was likely to soon fall onto a camp site. Because of a miscommunication within the HNF, the roost tree was not protected as originally intended by HNF biologists. The Service has considered this new information while preparing this BO and the consultation period was consequently extended.

# BIOLOGICAL OPINION

## I. DESCRIPTION OF THE PROPOSED ACTION

The HNF proposes to undertake a salvage timber harvest, the Tell City Windthrow 2004, in which downed and some standing damaged trees would be salvage harvested. Trees were damaged as a result of straight line winds over nearly 128,000 acres, which includes almost the entire Tell City Ranger District (Figure 1). Blowdown occurred on over 60,600 acres of National Forest System lands. On the Tell City Ranger District, approximately 3,950 acres of blowdown has merchantable timber that could be salvaged. However, 1,100 acres are not being proposed for salvage harvest due to limited access, low volumes, and other resource concerns on the remaining acreage (e.g. Mogan Ridge proposed roadless area). Thus, the HNF is proposing to conduct salvage harvest on a total of 2,850[1] acres. A majority of the harvest operations would occur during summer months to prevent equipment operation from causing significant soil erosion and deep ruts, which is more of a problem in the winter because of wetter soil conditions. Winter harvest operations would occur only when there are significant dry periods or frozen ground.

Prescribed fire would be applied to approximately 5,620 acres including many, but not all, of the proposed salvage units (as outlined in the BA figures and wall-map) to reduce fuels and release oaks and hickories from competing beech, maple, and pines. The prescribed burns will be broken into several burn areas, averaging 500 acres, with the largest being nearly 1,000 acres. Prescribed fire would be applied 2 to 5 years after the salvage harvest, and the initial prescribed burns would occur over a 3-year period. A second prescribed fire would be applied to the same burn areas 2 to 4 years following the first fire to enhance oak and hickory composition within the action areas. Fire managers would use existing landscape features to control fire intensity and extent.

The areas proposed for treatment activities, salvage, prescribed burning, or both, are within Management Areas 2.8 (5,460 acres, 84%), 6.4 (627 acres, 10%), 7.1 (223 acres, 3%), and 2.4 (176 acres, 3%), respectively. The current *Forest Plan* allows for salvage timber harvest and prescribed burning within these management areas, and these activities are consistent with the objectives in the *Forest Plan*. This project would use standards and guidelines established by the Hoosier National Forest Land and Resource Management Plan (USDA Forest Service 1991, 2000a) and exceed the best management practices guide for water quality in Indiana (IDNR 1998).

Approximately 34 miles of road work would be required to access the salvage units, and a majority of road work would be within or directly adjacent to units proposed for salvage. The road work would consist of maintenance, reconstruction, and new construction activities. The majority of these road work activities would not require the removal of any trees; however, some trees may be cleared, especially with reconstruction and construction activities. The HNF estimates that 35 acres of forest would have to be cleared in association with the proposed road work.

[1] Calculations were based on the best available data at the time. Calculation totals will vary slightly due to ongoing fieldwork and units being dropped or revised to address resource concerns and operability limitations. Therefore, the actual acreage and number of units implemented may vary somewhat from the values reported here. Although there may be minor acreage adjustments, no additional effects to T&E species are anticipated.

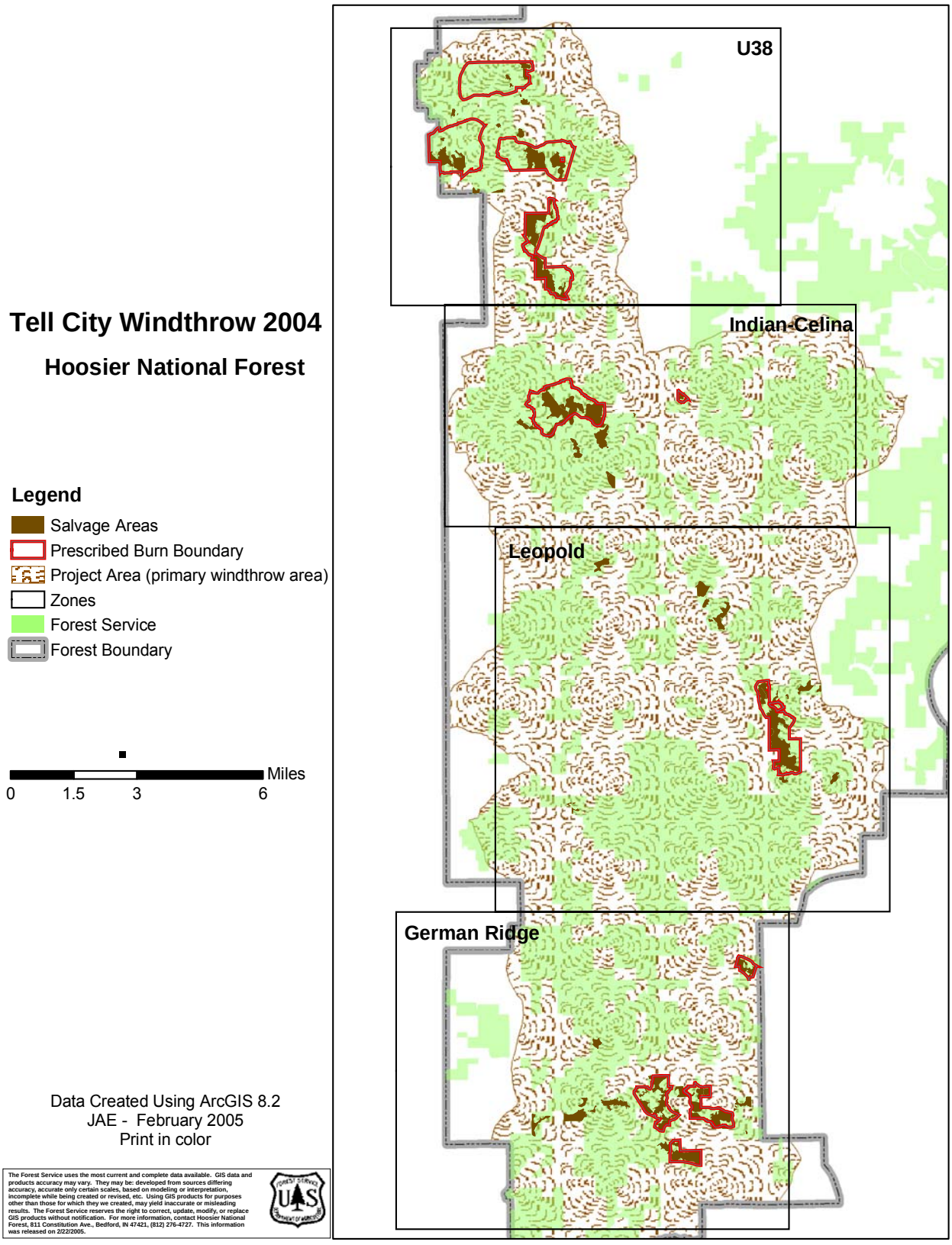


**Figure 1.** Location of the Tell City Windthrow 2004 action areas.

**Anticipated Project Chronology**

Sale and harvest of salvage timber would begin during spring 2006. Harvest operations would be completed during the spring, summer, and early fall of 2006. The earliest that prescribed fire would be applied is over the spring of 2008. The earliest that a second prescribed fire would be reapplied over the same burn areas would be the spring of 2010.

# Proposed Conservation Measures

As part of the Proposed Action, the HNF has committed to implementing conservation measures that would minimize incidental take of the Indiana bat and maintain and/or improve habitat suitability for Indiana bats in the Action Areas. The proposed conservation measures are described in Appendix A of the Windthrow BA and are hereby incorporated by reference. Many of these measures were specifically designed to avoid and minimize adverse affects of the proposed salvage timber harvest on Indiana bats and their habitat and to further the species' recovery, while other measures primarily were included to benefit other wildlife species. The Service has analyzed the effects of the Proposed Action with the understanding that all proposed conservation measures have been committed to and will be implemented. Likewise, all of the proposed conservation measures will be included in the HNF's NEPA documents, tree marking guidelines, and timber sale contracts.

After marking the trees to be left standing (i.e., leave trees) and those to be harvested, the HNF staff will randomly select a subset of stands where roost tree surveys will be conducted to ensure that desired conditions are being achieved on a stand-wide average.

The beneficial effects of the following measures were taken into consideration for both jeopardy and incidental take analyses.

### *Primary Conservation Measures for Indiana Bat*

- Standing "shagbark hickory or shellbark hickory trees shall not be harvested…unless the density of trees of these two species combined exceeds 16 trees/acre",

- "Snags shall not be removed for TSI purposes, unless they are safety hazards",

- When possible, at least three trees ≥20" dbh and six ≥11" dbh will be maintained on average per acre. Otherwise, at least 16 live trees per acre. The trees should be selected from 13 specified species (hickories, oaks, ashes, cottonwood, silver maple, elms, and black locust),

- High-quality, potential roost trees will be selected and marked as leave-trees. This will include dead snags and damaged trees that have sloughing and exfoliated bark, split bole cracks, or cavities. Additional characteristics that will be used to identify high-quality potential roost trees to be left in the stands will include relatively large dbh, significant solar exposure – especially along edges of blowdown, and close proximity to stream corridors,

- Standing undamaged live trees will be removed only if they present safety hazard or to facilitate access. Large mature hardwoods will be avoided and protected as much as possible, and

- To avoid the potential for direct take of roosting Indiana bats in the project area, all proposed prescribed burning will be conducted between September 15 and April 15, when Indiana bats are roosting within or near to their winter hibernacula and not anticipated to be roosting within the proposed burn units.

**Additional Mitigation Measures**

The project would incorporate the standard mitigation measures in Appendix K of the *Forest Plan*, which incorporates Section FSH 2509.22 of the Forest Service Soil and Water Conservation Practices Handbook. The purpose of this management guidance is to protect soil, water, riparian, and aquatic resources.

Standards, guidelines, and management requirements for water quality protection would be applied to all ground-disturbing activities. Erosion and sediment control measures would include, but would not be limited to equipment limitation zones during timber harvesting, contouring for drainage control, outsloping roads, and providing waterbars, mulching, and seeding. These mitigations plus additional mitigations are further clarified in Tell City Windthrow 2004 DEIS, Appendix B.

Additional mitigation measures are based on Standards and Guidelines in Appendix J of the *Forest Plan,* but made specific to conditions in this project. These mitigation measures, designed to prevent soil compaction or rutting, include the following:

- Equipment would be operated when soils are most resistant to compaction and rutting. Harvesting operations would primarily occur between June 1 to November 15 when soils are not saturated, unless otherwise authorized by a Forest Service representative.

- The Forest Service representative would limit harvesting during wet periods through increased inspection and restrictions within the timber sale contracts.

- The Forest Service representative would designate major skid trails prior to construction and use to minimize the total area affected by harvest operations.

- Log landings would be designated on the ground by Forest Service personnel prior to harvest operations.

- Following logging operations, landings would be put into favorable site conditions for seed germination. They would then be seeded and mulched to prevent erosion during the time before vegetation becomes reestablished. These actions would be taken as soon as practical after disturbance.

- Waterbars or other water diversion devices would be constructed and maintained on skid trails in accordance with recommendations in the Forest Service Handbook 2509.22, Soil and Water Conservation Handbook.

- Skid trails would be seeded as soon as practical after disturbance and would not be allowed to overwinter in a bare condition. The seed mixture would be approved by Forest Service personnel.

- Skidding would occur on slope contours, where possible, to prevent downhill soil movement or erosion during water run-off periods.

- Limit salvage harvest activities within 100 feet from top and base of large cliffs or overhangs when Regional Forester sensitive species or forest species of concern are likely or known to be present [Reference *Forest Plan Appendix C*, p. C-11].

- Temporary roads would be closed after use.

- Skid trails would be limited to less than 35 percent slopes.

- Naturally occurring oxbow ponds, sinkhole ponds, springs, and seeps will have the same mitigation measures as perennial streams. Man-made impoundments are excluded from any limitation on vegetation management activities.

### *Terrestrial Wildlife Additional Mitigation*

- Within all harvest areas, all snags will be retained unless they pose a safety problem or must be removed for access. The HNF will protect occupied raptor nests if they are found during marking or harvest operations.

- Abundant downed woody material will remain on site after timber harvesting, because no yarding of unmerchantable material is required, and most slash will be left in place.

**Riparian Corridor Guidelines**

Riparian corridors are defined as the riparian area plus a filter strip beyond the riparian area according to stream type. The edge of the filter strip will be the boundary of the entire riparian corridor. The following is a list of the filter strip widths, according to stream type: 100 foot (perennial), 50 foot (intermittent), and 25 foot (ephemeral). Riparian Corridor guidelines will comply with the 1991 Forest Plan and the 2005 draft Forest Plan riparian guidelines. Management activities within these zones will emphasize water quality, riparian area values, and enhancement of habitats such as introduction of large woody debris. Trees within riparian corridors are managed to provide sufficient amounts and sized of woody debris to maintain habitat complexity and diversity for aquatic and riparian species.

- No standing hardwood trees (damaged or undamaged) will be removed within 20 feet of perennial and intermittent streams. A standing tree is considered any tree not leaning more than 45 degrees. This guideline is intended to protect Regional Forester sensitive species by maintaining canopies adjoining streams (*Forest Plan Appendix C* p. C-11). In addition, it will protect potential roost trees for Indiana bats.

- In the riparian corridor a minimum of 60 square feet basal area per acre will be maintained for stream temperature regulation. Pulling trees out of the riparian corridor and stream channel will involve using cable; cable will be pulled perpendicular to the stream channel and designated skid trails will be used for access to pull cable. These skid trails will be perpendicular to the stream channel and will be designated at appropriate distances within the riparian corridor.

- A total of 300 pieces of large wood per mile will be left within the stream for aquatic and riparian species, aquatic habitat complexity, and to maintain stream channel function. A piece of large wood is designated as at least 4 inches in diameter and 12 feet in length.

- Management activities associated with the Tell City Windthrow project that may affect water quality must follow Logging and Forestry BMP's for Water Quality in Indiana (IDNR 1998), or the most recent version, as a minimum to achieve water quality objectives. When Forest Plan standards exceed Indiana BMP's or water quality standards, Forest Plan standards shall take precedence.

- There will be a minimum number of temporary stream crossings, with locations designated by the USDA Forest Service. Where needed, crossings will utilize approved structures to be removed after the project is complete.

- If stream crossings are necessary, construct crossings during the dry months of the year (approximately May 1 to October 31). This minimizes the potential for erosion from high water events.

- USDA Forest Service sale administrators will locate crossing approaches to minimize erosion and sediment introduction to the stream. For example, they locate crossings where the streambanks or side-slope grades are gently sloping or where hard substrates occur (bedrock, large boulder and cobble).

- USDA Forest Service sale administrators will design stream crossings to allow fish passage during low water (Forest Plan, p. 2-8, 1991).

- Contractors will return stream crossings to the appropriate elevation, so it maintains stream channel function and does not block fish passage.

- USDA Forest Service administrators will not allow heavy equipment within streambeds (Forest Plan, p. J-4, 1991).

- Rootwads will be kept attached to stream banks. Rootwads, when anchored in or against the bank, provide stability to the riparian area, and provide cover for aquatic organisms.

- Existing debris dams will be left in place within stream channels where they do not have potential to cause detrimental effects to downstream structures or excessive changes in hydrological flow in larger perennial streams. Debris dams are important for invertebrate production and for nutrient cycling within a stream. They also function as important habitat components for many aquatic species.

## Action Areas

An "action area" is defined by regulation as 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). The action area is not limited to the "footprint" of the action nor is it limited by the Federal agency's authority. Rather, it is a biological determination of the reach of the Proposed Action on listed species that encompasses the biotic, chemical, and physical impacts to the environment resulting directly or indirectly from the action. The Action Area is defined by measurable or detectable changes in land, air and water or to other measurable factors that will result from the proposed action. The area indirectly affected by the action includes the area affected by noise, smoke and sediment transport from upland areas into streams that occur in response to activities on the HNF property. Activities such as timber harvest and road construction will generate noise. The level of noise generated and its travel distance will vary depending upon the methods and equipment being used or operated and the local topography, but it is not expected to reach outside the project boundary. As an example bulldozers and chainsaws run at full throttle are expected to produce low frequency noise, that at a half mile away is detected at the decibel level of normal conversation (de Hoop and Lalonde 2003). Prescribed fire will generate smoke that may drift short distances from the project area. Smoke dissipates into the air column and detectable levels are minimal at a distance of one mile from the fire. Similarly, sediment originating on HNF lands and entering an aquatic system is likely to be deposited a certain distance downstream, depending on velocity and mean particle size (Ritter et al. 1995). Based on channel morphology and velocity of streams on the HNF, sediment particles would be expected to be deposited within one mile of the origination point under normal flow conditions. The action areas for the Indiana bat are described in the following subsection.

Because the proposed salvage and prescribed burn areas are widely distributed from north to south in the Tell City Ranger District, the HNF chose to subdivide the primary windthrow area into four different subareas or "salvage zones", which they have named "U38", "Indian-Celina", "Leopold", and "German Ridge" (see Figure 1). The HNF has delineated a total of 85 proposed "salvage units" within the four named salvage zones. Each salvage units has been identified with a unique unit number as depicted in Figures 2-10 within the Windthrow BA and the detailed Windthrow wall map provided to the Service. These color figures/maps are hereby incorporated by reference. When conducting our analyses, the Service considered anticipated affects to Indiana bats that were likely to occur within each of the salvage units delineated on the HNF maps as well as any anticipated affects to bats occurring within 2.5 miles in any direction of the delineated areas (i.e., we used an additional 2.5-mile buffer to establish the Action Areas). The 2.5-mile buffer was chosen based on a study in Illinois (Gardner et al.1991a) that found the maximum distance an Indiana bat traveled from its daytime roost tree to its original capture site was 2.5 miles (4.1 km). In addition, the 2.5-mile distance is consistent with unpublished data from Indiana bat studies conducted at the

Jefferson Proving Grounds and the Indianapolis Airport in Indiana (Pruitt 1995, 3D/International 1995). Therefore, we assume that only those Indiana bats that roost and forage within the proposed salvage units themselves or within a 2.5-mile buffer of them would be directly or indirectly exposed to any stressors associated with the Proposed Action. Likewise, no stressors (e.g., reduced water quality, noise, or smoke) associated with this project are anticipated to travel more than 2.5 miles beyond a boundary of a proposed salvage unit or prescribed burn unit.

No Indiana bat hibernacula are known to occur within the Action Areas for the Windthrow 2004 project as defined above or within a 5-mile buffer of any delineated salvage or prescribed burn boundaries. The 5-mile distance has biological significance, because Indiana bats have been documented roosting and foraging up to a maximum distance of approximately 5 miles (8 km) from their winter hibernacula during the fall swarming period (Rommé et al. 2002).

There is no designated Critical Habitat for the Indiana bat within the project's Action Areas and the nearest hibernaculum that has been designated as Critical Habitat, Wyandotte Cave, is over 10 miles east of the project area at its nearest point.

# II. STATUS OF THE SPECIES

## Indiana Bat

This section is a discussion of the rangewide status of the Indiana bat and presents biological and ecological information relevant to formulating the biological opinion. It includes information on the species' population size, life history, its habitat and distribution, and the effects of past human and natural factors that have led to the current status of the species.

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 of 1973 extended full protection to the species. The Service has published a recovery plan (USFWS 1983) which outlines recovery actions. Briefly, the objectives of the plan are to: (1) protect hibernacula; (2) maintain, protect, and restore summer maternity habitat; and (3) monitor population trends through winter censuses.

Thirteen winter hibernacula (11 caves and two mines) in six states were designated as Critical Habitat for the Indiana bat in 1976 (Federal Register, Volume 41, No. 187). In Indiana, two winter hibernacula (a cave in Crawford County and a cave in Greene County) were Designated Critical Habitat. Although the Critical Habitat in Crawford County is within the general vicinity of the current proposed project, it is over 10 miles from the proposed salvage and burn areas and therefore is not considered to be within the Action Area for this project.

**Population 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 surveys of the hibernating bats is the most feasible and efficient means of estimating and tracking population and distribution trends across the species'range in the eastern United States. 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 caution. First, winter survey data is 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, 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 approximately 90 percent of the 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 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). As such, the origin of the bats (hibernacula) that comprise the maternity activity in the action area is unknown.

***Rangewide Winter Hibernacula Surveys***

The data regarding Indiana bat abundance prior to Federal listing are limited, but the information suggests that they were once far more abundant than they were in the 1960s. Tuttle and colleagues, for example, believe the overall abundance of Indiana bats likely rivaled that of the now extinct passenger pigeon (Tuttle et al. 2004). The basis for Tuttle's and others estimates of millions of Indiana bats prior to European settlement is primarily based on historic accounts (e.g., Blatchley 1897, Silliman et al. 1851), extensive staining left on the ceilings of several historic hibernacula (Tuttle 1997, Tuttle 1999), and other paleontological evidence (Munson and Keith 1984, Toomey et al. 2002). For example, an analysis of bone deposits in Bat Cave, KY revealed that an estimated 300,000 Indiana bats died during a single flood event at some point in history (Hall 1962). Although we are never likely to know the true historical abundance of Indiana bats, it seems clear from the evidence above that Indiana bats were much more abundant than observed in 1960.

When the Indiana bat was originally listed as endangered in 1967, there were approximately 883,300 bats (Figure 2) and most of these hibernated in just a small number of hibernacula (Clawson 2002). Since it was listed the species' population numbers have apparently continued to decline until the past few survey years. Although some winter bat surveys began as early as the late 1950s, systematic surveys were not conducted across the range until the mid 1980s when there were an estimated 678,750 Indiana bats (Clawson 2002). Since being listed large population declines have been observed, especially at hibernacula in Kentucky and Missouri. 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 had continued to decline until 2005 when a increase was first observed (King, personal communication 2005). Despite recovery efforts, Indiana bats in Missouri caves have continuously declined with a loss of more than 80 percent of the previous population size (Clawson 2002). From the 1960s/70s to the most recent population survey in 2005, the rangewide population of the Indiana bat has declined from approximately 883,300 Indiana bats for 1960/1970 to 458,333 in 2005, or approximately 52 percent. The ten-year population trend (from 1960 – 2000) of the Indiana bat has shown a steady decline (Figure 2).

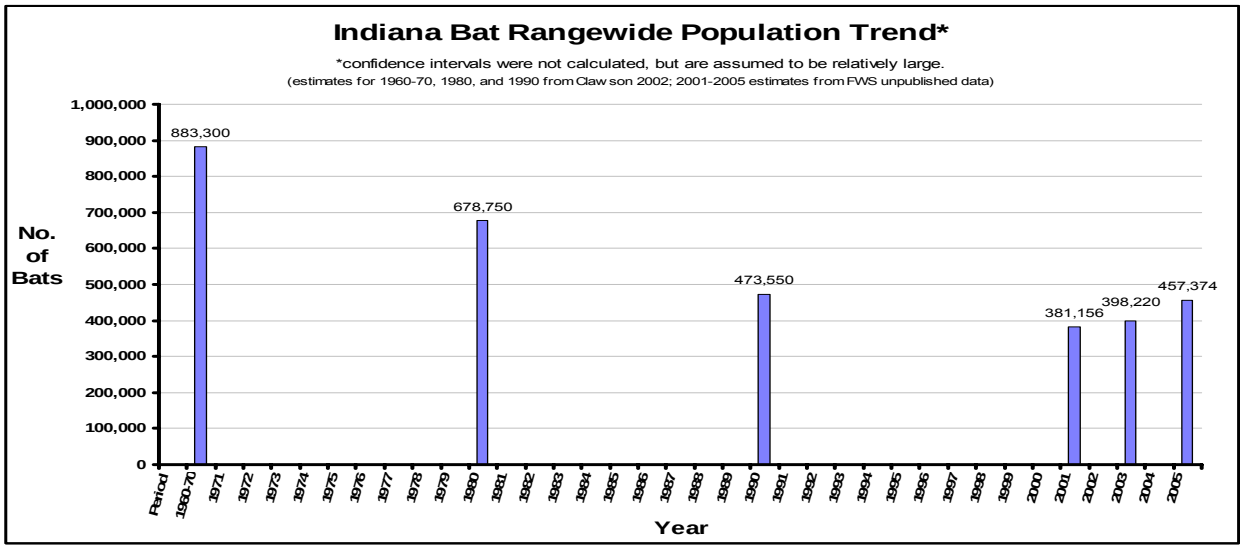


**Figure 2.** Estimated rangewide population trend for the Indiana bat.

The 2005 Indiana bat rangewide population estimate totaled 457,374 bats; a 15% increase over the 2003 estimate of 398,220 (Andy King, USFWS, unpublished data 2005; Figure 3). In 2005, about 60% of the estimated 457,374 Indiana bats were hibernating in nine Priority 1 hibernacula in four states: 4 hibernacula in Indiana, 3 in Missouri, 2 in Kentucky and 1 in Illinois (A. King, USFWS, unpublished data, 2005). Priority 2 hibernacula are known from the aforementioned states, in addition to Arkansas, New Jersey, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. Priority 3 hibernacula have been reported in 21 states, including all of the aforementioned states (Figure 3).

Although a slight increase (4.5%) over the previous biennial rangewide population estimate first occurred in 2003, these results may not be statistically or biologically significant, and no determinations can be made with confidence from such a limited survey period. Small fluctuations from year-to-year may be attributed to such factors as weather affecting the success of reproduction for a given year (Humphrey and Cope 1977, Ransome 1990); therefore, it is not appropriate to extrapolate long-term trends from changes between individual survey periods. Nonetheless, it should also be noted that in 2005 there was almost a 15% increase over the 2003 estimate, but again it is premature to know with any confidence whether this is the beginning of a sustained positive trend or just an upward anomaly in an otherwise downward trend. Until more data becomes available in coming years, we are cautiously optimistic and encouraged by what initially appears to be a slowing in what otherwise has been a steep long-term decline.

### *Causes of Decline*

One known primary cause of Indiana bat decline has been human disturbance of hibernating bats, especially during the decades of the 1960s-1980s. Direct mortality has been documented due to human vandalism. Some hibernacula have been rendered unavailable to Indiana bats by erection of solid gates or structures over the entrances (Humphrey 1978). It appears that by the 1990s, vandalism and improper installation of cave gates had been reduced. Despite 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. A hypothesis for documented

| | |
|---|---|
| Indiana | 206,610 |
| Missouri | 65,104 |
| Kentucky | 62,380 |
| Illinois | 44,343 |
| New York | 41,702 |
| West Virginia | 12,677 |
| Tennessee | 9,971 |
| Ohio | 9,769 |
| Arkansas | 2,067 |
| Pennsylvania | 746 |
| Virginia | 735 |
| New Jersey | 652 |
| Vermont | 297 |
| Alabama | 296 |
| Michigan | 20 |
| Oklahoma | 5 |
| Total | 457,374 |

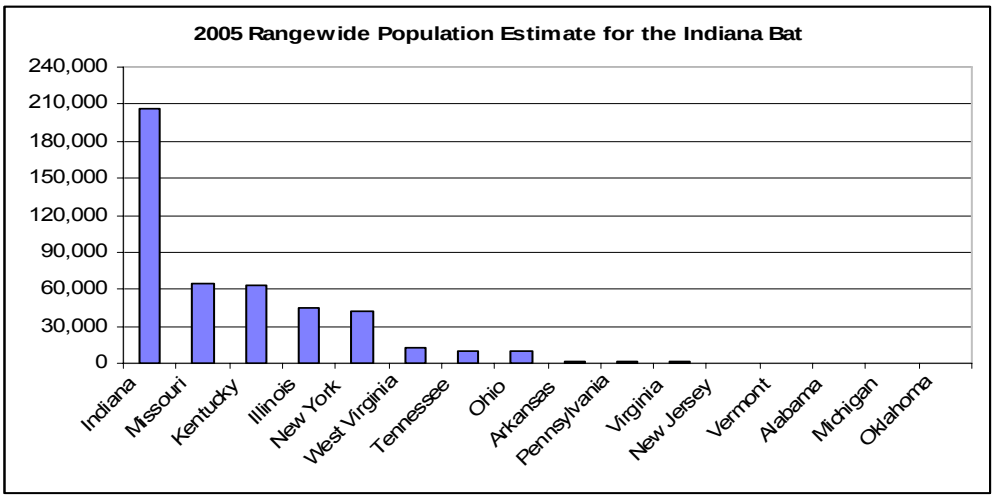


**Figure 3.** State-by-state results of the 2005 Indiana bat winter hibernacula surveys.

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), but this has yet to be rigorously investigated. Other declines have occurred as winter hibernacula have flooded, hibernacula ceilings have collapsed, or cold temperatures kill bats through hypothermia. Exclusion of bats from hibernacula through blocking of entrances, installation of gates that do not allow for bat ingress and egress, disruption of cave air flow, and human disturbance during hibernation have been documented causes of Indiana bat declines. Because many known threats are associated with hibernation, protection of hibernacula still remains a management and recovery priority. Although some hibernacula have been restored in order to support future wintering populations, Indiana bats have not returned to some of these hibernacula as anticipated while they have quickly recolonized others.

Despite the protection of most major hibernacula, population declines generally have continued until the apparent increases in 2003 and 2005. It is too early to tell whether these recent increases in the estimated population size are sustainable or simply a brief upward swing on an otherwise long-term decline. Continued population declines of Indiana bats, in spite of efforts to protect hibernacula, have led scientists to the conclusion that additional information on summer habitat is needed (Rommé et al. 1995) or a closer look at hibernacula microclimates and disturbance levels. In addition to increased focus on these issues, attention is also being directed to pesticide contamination. Insecticides have been known or suspected as the cause of a number of bat die-offs in North America, including endangered gray bats (*Myotis grisescens*) in Missouri (Clark et al. 1978). The insect diet and longevity of bats also exposes them to persistent organochlorine chemicals which may bioaccumulate in bat tissue and cause sub-lethal effects such as impaired reproduction.

***Maternity Colonies***

To date, most records of reproductively active female and juvenile Indiana bats have occurred in glaciated portions of the upper Midwest including southern Iowa, northern Missouri, most of Illinois, most of Indiana, southern Michigan, and western Ohio (Gardner and Cook, 2002, USFWS unpubl. data). The first maternity colony was found in east-central Indiana in 1971 and most subsequent surveys and studies of Indiana bat maternity habitat have been conducted in the upper Midwest (Cope et al. 1974, Clawson 2002). Unglaciated portions of the Midwest (southern Missouri, parts of southern Illinois, and south-central Indiana), Kentucky, and most of the eastern and southern portions of the species' range appear to have fewer maternity colonies per unit area of forest than does the upper Midwest. Increased summer survey efforts are needed elsewhere in the range, however, before final conclusions may be reached regarding relative abundance across the species' summer range.

Recently, multiple maternity colonies have been discovered in the Champlain Valley and lower elevations of adjacent hills between Burlington, Vermont, and Ticonderoga, New York (A. Hicks, pers. comm., September 2005). In contrast, the first maternity roosts in "the South" recently were found in very different types of habitat, in areas of extensive mature forest in the southern Appalachian Mountains of North Carolina and Tennessee. In further contrast, these colonies were found roosting in eastern hemlock (*Tsuga canadensis*) and pines (*Pinus* spp.), rather than deciduous trees (Harvey 2002).

Based on published literature and correspondence with Service and state biologists throughout the range of the Indiana bat, maternity activity has been documented at approximately 250 locations throughout the species' range and colonies are still considered extant at approximately 231 of these locations(Table 4) (USFWS, unpublished data, 2006). 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 and in the Northeast (i.e., NY and VT). Because the Indiana bat is philopatric, there is no evidence to suggest that maternity colonies are located in

**Table 4.** States and counties with recorded Indiana bat maternity colonies.[1,2,3]

| State | No. of Recorded Maternity Colonies | Counties with Recorded Maternity Colonies (if multiple colonies, then # is shown) |
|---|---|---|
| Arkansas | 1 | Clay |
| Illinois | 13 | Adams (2), Alexander, Henderson, Jackson (3), Jersey, Pike (2), Pulaski, Saline, and Schuyler |
| Indiana | 82 | Bartholomew (3), Clinton (2), Crawford, Davies (2), Dearborn, Gibson (2), Greene (3), Hendricks (2), Henry, Howard, Huntington, Jackson (3), Jasper, Jay, Jefferson (2), Jennings (2), Johnson (3), Knox, Koskiusko, LaPorte (2), Marion, Martin, Monroe (2), Montgomery (3), Morgan (4), Newton, Parke (2), Perry (2), Pike (2), Posey, Pulaski (2), Putnam (2), Randolph (3), Ripley (2), Rush, Shelby (2), Spencer, St. Joseph, Steuben, Tippecanoe (4), Vermillion, Vigo, Wabash (2), Warren (2), Warrick, Wayne, and Wells |
| Iowa | 26 | Appanoose (2), Davis, Decatur (2), Des Moines, Iowa, Jasper, Keokuk, Lucas (2), Madison (2), Marion (7), Monroe, Ringgold, Van Buren, Wapello, and Washington (2) |
| Kentucky | 31 | Ballard, Ballard/Carlisle, Bath (3), Breckinridge, Bullitt (4), Daviess, Edmonson (3), Harlan (3), Henderson (2), Hickman (2), Jefferson (3), Logan, McCracken (2), Pulaski, Rowan, Spencer, and Union |
| Maryland | 2 | Carroll (2) |
| Michigan | 11 | Calhoun, Cass, Eaton, Hillsdale, Jackson, Lenawee (2), Livingston, St. Joseph (2), and Van Buren |
| Missouri | 19 | Chariton, Iron, Jefferson, Knox (2), Lewis, Linn, Macon, Madison, Marion, Mercer, Monroe, Nodaway, Pulaski, Scotland, St. Francois, St. Genevieve, Sullivan, and Wayne |
| New Jersey | 2 | Morris (2) |
| New York | 23 | Dutchess (5), Essex, Jefferson (8), Onandaga, Orange (8) |
| Ohio | 10 | Ashtabula, Butler, Clermont, Cuyahoga, Greene, Hocking, Lawrence, Paulding, Summit, and Wayne |
| Pennsylvania | 1 | Blair |
| Tennessee | 2 | Blount and Monroe |
| Vermont | 4 | Addison (4) |
| Virginia | 1 | Lee |
| West Virginia | 3 | Boone (2) and Tucker |
| **Total** | **231** | |

[1] Unpublished data obtained in response to a data request sent to FWS Field Offices in February 2006.
[2] Most maternity colony records were based upon the capture of reproductively active females and/or juveniles between 15 May and 15 August.
[3] This table includes records of maternity colonies considered to still be locally extant. Although some additional records exist, we opted not to include them, if subsequent surveys failed to detect their presence (i.e., the colony may have disbanded, relocated, was extirpated, or was present but not found).

optimal foraging and roosting habitat. A possible explanation for the species' decline is that many of the existing maternity colonies are senescent (i.e. recruitment < death) or population sinks. 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 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 (Whitaker and Sparks 2003, Whitaker et al. 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 approximately 231 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 across the range of 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 make extrapolations regarding the densities or distribution of maternity colonies present within portions of the species range (Racey and Entwistle 2003); however, these figures do serve to provide a rough estimation regarding the number of maternity colonies that might be present across the landscape. The "Maternity Colony Size – Population" section found in the "Life History" section of this biological opinion provides more information with regard to the size of a maternity colony.

Recognizing the inherent deficiency in such an assumption, these calculations illustrate that the vast majority of maternity colonies for the Indiana bat have not been documented (Table 5). The location of most maternity colonies may always remain unknown because of the difficulty in detecting maternity activity for the Indiana bat. Some unknown proportion of these colonies may be at risk when land use practices and changes, such as timber harvesting and development, are carried out. Therefore, another likely cause for the decline of this species and the level of activity occurring across the landscape is that maternity colonies are being reduced in numbers, and in some cases extirpated, prior to their discovery.

***Indiana Bat Status in Indiana***

Historic hibernating population levels in Indiana were comprehensive enough to estimate on a statewide level for the first time in 1981, resulting in an estimate of 147,242 hibernating bats (Andrew King, USFWS, personal communication). Since that time, the statewide estimate fell to a low of 97,503 bats in 1985, then rose steadily to 175,795 in 1993. After that year, the population estimate fluctuated between 173,076 and 185,899 until the 2005 census, when it rose to 206,610. As of the winter of 2004-2005, Indiana's 40 hibernacula harbored approximately 45.2% of all known Indiana bats. In 2005, the two most populous Indiana bat hibernacula in the world were Wyandotte Cave (n=54,913 bats) and Ray's Cave (n=54,325 bats).

**Previous Incidental Take Authorizations**

*Summary*- All previously issued Service Biological Opinions involving the Indiana bat have been non-jeopardy. These formal consultations have involved (a) the Forest Service for activities implemented under various Land and Resource Management Plans on National Forests in the eastern United States, (b) the Federal Highway Administration for various transportation projects, (c) the U.S. Army Corps of Engineers (Corps) for various water-related projects, and (d) the Department of Defense for operations at several different military installations. 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.

It is important to note that in many of these consultations, survey information was lacking. 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 may be present. To ensure the Federal agency and the Service met the mandate of the section 7(a)(2), if the best available data indicated that Indiana bats may be present, the assumption was made that a maternity colony (in most instances) occurred within the action area. Although this approach, we believe, fully accords with the intent of Congress and the Endangered Species Act of 1973, it likely resulted in an over-estimate of the number of individuals or colonies that may have been impacted by Federal actions.

*National Forests*- Within the past several years, nearly all National Forests within the range of the Indiana bat have requested formal consultation at the programmatic level including the HNF. Consultation under Section 7 of the Act is necessary to ensure agency actions do not jeopardize the continued existence of listed species. These consultations have led to non-jeopardy biological opinions with associated incidental take statements. Although some of these incidental take statements anticipated the take of reproductive females, we have not yet confirmed a loss of a maternity colony on a National Forest. The reasons for this are likely two-fold. First, the programmatic conservation measures (i.e., standard and guidelines) and second, the project-specific reasonable and prudent measures were designed to minimize maternity colony exposure to the environmental impacts of Forest Plan actions. Specifically, these measures ensured an abundance of suitable Indiana bat habitat on the National Forests, and protected all known or newly discovered maternity colonies.

Over 95 percent of previously authorized habitat loss on National Forests is not permanent loss. Rather, it is varying degrees of temporary loss (short-term and long-term) as a result of timber management activities. Although this analysis does not include all National Forests that, to date, have received an incidental take statement, the concepts of the analysis are consistent, regardless of

the location. Conservation measures provided by the USFS 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 been designed to: (1) ensure an abundance of available remaining Indiana bat roosting and foraging habitat on all National Forests; and (2) ensure persistence of any known or newly discovered maternity colonies to the maximum extent practicable.

Although Indiana bat presence has been verified on most, if not all, National Forests within the range of the species, confirmation of maternity activity on these lands is scant. There have been less than six maternity colonies documented on National Forests. It must be noted that maternity activity was confirmed for the first time on two national forests (Monongahela National Forest [West Virginia] and Hoosier National Forest [Indiana]) as recently as 2004.

Take has been authorized in the form of habitat loss because of the difficulty of detecting and quantifying take of the Indiana bat due to the bat's small body size, widely dispersed individuals under loose bark or in cavities of trees, and unknown spatial extent and density of their summer roosting population range within the respective National Forests. For some incidental take statements, take has also been extrapolated to include an estimated number of individual Indiana bats. The estimate of the number of individual Indiana bats likely to be taken has been wide-ranging and based on various assumptions. Legal coverage has included the take, by kill, of individual Indiana bats; or take, by harm through habitat loss, or harassment.

Other Federal Agencies or Non-federal Entities- Several incidental take statements have been issued to other Federal agencies. Unlike those issued for the National Forest Land and Resource Management Plans, some of these projects were certain to impact known occupied habitat. To minimize the effect of these projects, the action agencies agreed to implement various conservation measures. These included: seasonal clearing restrictions to avoid disturbing female Indiana bats and young; protection of all known primary and alternate roost trees with appropriate buffers; retention of adequate roosting and foraging habitat to sustain the maternity colony into the future; and permanent protection of areas and habitat enhancement or creation measures to provide future roosting and foraging habitat opportunities.

With the exception of three (Fort Knox, Great Smoky Mountains National Park, and Laxare East and Black Contour Coal Mining projects), none of these biological opinions and associated incidental take statements anticipated the loss of a maternity colony. Required monitoring for 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 life-spans, the full extent of the anticipated impacts may not yet have occurred. Nonetheless, these monitoring results and the lack of data to suggest otherwise for the other projects, indicate that the conservation measures to avoid and minimize the impacts of Federal projects appear to be effective. Only with long-term monitoring will we definitively be able to determine the true effectiveness of our conservation measures.

In summary, we believe the take exempted to date via section 7 consultation has resulted in short-term effects to Indiana bat habitat and, in limited circumstances, on Indiana bat maternity colonies. As many of these consultations necessarily made assumptions about Indiana bat presence, we are

confident that the number of maternity colonies actually exposed to the environmental impacts of the Federal actions is far less than we have anticipated. Furthermore, although not definitive, monitoring of several maternity colonies pre- and post-project implementation preliminarily suggests that our standard conservation measures, when employed in concert, appear to be effective in minimizing adverse effects on the affected maternity colonies.

**Indiana Bat Description and Distribution**

The Indiana bat is a medium-sized bat with a head and body length that ranges from 41 to 49 mm (Thompson 1982). There are no recognized subspecies. The 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 Indiana bat is migratory, and the above described range includes both winter and summer habitat. The winter range is associated with regions of well-developed limestone caverns. Major populations of this species hibernate in Indiana, Kentucky, and Missouri. Smaller winter populations have been reported from Alabama, Arkansas, Georgia, Illinois, Maryland, Mississippi, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia. Two-thirds (66%) of the entire estimated 2005 population of Indiana bats hibernated in only eight hibernacula in Illinois, Indiana, Kentucky, Missouri, and New York and more the 75% of the rangewide population hibernated in only 12 hibernacula (USFWS unpublished data, 2006).

**Table 5**. Estimated number of Indiana bat maternity colonies range-wide.

| Year | Estimated Rangewide Population | % Change from Previous Period | Estimated Number of Maternity Colonies[1] | Approximate Number of Known Maternity Areas[2] | % of Est. Maternity Colonies that are Known |
|---|---|---|---|---|---|
| 1960/1970 | 883,300 | | 5,500 | 1 (in 1971) | ~0.02% |
| ~1980 | 678,750 | -23% | 4,200 | 31 | ~0.7%- |
| ~1990 | 473,550 | -30% | 3,000 | 70 | ~2.3% |
| 2001 | 376,932 | -20% | 2,400 | 149 | ~6.2% |
| 2005 | 457,374 | +22% | 2,900 | 231 | ~8.0% |

[1] Total rounded to the nearest 100. Estimates of the number of maternity colonies rangewide were developed based on the following assumptions: 1) the known hibernating population is the source of the entire summer population; 2) there is a 50:50 sex ratio (Humphrey et al. 1977); 3) average maternity colony size of 80 adult females (Whitaker and Brack 2002); and 4) the trend in decline of the total number of maternity colonies follows that of the hibernating population. [2] This is the number of areas where reproductive females and/or juveniles have been captured during the maternity season (USFWS, unpublished data, 2006).

**Life History**

The average life span of the Indiana bat is 5 to 10 years, but banded individuals have lived up to 14 and 15 years (Thomson 1982). 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 (Humphrey and Cope 1977).

Summering Indiana bats (males and females) roost in trees in riparian, bottomland, and upland forests. Roost trees generally have exfoliating bark which allows the bat 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). At one site in southern Indiana, black locust (*Robinia psuedoacacia*) was used extensively by roosting bats (Pruitt 1995). Structure is probably more important than the species in determining if a tree is a suitable roost site; and tree species which develop loose, exfoliating bark as they age and die are likely to provide roost sites. Male bats disperse throughout the range and roost individually or in small groups. In contrast, reproductive females form larger groups, referred to as maternity colonies in which they raise their offspring.

Females arrive in summer habitat as early as April 15. Temporary roosts are often used during spring until a maternity roost with large numbers of adult females is established. Indiana bats arrived at maternity roosts in April and early May in Indiana, with substantial numbers in mid-May. Most documented maternity colonies have 50 to 100 adult bats (USFWS 1999). Fecundity is low; and female Indiana bats produce only one young per year in late June to early July. Young bats can fly between mid-July and early August, at about 4 weeks of age. Mortality between birth and weaning was found to be about 8% (Humphrey et al. 1977). Many males stay near hibernacula (i.e., caves and mines) and roost individually or in small groups (Whitaker and Brack 2002). The later part of the summer is spent accumulating fat reserves for fall migration (USFWS 1999).

When arriving at their traditional hibernacula in August-September, Indiana bats "swarm". Some male bats may begin to arrive at hibernacula as early as July. Females typically arrive later and by September numbers of males and females are almost equal. Swarming is a critical part of the life cycle when Indiana bats converge at hibernacula, mate, and forage until sufficient fat reserves have been deposited to sustain them through the winter (Cope et al. 1977, USFWS 1983). Swarming behavior typically involves large numbers of bats flying in and out of cave entrances throughout the night, while most of the bats continue to roost in trees during the day. Body weight may increase by 2 grams within a short time, mostly in the form of fat. Swarming continues for several weeks and copulation occurs on cave ceilings near the cave entrance during the latter part of the period. (USFWS 1991 b, USFWS 1999). The time of highest swarming activity in Indiana and Kentucky has been documented as early September (Cope et al. 1977). 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. Research is needed to determine how far bats will forage in the fall. Most bats tracked have stayed within 2 to 3 miles of the hibernacula, but some have been found up to 4.2 miles away (Rommé et al. 2002). Studies suggest that the majority of foraging habitat in spring and autumn is within 2 mi of the hibernacula, but extends to 5 miles. Therefore, it is not only important to protect the caves that the bats hibernate in, but also to maintain and protect the quality and quantity of roosting and foraging habitat within 5 miles of each Indiana bat hibernaculum. Additional studies of fall swarming behavior are warranted to gain a better understanding of the bats' behavior and habitat needs during this part of its annual life cycle (Rommé et al. 2002).

During swarming, males are active over a longer period of time at cave entrances than females, probably to mate with females as they arrive. Females may mate their first autumn, whereas males may not mature until the second year (USFWS 1999). After mating, females soon enter into hibernation. Most bats are hibernating by the end of November, but hibernacula populations may continue to increase (USFWS 1999). Indiana bats cluster and hibernate on cave ceilings in densities of approximately 300-484 bats per square foot, from approximately October through April. Hibernation facilitates survival during winter when prey (i.e., insects) is unavailable. The season of hibernation may vary by latitude and annual weather conditions. Clusters may protect central individuals from temperature change and reduce sensitivity to disturbance. Like other cave bats, the Indiana bat naturally arouses at intervals of 7-14 days (Dr. John Whitaker, Jr. – per. comm.) during hibernation (Sealander & Heidt 1990). Arousals are more frequent and longer at the beginning and end of the hibernation period (Sealander & Heidt 1990). Limited mating occurs throughout the winter, and in early April as bats emerge (USFWS 1999).

After hibernation ends in late March or early April, most Indiana bats emerge, and forage for a few days or weeks near their hibernaculum before migrating to their traditional summer roosting areas. Female Indiana bats emerge first from hibernation in late March or early April, followed by the males. The timing of annual emergence may vary across their range depending on latitude and annual weather conditions. Shortly after emerging from hibernation, the females become pregnant via delayed fertilization from the sperm that has been stored in their reproductive tracts through the winter (USFWS 1999). The period after hibernation but prior to spring migration is typically referred to as "staging". Most populations leave their hibernacula by late April. Migration is stressful for the Indiana bat, particularly in the spring when their fat reserves and food supplies are low. As a result, adult mortality may be the highest in late March and April.

Most bats migrate to the north for the summer, although other directions have been documented (USFWS 1999, Gardner and Cook 2002). A stronger homing tendency has been observed along a north-south axis, than the east-west direction in release studies. Females can migrate hundreds of miles north of the hibernacula. In spring staging, males have been found almost 10 miles from their hibernacula (Hobson and Holland 1995). Less is known about the male migration pattern, but many males summer near the hibernacula (Whitaker and Brack 2002, USFWS 1999).

**Food Habits:**
Indiana bats feed exclusively on flying aquatic and terrestrial insects. Diet varies seasonally and variations exist among different ages, sexes, and reproductive status (USFWS 1999). It is probable that Indiana bats use a combination of both selective and opportunistic feeding to their advantage (Brack and LaVal 1985). Reproductively active females and juveniles show greater dietary diversity perhaps due to higher energy demands. Studies in some areas have found that reproductively active females eat more aquatic insects than do juveniles or adult males (USFWS 1999), but this may be the result of habitat differences (Brack and LaVal 1985).

Lepidoptera (moths), Coleoptera (beetles), and Diptera (midges and flies) consititute the bulk of the diet (Brack and LaVal 1985). Moths (Lepidoptera) have been identified as major prey items that may be preferentially selected (Brack and LaVal 1985), but beetles (Coleoptera) and flies (Diptera) were also found significant (Brack and Tyrell 1990). Diptera taken are especially midges and other species that congregate over water, but are seldom mosquitoes. Other prey include wasps and flying ants (Hymenoptera), caddisflies (Trichoptera), brown leafhoppers and treehoppers

(Homoptera), stoneflies (Plecoptera), and lacewings (Neuroptera) (Brack and LaVal 1985, USFWS 1999). Male Indiana bats summering in or near a hibernation cave eat primarily moths and beetles but feed on other terrestrial insects in lower percentages (USFWS 1999).

Indiana bats use small impoundments as well as permanent and intermittent streams for drinking water (HNF 2000). Water-filled road ruts may be used for drinking water in uplands, more commonly in the eastern portion of the range (Brack, Jr. per. comm.).

**Habitat: Winter Hibernacula Habitat**

Indiana bats roost in caves or mines with configurations that provide a suitable temperature and humidity microclimate (Brack et al. 2003, USFWS 1999). In many caves, suitable temperatures and therefore roosts are located near the cave entrance, but roosts may be deeper where cold air flows and is trapped. When bats arrive at hibernacula in October and November, they need a temperature of 50º F (10º C) or below (USFWS 1999). Mid-winter temperatures range from 39 to 46º F (4 to 8º C) (USFWS 1983); however, recent data in Indiana has recorded increased use of hibernacula ranging from 41 to 44.5º F (5 to 7º C) (Brack, Jr. per. comm.). Only a small percentage of caves available meet these temperature requirements (Brack et al. 2003, USFWS 1999). Stable low temperature allows bats to maintain low metabolic rates and conserve fat reserves to survive the winter (USFWS 1999). Relative humidity of roosts usually ranges from 74% to just below saturation, although readings as low as 54% have been recorded. This may be an important factor for successful hibernation (USFWS 1999). Hibernacula often contain large populations of several species of bats. Other bat species found in Indiana hibernacula include: a number of little brown bats (*Myotis lucifugus*) and eastern pipistrelles (*Pipistrellus subflavus*); some northern long-eared bats (*Myotis septentrionalis*); and a few gray bats (*Myotis grisescens*), big brown bats (*Eptesicus fuscus*), and silver-haired bats (*Lasionycteris noctivagans*) (Brack et al.2003).

**Habitat: Summer Roosting Habitat**

**FEMALE**

Indiana bats exhibit strong site fidelity to their traditional summer colony areas and foraging habitat, that is, they return to the same summer range annually to bear their young. (Kurta et al. 2002, Garner and Gardner 1992, USFWS 1999). 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.

Female Indiana bats generally migrate northward from the hibernacula to summer roosting areas. Indiana bat maternity colonies typically occupy multiple roosts in riparian, bottomland, and upland forests. Roost trees generally have exfoliating bark which allows the bat to roost between the bark and bole of the tree and have a southeast or south-southwest solar exposure and an open canopy. Cavities and crevices in trees also may be used for roosting. Roost tree structure is probably more important than the tree species in determining whether a tree is a suitable roost site; and tree species which develop loose, exfoliating bark as they age and die are likely to provide roost sites. Roost trees are often located on forest edges or openings with open canopy and open understory (USFWS 1999). Maternity colonies have often been found within forests that are streamside ecosystems or

are otherwise within 0.6 mi (1 km) of permanent streams. Most have been found in forest types similar to oak-hickory and elm-ash-cottonwood communities. While these characteristics are typical, research is showing adaptability in habitats used. Important summer roosting and foraging habitat for the Indiana bat is often in floodplain or riparian forests but may also be in more upland areas. A telemetry study in Illinois found most maternity roosts within 1640 ft (500 m) of a perennial or intermittent stream (Hofmann 1996). Bats in Illinois selected roosts near intermittent streams and far from paved roads (Garner and Gardener 1992). However, observations have revealed habitat use nearer paved roads than previously thought (Brack, Jr. per. comm.). Recent research has shown bats using upland forest for roosting and upland forest, and pastures with scattered trees for foraging. Indiana bats prefer forests with old growth characteristics, large trees, scattered canopy gaps, and open understories (USFWS 1999). The Indiana bat may persist in highly altered and fragmented forest landscapes for some unknown period of time. Instances have been documented of bats using forest altered by grazing, swine feedlot, row-crops, hay fields, residences, clear-cut harvests, and shelterwood cuts (Garner and Gardner 1992, USFWS 1999). Several roosts have been located near lightly traveled, low maintenance roads, as well as near I-70 at the Indianapolis Airport (USFWS 2002). Although, Indiana bats may be more adaptable than previously thought, it still is not known how a maternity colony's stability and reproductive success responds to increasing levels of habitat alteration and fragmentation.

Suitability of a roost tree is determined by its condition (dead or alive), suitability of loose bark, tree's solar exposure, spatial relationship to other trees, and tree's spatial relationship to water sources and foraging areas. Good roost trees are species whose bark springs away from the tree on drying after dead, senescent, or injured; and living species of hickories (*Carya* spp.) and large white oaks (*Quercus alba*) with shaggy bark. Cottonwoods are probably one of the best tree species. Many maternity colonies have been associated with oak-hickory and elm-ash-cottonwood forest types. Tree cavities, hollow portions of tree boles or limbs, and crevice and splits from broken tops have been used as roosts on a very limited basis, usually by individual bats. Roost longevity is variable due to many factors such as the bark sloughing off or the tree falling down. Some roosts may only be habitable for 1-2 years, but species with good bark retention such as slippery elm (*Ulmus rubra*), cottonwood (*Populus deltoides*), Green ash (*Fraxinus pennsylvanica*), oaks (*Quercus* spp.), and hickories (*Carya* spp.) may provide habitat 4-8 years (USFWS 1999). Trees in excess of 15.7 in (40 cm) diameter breast height (dbh) are considered optimal for maternity colonies, but trees in excess of 8.6 in (22 cm) dbh are used as alternate roosts (USFWS 2002). Females have been documented using roost trees as small as 5.5 inches.(Kurta 2005).

Indiana bat roosts are ephemeral and frequently associated with dead or dying trees. Gardner et al. (1991b) evaluated 39 roost trees and found that 31% were no longer suitable the following summer, and 33% of those remaining were unavailable by the second summer. A variety of suitable roosts are needed within a colony's traditional summer range for the colony to continue to exist. Indiana bat maternity sites generally consist of one or more primary maternity roost trees which are used repeatedly by large numbers of bats, and varying numbers of alternate roosts, which may be used less frequently and by smaller numbers of bats. Primary roosts are often located in openings or at the edge of forest stands, while alternate roosts can be in either openings or the interior of the forest stand. Primary roosts are usually surrounded by open canopy and are warmed by solar radiation. Alternate roosts may be used when temperatures are above normal or during precipitation. Bats move among roosts within a season and when a particular roost becomes unavailable from one year to the next. It is not known how many alternate roosts must be available to assure retention of a

colony within a particular area, but large, nearby forest tracts would improve the potential for an area to provide adequate roosting habitat (Callahan 1993, Callahan et al. 1997). In addition to having exfoliating bark, roost trees must be of sufficient diameter. Trees in excess of 16 in. diameter at breast height (dbh) are considered optimal for maternity colony roost sites, but trees in excess of 9 inches dbh are often used as alternate maternity roosts. Male Indiana bats have been observed roosting in trees as small as 2.5 inches dbh (Gumbert et al. 2002).

Exposure of trees to sunlight and location relative to other trees are important to suitability. Cool temperatures can delay development of fetal and juvenile young and selection of maternity roost sites may be critical to reproductive success. Dead trees with a southeast and south-southwest exposures allow warming solar radiation. Some living trees may provide a thermal advantage during cold periods (USFWS 1999). Maternity colonies use multiple roosts in both dead and living trees that are grouped. Extent and configuration of a use area is probably determined by availability of suitable roost sites. Distances between roosts can be a few meters to a few kilometers. Maternity colony movements among multiple roosts seem to depend on climatic changes, particularly solar radiation (Humphrey et al. 1977). Kurta et al. (1993) suggests movement between roosts may be the bats' way of dealing with a roost site as ephemeral as loose bark. The bat that is aware of alternate roost sites is more likely to survive the sudden, unpredictable, destruction of its present roost than the bat which has never identified such an alternate.

Primary roosts are often located in openings or at the edge of forest stands, while alternate roosts can be in either openings or the interior of the forest stand. Primary roosts are usually surrounded by open canopy and are warmed by solar radiation. Alternate roosts may be used when temperatures are above normal or during precipitation. Shagbark hickories (*Carya ovata*) are good alternate roosts because they are cooler during periods of high heat and tight bark shields the bats from rain (USFWS 1999). Weather has been found to have profound influence on bat behavior and habitat use (Humphrey et al. 1977).

Humphrey et al. (1977) observed that each night after the sunset peak of foraging activity the bats left the foraging areas without returning to the day roosts, which indicated the use of "night" roosts. Kiser et al. (2002) found three concrete bridges on Camp Atterbury, 25 mi (40 km) south of Indianapolis, Indiana, used by Indiana bats as night roosts and to a limited extent as day roosts. Bat species using the bridges included the big brown bat (*Eptesicus fuscus*), northern myotis (*Myotis septentrionalis*), little brown myotis (*Myotis lucifugus*), Indiana bat, and eastern pipistrelle (*Pipistrellus subflavus*). The Indiana bat was the most common species, representing 51% of all bats observed, whereas the big brown bat was the second most abundant at 38%. Clusters of Indiana bats were observed night roosting under the bridges that were lactating, post-lactating, and newly volant juveniles. Bridges used were concrete-girder (multi-beam) bridges with deep, narrow expansion joints. The bridges ranged from 46 to 223 ft in length and 26 to 39 ft in width. Average daily traffic ranged from less than 10 vehicles per day to almost 5,000 vehicles per day. All used bridges were located over streams bordered by forested, riparian corridors that connected larger tracts of forest. Riparian forest did not overhang the bridges allowing solar radiation to warm the bridges; however, forest was within 9 to 16.5 ft of each bridge. Bat clusters under bridges were located over land, near the ends of the bridges. Mean ambient temperatures at night were consistently higher and less variable under bridges than external ambient temperatures. The bridges apparently act as thermal sinks. The warmer, more stable environment presumably decreases the energetic cost of maintaining high body temperature, thus promoting fetal development, milk

production, and juvenile growth. Three individuals were radio-tracked to their day roosts within 0.6 to 1.2 miles from their night rooost (Kiser et al. 2002).

**MALE:**
Many male Indiana bats appear to remain at or near the hibernacula in summer with some fanning out in a broad band around the hibernacula (Whitaker and Brack 2002). Males roost singly or in small groups in two to five roost trees similar to those used by females. Males may occasionally roost in caves. Suitable roost trees typically have a large diameter, exfoliating bark, and prolonged solar exposure with no apparent importance in regard to the tree species or whether it is upland or bottomland (Whitaker and Brack 2002). Because males typically roost individually or in small groups, the average size of their roost trees tends to be smaller than the roost trees used by female maternity colonies, and in one instance a roost tree only 2.5 inches (6.4 cm) in diameter was used (Gumbert et al. 2002). Male bats have also been observed using trees as small as 3.1 in (8 cm) dbh (USFWS 2002). Also, males are more likely than females to be found in disturbed areas; possibly because the roost trees in those areas are likely to be to small for colony use, but still suitable for an individual roost (Brack, Jr. per. comm.). One individual was found roosting on the Hoosier National Forest within the easement of I-64 (HNF 2000). Males have shown summer site fidelity and have been recaptured in foraging areas from prior years (USFWS 1999). At Camp Atterbury in Indiana, male bats were observed using the same bridges as females for night roosts, but they roosted singly (Kiser et al. 2002).

**Autumn Swarming / Spring Staging Habitat**
Indiana bats use roosts in spring and fall that are similar to those used in summer (USFWS 1999). However, because habitat is used by individuals rather than colonies, sites may be much smaller (Brack, Jr. per. comm.). Females use smaller, more disturbed areas during swarming and staging than in summer in maternity colonies (Brack, Jr. per. comm.). During fall, when bats swarm and mate at their hibernacula, male bats roost in trees nearby during the day and fly to the cave during the night. Studies have found males roosting in dead trees on upper slopes and ridgetops within a few miles of the hibernacula (USFWS 1999). In Jackson County, Kentucky, research showed fall roost trees tend to be located in canopy gaps created by disturbance (logging, windthrow, prescribed burning) and along edges (Gumbert et al. 2002). Fall roost trees are often exposed to sunshine (USFWS 1999). Within-year fidelity to fall roosts has been observed, where an individual bat uses an individual roost for an average of 2 to 3 days before moving to a new tree (Gumbert et al. 2002). Bats have been observed moving among multiple roosts in an area using particular roosts alternatively (Brack, Jr. per. comm., Gumbert et al. 2002).

In the spring, upon emergence, females and some males disperse from the hibernacula. Migration within the core of the species' range is generally northward to form colonies throughout Indiana, southern Michigan, and adjoining Ohio and Illinois. Male Indiana bats remain at or near the hibernacula, although some fan out in a broad band or zone around the hibernacula (Whitaker and Brack 2002).

Spring and autumn habitat use is variable due to proximity and quantity of roosts, weather conditions, and prey availability (Rommé et al. 2002). Several studies support the idea that during the autumn and spring, bats primarily use habitat within 5 miles (8 km) of the hibernacula (Rommé et al. 2002, Brack, Jr. per. comm.). However, more studies of autumn and spring habitat use is recommended due to low sample sizes and difficulties with telemetry research techniques (USFWS 1999).

**Foraging Habitat**

Indiana bats forage between dusk and dawn and feed exclusively on flying insects, primarily moths, beetles, and aquatic insects. They typically forage in and around tree canopy and in openings of floodplain, riparian, and upland forests (USFWS 1999). Optimum canopy closures are 50-70% with relatively open understory (<40% of trees are 2-4.7 in (5-12 cm) dbh) (HNF 2000). Woody vegetation with a width of at least 100 ft (30 m) on both sides of a stream has been characterized as excellent foraging habitat. Streams, associated with floodplain forests and impounded water bodies, are preferred foraging habitats for pregnant and lactating Indiana bats, some of which may fly up to 1 ½ mi from upland roosts (Garner and Gardner 1992, USFWS 2002). Brack and Tyrell (1990) found that in early summer, foraging was restricted to riparian habitats. Foraging also occurs over clearings with successional vegetation, along cropland borders, fencerows, and over farm ponds. Bats have been observed crossing Interstate 70 in Indiana to reach foraging habitat (USFWS 2002). Bats have been documented routinely flying at least 1.25 mi (2 km) from the roost to forage and some were tracked up to 3 mi (5 km) from the roost (USFWS 2002). Foraging bats usually fly between 6 – 100 feet above ground level (USFWS 1999). In Illinois, Gardner et al. (1991a) found that forested stream corridors, and impounded bodies of water, were preferred foraging habitats for pregnant and lactating Indiana bats, which typically flew up to 1.5 miles (2.4 km) from upland roosts to forage. However the same study reported the maximum distance that any female bat flew (regardless of reproductive status) from her daytime roost to her capture site was 2.5 miles (4.2 km). Females typically utilize larger foraging ranges than males (Garner and Gardner 1992).

# III. ENVIRONMENTAL BASELINE

This section is an analysis of the past effects of State, tribal, local and private actions already affecting the species within the Action Areas and the present effects within the Action Areas that will occur contemporaneously with the consultation in progress. It includes a description of the known status of Indiana bats and their habitats within or near the Windthrow 2004 Action Areas. The natural environments surrounding the Action Areas are summarized below. Additional information available in Windthrow 2004 BA is hereby incorporated by reference.

**Natural Character of the Action Areas**

The Action Areas are within the Shawnee Hills Natural Region, which includes the Crawford Upland Section and the Escarpment Section (Homoya et al. 1985). This natural region appears to represent general presettlement conditions better than any other terrestrial region in the state. It is a rugged and generally sparsely populated area. Most natural communities are upland forest, although a few sandstone and limestone glades, gravel washes, and barrens are known. All of the proposed salvage units are within the Crawford Upland Section, in Crawford and Perry counties. This section of the Shawnee Hills Natural Region contains rugged hills with sandstone cliffs and "rockhouses". The soils are characteristically well drained acid silt loams. Forest vegetation consists of an oak-hickory assortment on upper slopes, while coves have a mesic component. Characteristic upper slope species include black oak, white oak, chestnut oak, scarlet oak, post oak, pignut hickory, small-fruited hickory, shagbark hickory, and rarely, sourwood. Characteristic species of cove forests include beech, tulip tree, red oak, sugar maple, black walnut, white ash, and locally, yellow buckeye, white basswood, hemlock, yellow birch, and umbrella magnolia.

**Historic Setting**

As European Americans acquired land, one of their first concerns was to clear the land of trees. The forest was an obstacle to be conquered. The settlers harvested timber to use as building material or fuel, or simply cleared fields to provide farmland for crops and pasture. Southern Indiana boasted some of the finest hardwoods in the world. With the advent of the sawmill in 1860, extensive commercial forest clearing operations began. During the period following the Civil War, thousands of sawmills operated in Indiana. In 1899, Indiana led the nation in lumber production. Though most of the good farm land had been cleared and settled in the early 1800s, the steep hills and valleys which today make up most of the Hoosier National Forest, was harvested between 1870 and 1910. Cut over lands sold for approximately $1 per acre. Early production records show oak comprising approximately 80 percent of the total hardwood production in Indiana during the period 1869 to 1899. Considering the marketability and utilization standards of this period there must have been many oak trees over 24 inches in diameter (DenUyl, 1954). The estimated total cut of hardwood sawtimber during the period of 1869 to 1903 was approximately 30 billion board feet. This means an average yearly cut of about 800 million board feet. The records of lumber cut are conservative because some operating sawmills did not report their cut.

The type of cutting that occurred in the late 1800's had a profound effect on the composition of the present forest. The high quality trees were cut off first: black walnut, tulip poplar, black cherry, and white oak. Later cuts removed every other marketable tree left on the land. The residual stands consisted of cull trees, small trees, and species not desirable for market use. The areas were often burned repeatedly to clear the brush (DenVyl, 1954). The land was converted to agricultural uses

and settled. The human population during the 1800's peaked in the 1890s, and then, in the Forest area, began to steadily decline. By 1930, the human population had decreased to just 57 percent of the 1890 population. By 1930, most of what would one day be Forest Service lands contained small farms devoted to crops or pasture with a few acres in woods. Times were hard, and many of the settlers gave up and moved on. The Great Depression sealed the fate of the small farmers in south central Indiana. After 100 years of wear on land never suitable for farming, the steep hills were eroding; and the soil was depleted of nutrients. Crop prices were low, and droughts occurred several years in a row. Though many families left their unproductive lands, a few returned to raise food they could not get in the cities.

As many of the farmers moved out in the 1930's, generally just abandoning their farms and homes, local officials became concerned about the growing amount of tax delinquent lands on the tax rolls. Indiana's governor, Paul V. McNutt, and the 73rd Indiana Congress in June, 1934, asked the Forest Service to buy this land for the eventual creation of a National Forest. Chapter 29 of Senate Bill 39, formally approved this action on February 6, 1935.

The first Forest Service parcels were purchased in 1935, and the land base gradually grew over the next few decades. The Forest Service's immediate goals were to rehabilitate the damaged land and control wildfires. The Civilian Conservation Corp (CCC) Program of the 1930's provided jobs for the unemployed and manpower to begin reforesting the hillsides and controlling the massive erosion problems (e.g., planting of non-native pine plantations).

Throughout much of the the mid and late 1900s, construction of roadways (e.g., Interstate 64, S.R. 37), private residences, recreation facilities, and other developments required the removal of small areas of forest in the general vicinity of the proposed salvage areas. For example, The HNF, constructed Indian and Celina lakes (152 acres and 164 acres, respectively) and the Celina Lake Campground during this time frame.

Activities that are taking place on non-Federal lands surrounding the project area include timber harvesting, farming operations, and residential development. The proposed action would salvage downed and damaged trees and introduce prescribed fire to the areas, thereby altering the character of the forest by encouraging the growth of shade-intolerant native hardwood species. Although timber harvesting of some type and extent is frequent in the project vicinity, salvage harvests followed by prescribed burning is less likely to occur on those lands. On the other hand, recent and/or reasonably foreseeable future treatments on NFS land, particularly Goosetown Salvage, German Ridge Restoration, Morgan Ridge, and Buzzard Roost projects, would take steps to restore native hardwood communities. Agricultural and rural development may slowly be reducing the acreage of hardwood stands in southern Indiana, and while past timber treatments on private lands have tended to perpetuate hardwood communities, they generally have not encouraged dominance of the oak-hickory component.

**Fire and Oak Species**

Fire is an important natural force that helped shape the climax community of the region, but it has been suppressed for about 100 years. Long-term absence of fire has resulted in the decline of native oak-hickory communities. Over time, as more and more of the non-native pine stands die and fall to the forest floor, the risk of fire becomes high with increased fuel loading. Not only does the likelihood of fire increase under those conditions, but also the potential severity of the burning

greatly increases. Abundant snags and downed woody vegetation create conditions ripe for threats to the forest and neighboring property, structures, and possibly human life. Without the occurrence of fire over the next 100 years, some existing pine stands would be succeeded by maple, beech, and othershade-tolerant species. A study by Sutherland (1997), which dated fire scars in Eastern forests, revealed that fire occurred every 1 to 24 years and averaged 7.5 years in a healthy oak forest. Two black oak woodlands in Indiana had a fire return interval of 11.1 years (Henderson and Long 1984).

## Indiana Bats within the Action Areas

To our knowledge, there are four confirmed records of Indiana bats within 2.5 miles of any the proposed salvage units (Brack et al. 2004; Meade 2004; pers. comm. with Clark McCreedy, HNF biologist). The first and second were two single adult male Indiana bats, one captured near the town of St. Croix in Perry County and the other captured south of Magnet, in Perry County, during a 1998 mist net survey (Brack et al. 2004). The third record is an Indiana bat maternity colony near Magnet, Indiana, discovered in summer 2004. The forth record is of an Indiana bat maternity colony that was discovered by HNF biologist, Clark McCreedy, in the Celina Lake Campground during an evening emergence survey of a hazard tree (a dead American elm, *Ulmus Americana*) on 4 August 2005 (pers. com. with Clark McCreedy, HNF 2005). Approximately 30 *Myotis*-sized bats were counted as they emerged from beneath sheaths of loose bark on the snag indicating that the tree was likely being used as a primary maternity roost. Some guano pellets (i.e., fecal droppings) were later collected from beneath the roost tree and submitted for fecal DNA analysis to determine what species of bat was roosting in the tree. On 21 October 2005, a BFO biologist and HNF biologists visited the campground at Celina Lake and discovered that the maternity roost tree had been felled with a chainsaw by HNF maintenance staff on 22 September 2005 because of a miscommunication. HNF recreation maintenance staff felled the dead tree because it posed a potential safety hazard of falling in a recreation camp site. Apparently it was not clearly communicated to the maintenance staff workers that the intent was for the tree to be left standing as bat habitat and to keep the camp site closed. On 29 November 2005, HNF staff notified the BFO, that the fecal DNA analysis had confirmed that the bats that had been roosting in the dead elm tree were indeed *Myotis sodalis*, Indiana bats. This evidence confirmed the presence of the second known maternity colony on the Hoosier National Forest.

For this consultation, the Service has assumed that the felled snag in the Celina Lake Campground was a primary roost tree for a maternity colony consisting of approximately 80 adult female Indiana bats and their offspring. Further we assumed that the maternity colony has an unknown number of additional primary and alternate roost trees within a 2.5-mile radius of the felled roost tree in the Celina Lake Campground. Given the close proximity of the felled primary roost tree to the proposed salvage areas near Celina Lake, we believe it is reasonable to assume that some Indiana bats from this maternity colony have been roosting and foraging within some of the proposed salvage areas.

Based on the information above and other evidence discussed below, the Service concurs with the BA's conclusion that Indiana bats may be present in all suitable habitat in the Windthrow 2004 project area. Further the Service believes that based on the evidence provided here, the relatively limited geographic coverage of mist netting efforts in the areas of the proposed salvage harvest, and the expansive acreage of suitable habitat on the Forest and surrounding areas, that it is reasonable to assume that multiple maternity colonies of Indiana bats are present on the HNF and may be utilizing roosting and foraging habitat within or near portions of one or more of the proposed salvage areas.

Likewise, we believe it is reasonable to assume that an unknown number of adult males and adult non-reproductive females are widely dispersed throughout the HNF including the proposed salvage areas during the summer.

Recent investigations support our assumption of Indiana bats being present in the Action Areas. For example, Brack et al. (2004) recently summarized previous mist net surveys and radio-tracking studies conducted on the HNF from 1981 to 2003, which had captured small numbers of adult male Indiana bats and successfully located several of the males' roost trees. Likewise, the first reproductive (post-lactating) adult female Indiana bat to be captured on the HNF was taken during a 2004 mist net survey of 40 sites in the Buzzard Roost Area of Tell City Ranger District in Crawford and Perry counties. Radio-tracking of this bat lead to the discovery of the first Indiana bat maternity colony and maternity roost trees on the HNF near the town of Magnet in Perry County.

Prior to these and other recent surveys in southern Indiana, it was known that adult male Indiana bats could be found throughout southern Indiana in summer, but it was unclear whether the unglaciated portions of south central Indiana supported maternity colonies of Indiana bats or not. Summer records of reproductive female or juvenile Indiana bats provide evidence of a nearby maternity colony. There are relatively few records of reproductive female Indiana bats or juveniles from the cave region of southern Indiana, which includes the Hoosier National Forest, during the summer (Whitaker and Brack 2002, Brack et al. 2004); however, the number of records has grown in recent years. At Camp Atterbury, Johnson County, 2 reproductive female and 8 juvenile Indiana bats were captured in 1997(Montgomery Watson 1997). At Jefferson Proving Ground, a closed Army ammunition testing facility in southern Indiana, 9 of 14 Indiana bats captured between 1993-1995 were adult females or juveniles (Pruitt 1995). Whitaker (1994) captured a lactating female Indiana bat in Jennings County. One reproductive female was also captured at Crane Naval Weapons Support Center during 1998 and adult males were captured in 1998 and in 2005 (pers. comm. with Dr. Virgil Brack). Tyrell and Brack (1990) reported that there are records for reproductive females or juveniles in Knox, Martin, and Ripley counties, in Indiana. In 2004, extensive mist netting along the proposed corridor for I-69 lead to the discovery of approximately 13 "new" Indiana bat maternity colonies between Indianapolis and Evansville in southwestern Indiana USFWS, unpublished data, 2004). Collectively, these records provide evidence that southern Indiana is clearly within the maternity range of the Indiana bat (see Appendix A).

The only previous formal section 7 consultations involving Indiana bats that have been conducted within the boundaries of the current Action Area was the formal consultation and BO for the amended Forest Plan in 2001 and its appended projects and the HNF's new Forest Plan (BO issued on 3 January 2006). However, numerous informal consultations with the HNF have occurred for this species within Crawford, Perry, and surrounding counties. According to BFO records, there have been over 50 recorded Indiana bat occurrences (mostly hibernacula records in Crawford Co.) in Crawford and Perry counties from 1896 to 2005, with a majority recorded after 1990.

**Winter Habitat within the Action Areas and Vicinity**

No Indiana bat hibernacula are known to occur within the Action Areas for the Windthrow 2004 project as defined above or within a 5-mile buffer of any delineated salvage or prescribed burn boundaries. The 5-mile distance has biological significance, because Indiana bats have been documented roosting and foraging up to a maximum distance of approximately 5 miles (8 km) from their winter hibernacula during the fall swarming period (Rommé et al. 2002).

There is no designated Critical Habitat for the Indiana bat within the project's Action Areas and the nearest hibernaculum that has been designated as Critical Habitat, Wyandotte Cave, is over 10 miles east of the project area at its nearest point.

**Summer Habitat within the Action Areas and Vicinity**

Although an estimated percentage of forest cover was not available for the entire Windthrow 2004 project area, aerial images clearly reveal that the majority of the land in this area is forested. For example, a GIS-based analysis that used a 2.5-mile radius centered on the felled roost tree at Celina Lake, revealed that 73% of the surrounding area consisted of closed-canopy forest and another 14% was covered in grass (HNF unpublished data). Therefore, in very general terms, it does not appear that summer roosting or foraging habitat for the Indiana bat is limiting in the Action Area. We do not have estimates of the quantity or quality of potential roost trees that existed before or after the storms of 2004.

The July 2004 storm damaged thousands of trees as a result of straight line winds across an area of nearly 128,000 acres, which includes almost the entire Tell City Ranger District. Blowdown occurred on over 60,600 acres of National Forest System lands, but only about 3,950 acres of the blowdown areas contained merchantable salvage timber. Of the 3, 950 acres of blowdown that occurred on the Tell City Ranger District, the HNF is only proposing to conduct salvage harvest on 2,850 acres (72%), because, the remaining 1,100 acres (28%) of blowdown had limited access, low volumes, or other resource concerns (e.g. Mogan Ridge proposed roadless area). Thus, many storm-damaged areas will not be harvested, but will remain and be allowed to naturally regenerate and provide summer habitat for the Indiana bat and its prey.

Based on our first-hand aerial and ground inspections of several of the windthrow areas near Celina Lake, it was the Service's observation that most of the undamaged forest stands in the project area were relatively mature (second-growth) and healthy, had contiguous canopies, and appeared to have very few large-diameter snags with good solar exposure (i.e., none seen in canopy openings or along forest edges) to serve as high-quality maternity roosting habitat. Therefore, in effect, the changed forest structure and mosaic of downed and damaged trees left by the July 2004 wind storm likely caused a net increase in the number of potential roost trees (i.e., in the form of standing trees with splintered boles and cracks) that had existed prior to the storm and thereby improved the overall quantity and quality of summer roosting and foraging habitat on the Tell City Ranger District. We anticipate that these improved roosting conditions should persist for at least a decade.

Other parameters that may affect the quality of the summer habitat within the action area is the size of existing forest tracts and the degree of forest fragmentation. Based on a thorough review of literature on Indiana bat summer habitat, Rommé et al. (1995) concluded that areas with less than 5% cover by deciduous forest will not support summering Indiana bats. Areas considered optimal are generally at least 30% forested. All of the Action Areas for this project (including their 2.5-mile buffers) are well above 30% forest.

The majority of the forested tracts within the Action Areas are federally owned, but many private inholds and adjacent lands are present as well. Some unknown number of Indiana bats occupying private forests is likely to be adversely affected by non-protective timber harvest methods or other activities conducted in a manner that degrades or destroys the suitability of the habitat for Indiana bats (e.g., cutting snags for firewood and summer timber harvest). Conversely, some privately held

lands are likely being managed in a manner that is knowingly or unknowingly protective of Indiana bats.

**Ongoing Stressors**
The Service believes the following State, local, and private actions are currently occurring within the Action Area, are likely to be adversely affecting Indiana bats to some degree, and are likely to continue into the reasonably foreseeable future.

- Loss and degradation of roosting and foraging habitat – some commercial and residential developments are converting, fragmenting, or otherwise degrading forest habitat available for roosting and foraging, especially near larger towns and along primary and secondary roadways. Private forest land surrounds much of the HNF and there are numerous private inholdings, which may be managed in a manner that degrades the quality or completely eliminates the habitat.
- Degraded water quality – Point and non-point source pollution from agricultural, commercial, and residential areas is likely present in waterways within the Action Area and may reduce aquatic insect biomass that form a portion of the Indiana bat prey base.
- Commercial and private timber harvesting –Because some private timber harvests occur on private lands within the Action Area while bats are roosting in trees between 15 April and 15 September, some unknown number are exposed to this stressor and may be directly killed, harmed, or displaced as trees are felled in the summer.

# IV. EFFECTS OF THE ACTION

While analyzing direct and indirect effects of the proposed action on Indiana bats, the Service considered the following factors:

- proximity of the action to known species locations and designated critical habitat,
- distribution of the disturbances and impacts,
- timing of the effects in relation to sensitive periods in the species' lifecycle,
- nature of the effects – how the effects of the action may be manifested in elements of a species' lifecycle, population size or variability, or distribution, and how individual animals may be affected,
- duration of effects - short-term, long-term, permanent,
- disturbance frequency - number of events per unit of time, and
- disturbance severity - how long would it take a population to recover?

For our effects analysis, the Service assumed no Indiana bats, their hibernacula and associated karst systems, their prey, or surrounding habitat would be directly or indirectly affected beyond 2.5 miles from any proposed salvage area, prescribed burn area, or project-associated roadway (i.e., will not extend beyond the Action Area). Most direct and indirect effects from the Proposed Action will occur within the confines of the individual salvage units themselves. The only project-induced effects that have some small potential to travel beyond 2.5 miles are smoke plumes from prescribed burns and finely eroded sediments and nutrients carried down streams. However, we believe it is reasonable to assume that these two factors will have greatly dissipated to undetectable or insignificant levels before traveling beyond the 2.5-mile buffer zones and would therefore no longer illicit a response from any Indiana bats that might be exposed. Since prescribed burns and resulting

smoke would occur at a time when bats typically are still hibernating in caves their possibility of exposure is even further reduced.

Our analysis took into account the specific avoidance, minimization, and mitigation efforts, if any, that HNF has already taken or agreed to implement in order to further reduce adverse effects and incidental take of Indiana bats within the Action Area. The complete list of proposed avoidance and minimization measures is included in the "Proposed Conservation Measures" subsection under the PROPOSED ACTION section above.

**Exposure Analysis**

As a first step in our effects analysis, we conducted an exposure analysis to determine whether any Indiana bats would be directly or indirectly *exposed* to any physical, chemical, or biotic environmental consequences (i.e., stressors) stemming from the proposed forest management activities. We identified the spatial and temporal co-occurrences between stressors and Indiana bats as well as any direct and/or indirect exposure pathways and types and estimated numbers of bats that may be affected.

Because the salvage harvest and other related activities will be conducted during the spring staging/migration, summer maternity, and fall migration/swarming seasons (i.e., btwn. 15 April and 15 September) when male, non-reproductive female, reproductive female (i.e., pregnant, lactating, and post-lactating), and juvenile Indiana bats are all most likely to be present in the Action Area, we assume that each of these categories of bats will be present and exposed to the stressors associated with the Proposed Action. Likewise, these same types of Indiana bats would also be exposed to any beneficial environmental consequences (i.e., subsidies) directly or indirectly resulting from the Proposed Action.

Estimated Numbers of Exposed Bats

Because the HNF did not conduct presence/probable absence surveys in the Action Areas for this particular project, the Service had to make some assumptions regarding the likely abundance and distribution of Indiana bats in the Action Areas. Based on conservative assumptions derived from previous studies (Brack et al. 2004) of four male Indiana bats on the Tell City Ranger District of the HNF (see Appendix B for details), we estimated a maximum of 673 male and non-reproductive female Indiana bats may be roosting/foraging in some portion of the Action Areas and exposed to some level of project-related stressors. To determine how many reproductive females and juveniles may be exposed to project-related stressors, we used similar logic and assumptions as those made by Whitaker and Brack (2002) (see Appendix B for details). To be conservative and to simplify our effects analysis, we assumed that one maternity colony comprised of 80 reproductive adult females and their offspring, 80 juveniles (100% reproduction; after birth in mid to late June), was centrally located within each of the four Salvage Zones (U38, Indian-Celina, Leopold, and German Ridge; see Figure 1) on the Tell City Ranger District. Thus a total of 320 reproductive female and 320 juvenile Indiana bats are assumed to be present in the Action Areas and exposed to some level of project-related stressors. This assumption has been justified in part for at least one of the four zones, since the HNF staff provided us with field and subsequent DNA evidence indicating that a primary roost tree was being used by a maternity adjacent to the eastern edge of the Indian/Celina Salvage Zone during the summer of 2005.

Stressors

The primary, project-related stressors that we determined Indiana bats were likely to be directly or indirectly exposed to that were also likely to cause some level of incidental "take" included:

- direct loss of standing, storm-damaged trees that may be serving as primary or alternate roost trees by maternity colonies or roost sites for solitary males and non-reproductive females during the salvage harvest,
- direct loss of some standing healthy (shaggy barked) trees and/or snags that may be serving as roost trees during road and firebreak construction, maintenance, and repair, and
- direct exposure to loud day-time noises from the nearby operation of chainsaws, skidders, trucks, and other heavy equipment the may lead to roost site abandonment, increased energy expenditure, and increased predation risk (See Appendix B).

Other potential project-related stressors that bats may be exposed to, but are not anticipated to cause incidental take because of their insignificant or discountable effects, include:

- indirect changes in roosting habitat from prescribed burns (some loss/some gain of mostly small-diameter snags while bats are absent from the area),
- indirect changes in prey base abundance and diversity following prescribed burns (after a cool-season prescribed burn, there may be an insignificant short-term decline in terrestrial and/or aquatic insect abundance followed by a longer-term, beneficial increase in overall insect diversity and biomass), and
- direct or indirect changes to foraging habitat, because the salvage harvest, prescribed fire, and related roadwork will have relatively little impact on healthy mature trees or relative percentage of remaining forest canopy cover. Any changes to foraging habitat would be temporary.

Because the HNF will only be conducting cool-season prescribed burns (i.e., the season when bats are not present), Indiana bats will not be exposed to fire/flames/smoke/heat from prescribed fires. Relevant stressors that bats will be exposed to are summarized in the table in Appendix B.

**Responses of Exposed Bats to Stressors**

With an understanding of how, when, and where Indiana bats will be exposed to the proposed action, we then determined whether and in what manner these individuals are likely to respond after being exposed to the proposed action's effects on the environment or directly on the Indiana bats themselves. To accomplish this, we asked "How will Indiana bats likely respond after being exposed to the effects of the proposed?" Our analysis entailed identifying the range of possible responses Indiana bats could exhibit as a result of being exposed to the project-related stressors (see Appendix B). To ensure a thorough analysis of effects, the range of probable responses, not just the most deleterious, for each exposure pathway were identified. As is true in humans, bats typically demonstrate some degree of individual variability as seen by their range of responses to various stimuli. Therefore, accurately predicting how a generic, individual Indiana bat may or may not respond to a stressor is an inherently difficult task with little scientific literature available for guidance. Nevertheless, relying heavily on our personal knowledge of the species and general biological principles and logic, we identified the following range of responses of individuals and their local populations during or after exposure to project-related stressors:

0. no response
1. startled: increased respiration/heart rate
2. **death/injury of adults and/or offspring**
3. **flees from roost during daylight → ↑predation risk**
4. abandons roost site(s)
5. abandons foraging areas
6. shifts focal roosting and/or foraging areas
7. **↑ energy expenditures / ↓ fitness (short-term)**
8. ↓ energy expenditures / ↑ fitness (long-term)
9. **aborted pregnancy/reproductive failure (1 season)**
10. **↑torpor, delayed development/partuition, and/or delayed maturation of young**
11. **short-term ↓ colony reproductive rate (1-2 seasons post salvage)**
12. **short-term ↓ in colony size (2-3 seasons post salvage)**
13. long-term ↑ colony reproductive rate
14. long-term ↑ colony size

Response numbers 2, 3, 7, 9 and 10 are in bold because we anticipate that these negative responses are likely to rise to the level of take (as defined in the ESA) of one or more exposed Indiana bats in the Action Areas. Similarly, Responses 11 and 12 are the negative responses to local populations that would result from take of individual bats.

Please see the summary table in Appendix B, which identifies the specific behavioral and physiological responses of individuals and the demographic responses of local maternity colonies that we anticipate will occur for each of the project-related activities.

**Risk Analysis of Stressors Causing Take of Individual Bats**

Loss of Roost Trees - Because standing, storm-damaged trees (i.e., potential roost trees) will be harvested during the summer maternity season it is reasonable to assume that some of these trees may be felled while adult male or female and/or juvenile bats are actually roosting in them during the daytime and that some proportion of these bats would be killed or injured as a direct result (Belwood 2002). To minimize the potential risk of this type of direct take during the salvage harvest, the HNF is proposing to mark as "leave trees" all standing trees that they judge to be "high-quality, potential roost trees." This will include dead snags and standing storm-damaged trees that have sloughing and exfoliated bark, split bole cracks, or cavities. Additional characteristics that will be used to identify high-quality potential roost trees to be left in the stands will include relatively large diameter-at-breast-height (dbh) trees with significant solar exposure – especially along edges of blowdown, and close proximity to stream corridors. By leaving these high-quality, large-dbh roost trees, the potential for felling an important roost tree being used by a maternity colony of Indiana bats is greatly reduced. Therefore, we have assumed that no primary maternity roost trees (i.e., roost trees used by ≥ 30 adult females and or their offspring on multiple occasions) are likely to be felled during the salvage harvest or other related tree-clearing activities. However, we do believe it is reasonable to assume that between one to ten occupied alternate roost trees typically containing far less than 30 bats may be felled and lead to the death or injury of some proportion (but not all) of the bats. We assume that some bats would be startled by the noise and vibrations coming from a chainsaw and would successfully exit their roost trees prior to the tree being felled. Bats that remained in a roost tree and survived the initial felling would likely try to crawl and fly away from the immediate area, but being unaccustomed to flying during the daytime and likely injured or disoriented from the fall, would likely have a relatively high risk of predation

from diurnal predators. Bat that successfully flee the disturbance uninjured would not be expected to return to that area and would likely shift their focal roosting (and perhaps foraging) area at least temporarily. We assume that any surviving young that were still nursing and non-volant (i.e. to young to fly) would soon die if their lactating mothers were directly or indirectly killed by a felled roost tree during the middle of the maternity season.

Because maternity colonies and individual male Indiana bats commonly shift their use among multiple roost trees it is assumed that some unoccupied roost trees will be felled as well. In this case no direct adverse effects or take will occur, but some indirect adverse affects could still stress some Indiana bats to the point where take is reasonable certain to occur. For example, it is possible that the majority of the alternate roosts trees being used by one or more of our four assumed maternity colonies are located within or near some of the proposed salvage units and as a result a large proportion of a colony's alternate roosts (assuming primaries will remain standing) may be felled. Loss of multiple alternate roost trees would cause displaced individuals to expend increased levels of energy while seeking out replacement roost trees. If this increased expenditure occurred during a sensitive period of a bat's reproductive cycle (e.g., pregnancy) it is assumed that spontaneous abortion or other stress-related reproductive delays or losses would be a likely response in some individuals, particularly those that may have already been under other environmental stresses or perhaps stressed by other project-related stressors (e.g., increased noise levels). It has been hypothesized that these stresses and delays in reproduction could also cause lower fat reserves and ultimately lead to lower winter survival rates (USFWS 2002). For example, females that do give live birth may have pups with lower birth weights or their pups may have delayed development (i.e., late into the summer). This could in turn affect the overwinter survival of the young-of-the-year bats if they enter fall migration and winter hibernation periods with inadequate fat reserves.

Noise – Noise generated from the project-related activities will occur during daylight hours when Indiana bats are roosting in trees. Unfamiliar noises from the operation of chainsaws, bulldozers, skidders, trucks, etc. is likely to occur in relatively close proximity to occupied primary and alternate roost trees during the summer reproductive season. The novelty of these noises and their relative volume levels will likely dictate the range of responses from individuals or colonies of bats. At low noise levels (or farther distances), bats initially may be startled and have increased respiration/heart rates, but they would likely habituate to the low background noise levels. At closer range and louder noise levels (particularly if accompanied by physical vibrations from heavy machinery and the crashing of falling trees) many bats would probably be startled to the point of fleeing from their day-time roosts and in a few cases may experience increased predation risk. Because the noise levels in salvage units will likely continue for more than a single day the bats roosting within or close to these areas are likely to shift their focal roosting areas further away or may temporarily abandon these roosting areas completely. Callahan (1993) noted that the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree. Female bats in Illinois used roosts at least 1640 ft (500 m) from paved roadways (Garner and Gardener 1992). Very low bat usage close to Interstates has also been noted by other bat biologists (Whitaker, Jr. per. comm.). Conversely, some bats did use roosts near the I-70/Indianpolis Airport area, including a primary maternity roost 1970 ft (0.6 km) south of I-70. This primary maternity roost was not abandoned despite constant noise from the Interstate and airport runways, however; their proximity to the Interstate could also have been due to lack of more suitable roosting areas and furthermore the noise levels from the airport were not novel to the bats, so they had apparently habituated to them (USFWS 2002).

**Insignificant and/or Discountable Stressors to Individual Bats**

Forest fragmentation – Because the salvage units occur in a predominately forested area and tree clearing will mostly be limited to blowdown areas created by the 2004 storms, any further fragmentation of roosting and foraging habitat from the additional clearing of standing damaged trees will be of little affect and is not likely to degrade the remaining habitat's quality.

Short-term Water Quality Impacts

Water quality affects the Indiana bat in the Action Areas in terms of its aquatic insect prey and drinking water sources. In general, the streams in the project area exhibit a wide variety of aquatic habitat types and associated species. The riparian zones within the project area generally consist of hardwood and pine forest, with a shrub or herbaceous understory. The project area has many ephemeral streams with narrow riparian areas that may be crossed by skid trails or roads. There is some potential for sediment to move down the ephemeral channels into intermittent and perennial streams after a rainfall event. Removal of vegetation by timber harvest or other general management activities could potentially cause short-term adverse effects on the hydrologic characteristics and water quality in a watershed. A reduction in vegetative cover could potentially increase water yield and stream discharge; changes in vegetation cover could alter normal nutrient cycles in both terrestrial and aquatic systems, and increased use of access roads and trails during harvest operations could cause soil erosion leading to sedimentation. Potential effects from removal of vegetation and soil disturbance would be temporary. Controlled fire might remove organic matter along streams and may affect nutrients carried to stream channels. Seasonal timing of activities, rotation of areas to be burned, and control of burn temperature would lessen effects of organic energy loss, sedimentation, and leaching. Proposed erosion and sediment control measures such as riparian vegetative buffer strips, equipment limitation zones, contouring for drainage control, outsloping roads, and providing waterbars, mulching, and seeding would be implemented and greatly reduce water quality degradation. Finally, some small potential exists for accidental fuel/oil spills or spills of other hazardous materials from chainsaws and heavy equipment during the salvage harvest operations and related roadwork, which could degrade the quality of both surface and ground water, but given the degree of project oversight, we believe the odds of a large spill occurring and entering a waterway are discountable.

Post-Salvage Prescribed Burns

No direct or indirect take is anticipated for the reasons outlined below.

- Direct take of roosting bats will be avoided by not applying prescribed fire while the bats are present (i.e., before 15 April). Although a few potential roost trees may be consumed by the fires, more are likely to be created than lost by the fire.
- Given the very long distances to the nearest known hibernacula and the physical configuration of most of the caves, it is extremely unlikely (i.e., discountable) for smoke from the prescribed fires to travel to and enter any Indiana bat hibernacula.
- The prescribed burn may directly kill some unknown proportion of the Indiana bats' spring-time prey base that includes insect species that overwinter in the leaf litter. However, because the HNF will apply a cool-season fire, the burn will create a mosaic pattern that leaves many unburned areas on the ground to function as refugia for overwintering stages of insects. These insects would still be available as prey and presumably will rapidly recolonize new vegetation as it emerges within nearby burned areas. Any short-term

declines in insect abundance may be offset by a relative increase in insect availability due to the fire removing some of the vegetative clutter in the forest understory and thereby increasing the availability of resident insects to Indiana bats as they forage on the wing. Over a longer term, insect diversity and abundance in burned areas is expected to increase for several years after the initial burn due to an increase in the amount and diversity of herbaceous vegetation. Therefore, cool-season prescribed burns should not have a significant direct or indirect adverse effect on foraging Indiana bats.

**Risks to Local Bat Populations**

Maternity Colonies – We assumed the presence of four maternity colonies comprised of 80 adult females and their 80 young (4 colonies x 160/colony = 640 reproductive female and juvenile bats in the Action Areas). We estimated that a maximum total of 16 reproductive female (n=8) and juvenile (n=8) Indiana bats may be taken project-related activities (see Appenix B). This represents a very small fraction of the estimated local breeding population (16/640 = 2.5%) in the Action Areas. We assume that take of these individuals would likely be spread among several of the four assumed maternity colonies. However, in a worst-case scenario, where all 16 estimated bats were taken from a single colony, this would still only represent a 10% reduction in a single colony's membership. Under no conceivable scenarios, is this estimated amount of loss/take of reproductive individuals likely to cause an appreciable long-term change in viability of an individual maternity colony yet alone to the species' regional or range-wide status. At worst, only short-term (1 or 2 maternity seasons) reproductive loss and reduction in numbers of four local maternity colonies is anticipated as a result of the Proposed Action.

It seems reasonable to assume that more take may occur among members of the recently discovered maternity colony near Celina Lake, because they may already be somewhat stressed from the overwinter loss of one of their primary roost trees before the salvage harvest activities begin. Take of individual bats would cause a concomitant decline in maternity colony reproductive rates and size, however, these should only be temporary or short-term effects lasting only one or two maternity seasons. Lastly, we believe some of proposed activities such as prescribed burns will improve the long-term quality of some roosting and foraging areas and thereby has potential to improve a maternity colony's reproductive rate and size over time.

In no areas is the amount of proposed tree clearing/harvest believed to be extensive enough to cause a maternity colony to be permanently displaced from its traditional summer range. The majority of the salvaged timber is already lying on the ground and of no roosting value to the bats and only a portion of the standing damaged trees will be harvested. In fact, even after the salvage harvest and related activities have been completed, we firmly believe the salvage areas will still possess a net increase in roosting habitat as compared to what these same areas had prior to the 2004 storm events. Furthermore, thousands of acres of additional roosting habitat/potential roost trees will remain available surrounding the salvage units in areas that were storm-damaged, but for various reasons were not accessible or economically feasible to conduct salvage operations. In short, high to moderate quality maternity roosting habitat should not be a limiting resource in most storm-damaged areas for many years.

Local Populations of Males and Non-reproductive Females – Because adult males and presumably most non-reproductive females do not participate in the rearing of offspring, they typically lead solitary lives or in some cases small bachelor colonies during the summer. Because these

individuals are not burdened with a dependent young they presumably would be more apt to flee from their roost trees than reproductive females would be when faced with a disturbance. Therefore, it is very unlikely that the felling of an occupied roost tree would ever have more than a few adult males or non-reproductive females in it at any one time and even more unlikely for take of more than one male/non-reproductive female to occur. We estimated a maximum total of 6 adult males and/or non-reproductive females out of potentially 672 bats may be taken as a result of the Proposed Action. The potential loss of this very small percentage (6/672 = 0.9%) of bats will have no measureable or significant impact on the non-breeding Indiana bat population in the Action Area or beyond.

# V. CUMULATIVE EFFECTS

Cumulative effects include the effects of local, state, tribal 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 under section 7 of the Act.

Reasonably foreseeable actions on other ownerships are difficult to predict, since there are an abundance of owners within the nine-county area. Other state landowners or managers include the Indiana Department of Natural Resources (DNR) and Indiana Department of Transportation (INDOT). Each entity has a different purpose and objectives for managing their lands, although based on past management practices and planning documents, their activities can be reasonably predicted. While all have differing management objectives, the state land management agencies all have conducted similar management activities over the past years that are indicative of the types of reasonably foreseeable future actions that could likely occur. These include forest and openland management through prescribed burning, various types of timber harvest, limited herbicide and pesticide use, provision of recreational experiences.

The Indiana DNR recently issued its Strategic Plan for 2005 through 2007. This plan states that efforts over the next two years will be directed towards management of forest resources for increased timber production and enhanced wildlife habitat. If implemented, this could result in an increased timber harvest from an estimated 3.4 million board feet per year to approximately 10 to 17 million board feet per year on State lands. This will increase the amount of early successional habitats available on these lands, as well as provide wood products and revenue to the state of Indiana and its citizens.

The INDOT and county road departments regularly conduct road and highway maintenance, as well as various road reconstruction and relocation projects across the state. One major highway project that has been proposed and is in the planning stage is the I-69 expansion from Indianapolis to Evansville. This project, other federal highway projects and state highway projects that use federal monies would be subject to Section 7 consultations and would not be included in the discussion of cumulative effects as defined by the Act.

There are hundreds, of private landowners who own property within the Windthrow Action Area. However, past trends on private properties within this area offers some indication of reasonably foreseeable trends for the future. Activities on private lands which may be reasonable to expect to occur and which might have some impacts on Indiana bats or their habitat include:

- Commercial or recreational use of caves that Indiana bats use for hibernating/swarming;
- Winter recreational use of Indiana bat hibernacula resulting in some disturbance;
- Land clearing, road construction and other uses that may result in permanent loss of forest cover and large, dead trees and potential sedimentation of streams; and
- Agricultural use of herbicides and pesticides.

In addition, private landowners also conduct burns on their land and wildfires occur both on private land and National Forest land within the proclamation boundary.

Any of these activities would have varying degrees of effects on Indiana bats, ranging from no effect to adverse effects. Human disturbance in hibernacula and permanent conversion of lands to unsuitable habitat (urban and residential development, road construction, permanent pasture with few or no trees, etc.) would have the greatest potential impact to Indiana bats. Other activities would have the same general effects as HNF activities would providing they are implemented with similar methods and protective measures.

We can not accurately quantify how much forest land on private lands will be converted to other habitat types, the extent of future timber harvests on private lands, nor the amount of privately owned habitat that will be developed for other purposes. However, we can look at the trends state-wide and extrapolate assumptions as to how the private lands within the Action Area will likely be managed in the foreseeable future.

The following Indiana forest trends were highlighted within the North Central Research Station's 2005 report, "Indiana Forests: 1999-2003, Part A":

- There are no major tree die-offs anywhere in the state; natural tree mortality appears evenly across the state.
- The ratio of harvested tree volume to tree volume growth indicates sustainable management.
- Diverse and abundant forest habitat (snags, coarse woody debris, forest cover and edges) support healthy wildlife populations across the state.
- Indiana possesses a diversity of standing dead tree wildlife habitat with an abundance of recently acquired snags to replenish fully decayed snags as Indiana's forests mature.
- Indiana's oak species continue to grow slower than other hardwood species.
- The average private forest landholding dropped from 22-acres in 1993 to 16-acres in 2003, indicating a continued "parcelization" of Indiana forests.
- Introduced or invasive plant species inhabit a majority of inventories plots.
- The amount of forest edge doubled from 1992 to 2001, indicating smaller forest plots.
- Due to land use history and natural factors, the forest soils of southern Indiana are generally below-average in quality.
- Although Indiana's overall forested land mass is increasing, the rate of increase has slowed over the past decade.
- Indiana's forests continue to mature in terms of the number and size of trees within forest stands.
- Tree-of-Heaven, a highly invasive species, has become well established in forests along the Ohio River and has the potential to spread farther into Indiana forests.
- Increases in total volumes of oak species are less than those for most other hardwood species.
- The advanced ages and inadequate regeneration of Indiana's oak forests may signal a successional shift from an oak/hickory-dominated landscape to one where other hardwood species, such as maples, occupy more forested areas.
- Indiana's hardwood saw-timber resource continues to be at risk due to maturing of hardwood stands, loss of timberland to development and new pests (gypsy moth, emerald ash-borer, sudden oak death, beech-bark disease, and more).
- Ownerships of Indiana forests have changed in the past decade, resulting in more parcelization and fragmentation.

While the data shows there has been loss of continuous forest, resulting in smaller, fragmented stands, there is also an overall increase in forested land across the state.

# VI. CONCLUSION

After reviewing the current status of Indiana bat, the environmental baseline for the action area, the aggregate effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Tell City Windthrow 2004 Salvage Timber Harvest, as proposed, is not likely to jeopardize the continued existence of the Indiana bat. Although critical habitat for the Indiana bat has been designated at two locations in Indiana, neither locations will be affected, and therefore, no destruction or adverse modification of critical habitat is anticipated.

This conclusion is based on the following factors:

- The probability of unknown occupied roost trees being removed through salvage harvest is relatively small. If a tree were to be cut that had an unknown maternity colony roosting in it, most of the bats would likely escape unharmed, including non-volant juveniles (Belwood 2002, Carter et al. 2002), but some individuals may be injured or killed. Since the HNF will not be harvesting all suitable roost trees in any one area, suitable (alternate and/or primary) roosts will remain available for maternity colonies and solitary bats. The estimated number of anticipated injuries and/or deaths to reproductive and juvenile Indiana bats is small (16 bats) and therefore no appreciable long-term reductions in reproduction, numbers and distribution are expected within the Action Areas or beyond.
- In regards to adult male and non-reproductive female Indiana bats being harmed or killed while roosting in a tree targeted for harvest or clearing, the likelihood is very remote that this would ever occur. It is highly unlikely that a bat would remain in a tree being cut down, and if it did, the odds that the tree would fall exactly on the spot in the tree where the bat was roosting are remote. Furthermore, since male Indiana bats predominantly roost alone, there would be very little chance for multiple bats being taken if this very improbable scenario ever unfolded. Increased predation risk is also very small. The number of anticipated injuries and/or deaths to male Indiana bats is so small that no appreciable reductions in reproduction, numbers and distribution are expected to male and non-reproductive female populations within the Action Areas or beyond.
- The long-term range-wide rate of decline for the Indiana bat appears to have slowed, and recent population estimates have shown for the first time in 60-years an apparent increase in overall population. However, at this time we are unable to confidently interpret the meaning and/or causes of these apparent increases in terms of current population trends.
- The Proposed Action will only take or otherwise reduce the fitness of a small number of individual bats (estimated total = 22 bats) within the Action Area and will only have minimal, short-term effects on these bats' respective maternity colonies or local populations. Similarly, loss of these individuals will have no adverse effect on the viability of other maternity colonies in the region or the species' range or to hibernating populations to which these individuals belong. Therefore, the Proposed Action is not reasonably expected, directly or indirectly, to cause an appreciable reduction in the reproduction, numbers or distribution of the Indiana bat as a species.

# INCIDENTAL TAKE STATEMENT

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

The measures described below are **non-discretionary**, and must be undertaken by the HNF or their designee for the exemption in section 7(o)(2) to apply. The HNF has a continuing duty to regulate the activity covered by this incidental take statement. If the HNF fails to assume and implement the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the HNF must also 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

The Service believes it is reasonably certain to anticipate that incidental take of Indiana bats will occur in the following forms:

- death and injury from direct felling of occupied trees,
- harassment of roosting bats from noises/vibrations/disturbance levels causing roost-site abandonment and atypical exposure to day-time predators while fleeing and seeking new shelter during the day-time, and
- harm through loss of primary and/or alternate roost trees.

Based on our analysis of the environmental baseline and effects of the proposed action, the Service anticipates that one known and three other, assumed maternity colonies and a widely dispersed population of adult male and non-reproductive female Indiana bats occupy the Action Areas and may be adversely impacted as the result of the proposed project. The direct and indirect effects from the felling and loss of roosting habitat and indirect effects from exposure to loud noises and disturbances at roost sites are expected to result in the death of some bats. Loss of some roosting habitat and temporary degradation of remaining habitat may also result in harm to individual bats. While some adverse effects are not expected to directly result in the death of bats, they may exacerbate the effects of other ongoing stressors on the bats. Collectively, the effects of the action are expected to result in behavioral or physiological effects which impair reproduction and recruitment, or other essential behavioral patterns. We anticipate take/death of individuals, decreased fitness of individuals, reduced reproductive potential, and reduced overwinter survival of an estimated maximum of 22 Indiana bats as detailed in Appendix B. The effects on the four

assumed maternity colonies may be lost reproductive capacity and potentially a short-term decline in their colony sizes. No adverse long-term effects to affected maternity colonies are anticipated.

It is unlikely that direct mortality of small-sized bats will be detected, that is, we do not expect that dead or moribund bats are likely to be found as the project activities are being conducted, even though we expect that up to 22 individuals may be taken as a result of the proposed actions. Because there is no practical means to directly monitor or measure impacts to individual Indiana bats, the anticipated level of take is being expressed below as the temporary loss or unavailability of currently suitable acreages of summer habitat for Indiana bats that will result from project implementation as estimated in the Windthrow BA. In short, we will exempt anticipated levels of take by using affected habitat acreages as a surrogate as summarized in Table 1.

**Table 1.** Anticipated surrogate levels of incidental take.

| Proposed Activity | Total Amount or Extent of Activity Serving as a Surrogate Amount of Exempted Incidental Take |
|---|---|
| Maintain, Repair, & Construct Roads | 34 miles/35 forested acres (16 ac. for temp. roads) |
| Salvage Timber Harvest | 2,850 acres in ≈ 85 salvage units |
| Maintain and Create Fire Breaks | 20 forested acres |
| Post-salvage Prescribed Fire | 5,620 acres in multiple burn units (≈ 500 ac./unit) |
| Project-wide Combined Total*: | 8,525 acres |

* There is a high degree of overlap in the acreages proposed for salvage harvest and prescribed fire, so they are not mutually exclusive.

## EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that the aggregate level of anticipated take is not likely to result in jeopardy to Indiana bats or destruction or adverse modification of designated critical habitat.

The surrogate amount of incidental take being exempted here (total of 8,525 acres), as expressed in acres of habitat lost or altered, when compared to all forested portions of the entire HNF (187,201 acres) represents only 4.6 % of the HNF. This percentage decreases significantly when unaffected private inholdings and surrounding private forest land is considered. Although, it is likely that additional forest management will likely occur on non-Forest Service properties within the Action Area, it is difficult to estimate the amount of management and subsequent habitat loss/alteration that will occur on non-Forest Service-managed land. It is only reasonable here to comment on the effect of the take on HNF property, since we have no assurance or presumption that non-Forest Service property will be managed in a manner similar to that on the HNF.

## REASONABLE AND PRUDENT MEASURES

Within the Windthrow BA the HNF has already committed to implementing specific conservation measures, standards and guidelines, and other best management practices that will benefit a variety of wildlife species, including the Indiana bat. However, the Service believes the following reasonable and prudent measures (RPMs) are also necessary and appropriate to further minimize take of Indiana bats:

1. Ensure all HNF and contracted personnel working on the Tell City Windthrow 2004 Salvage Harvest are aware of and clearly understand the proposed conservation measures and relevant RPMs and TCs included in this Incidental Take Statement.

2. Avoid disturbances to the known Indiana bat maternity colony at the Celina Lake Campground, in an effort to avoid compounding any existing physiological stresses to pregnant and lactating females and their non-volant young during the first half of the 2006 reproductive season as a result of the recent loss of one of this colony's primary roost trees.

3. Ensure the Celina Lake Campground maternity colony is adequately protected from future disturbances and plan for its long-term conservation.

4. Minimize disturbance to bats in known or newly discovered maternity roost trees throughout the project area.

5. Monitor proposed levels of project-related activities to ensure that they, and thereby anticipated levels of incidental take, are not exceeded.

## TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the HNF must comply with the following terms and conditions, which implement the corresponding reasonable and prudent measures above. These terms and conditions are non-discretionary.

1. Before any project-related habitat alterations commence, all HNF personnel and contractors directly involved with the Tell City Windthrow Salvage Harvest project (i.e., on-site project managers, biologists, field crews, maintenance staff, equipment operators, and private contractors) must attend/take/view some form of a mandatory environmental awareness training session that explains all relevant conservation measures and RPMs and TCs, and other concerns regarding Indiana bats and their habitat in the project area, and presents a clear protocol for reporting the presence of any live, injured, or dead bats observed or found within or near the project area. For Forest Service staff directly involved with management and implementation (e.g. contracting officer, sale administer, recreation manager) of activities where Indiana bat roost trees are located should be given additional training for disclosing roost tree locations and measures developed to protect those roosts.

   Note: Should any dead *Myotis* bat species be located within the Windthrow Action Area, they should be immediately reported to BFO [(812) 334-4261], and subsequently transported (frozen or on ice) to BFO. No one other than trained biologists should attempt to handle any live bat, regardless of its condition; report bats that appear to be sick or injured to BFO. BFO will make a species determination on any dead or moribund bats. If an Indiana bat is identified, BFO will contact the appropriate Service Law Enforcement office

as required.

2. Delay road construction/reconstruction activities and salvage harvest until after mid summer (July 15, 2006) within a one-mile radius of the former Celina Lake Campground roost site. Specifically, all individual timber sale units with >50% of their area within the one-mile distance will be delayed. This would allow returning Indiana bats to establish roosts their roosts without disturbance, and allow juvenile bats time to become volant before project-related activities occur.
3. Before 1 May 2006, design a mist netting and radio-tracking study and a pedestrian survey to identify potential roost trees of the Celina Lake Campground maternity colony in coordination with the Service's Bloomington Field Office. The bat studies should be initiated in the spring of 2006. The HNF will use any new information provided from the 2006 studies (e.g., new roost sites locations, emergence counts, etc.) and other sources to develop a site-specific "conservation plan" outlining the Forest's plans to conserve and monitor this maternity colony's long-term status. The conservation plan should include emergence survey results, plans for future surveys, general locations with maps, mitigations implemented (e.g. project specific, Forest Plan standards, and BO T&C), and necessary resource personnel informed. The plan should also outline how HNF staff members, volunteers, and recreational users that may be in the Celina Lake area will be made aware of any protective measures or restrictions regarding the Indiana bats in the area. A draft conservation plan should be submitted (along with the first annual report) to the BFO by January 31, 2007.
4. Any known or newly identified maternity roost trees throughout the project area will be appropriately protected and/or buffered from salvage harvest or other land management activities as deemed necessary on a case-by-case bases in coordination with the BFO. The HNF must consult with USFWS before felling any known roost tree for additional guidance and potential minimization measures.
5. Because acreages of altered Indiana bat habitat are being used as surrogates to monitor anticipated levels of incidental take within the Action Areas, the HNF will prepare an annual report detailing the acreages/amounts of each project-related activity listed in Table 1 of this Incidental Take Statement. The annual report will also summarize the status of and detail any problems incurred while implementing proposed conservation measures, habitat monitoring efforts, and bat monitoring activities that had been initiated, are ongoing, or were completed during the previous calendar year as well as the status of those yet to be completed. The report will be submitted to the Service's BFO by 31 January each year (the first report will be due 1/31/07) and reporting will continue until all proposed project-related actions and RPMs and TCs have been completed.

   ATTENTION: If at any point in time during this project, the exempted levels/acreages of habitat listed in Table 1 of this ITS are exceeded by more than 10% for any particular activity, then we will assume that the exempted level of take for this project may have been exceeded and the HNF should immediately reinitiate formal consultation.

The reasonable and prudent measures, with their implementing 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 action, this level of incidental take is exceeded such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The HNF 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.

# CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities designed to minimize or avoid adverse effects of a proposed action/program on listed species or critical habitat, to help implement recovery plans, or to develop information. Conservation recommendations generally do not focus on a specific project, but rather on an agency's overall program.

The Service provides the following conservation recommendations for the HNF's consideration; these activities may be conducted at the discretion of HNF as time and funding allow:

1. Working with the Service's BFO, design an educational brochure, interpretive display, or other media about Indiana bats to be distributed to HNF visitors or a broader audience. The Indiana bat recovery plan (USFWS 1983) identifies public education on Indiana bats as a priority activity needed for recovery of the species.

2. Continue and expand upon scientific research and educational outreach efforts on Indiana bats in coordination with the Service's BFO.

3. Obliterate temporary or obsolete service roads by converting them into ephemeral wetlands/vernal ponds where feasible.

4. In coordination with the BFO, purchase or otherwise protect additional Indiana bat hibernacula in Indiana.

In order for the Service to be kept informed of actions for minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

# REINITIATION NOTICE

This concludes formal consultation with the HNF for the proposed Tell City Windthrow Salvage Harvest and related activities. 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 are subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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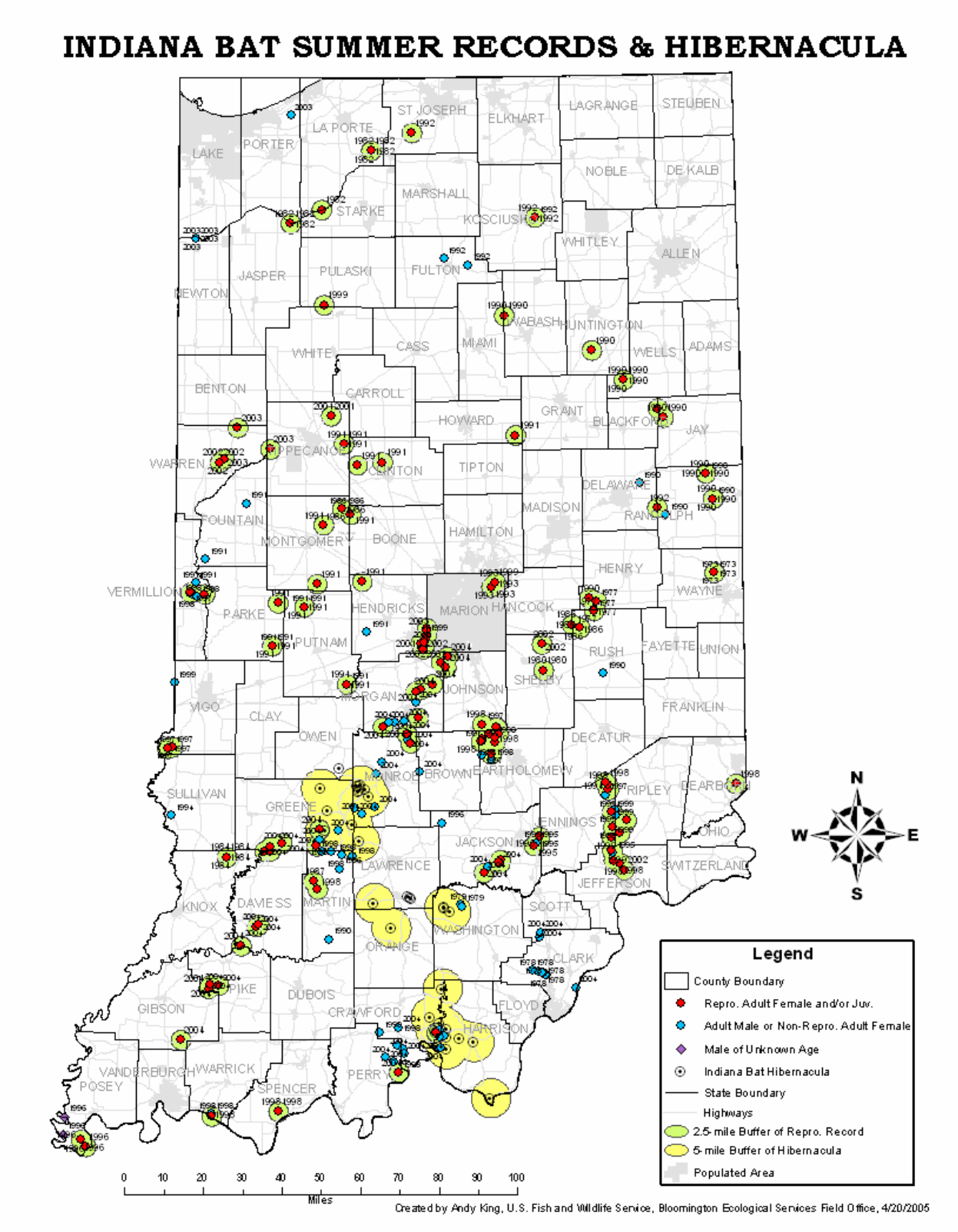
# Appendix A:


INDIANA BAT SUMMER RECORDS & HIBERNACULA
LAKE
PORTER
LA PORTE
ST JOSEPH
ELKHART
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MARSHALL
STARKE
KOSCIUSKO
WHITLEY
ALLEN
JASPER
PULASKI
FULTON
NEWTON
WABASH
HUNTINGTON
WELLS
ADAMS
WHITE
CASS
MIAMI
BENTON
CARROLL
HOWARD
GRANT
BLACKFORD
JAY
WARREN
TIPTON
DELAWARE
RANDOLPH
MADISON
FOUNTAIN
MONTGOMERY
BOONE
HAMILTON
HENRY
WAYNE
VERMILLION
PARKE
HENDRICKS
MARION
HANCOCK
PUTNAM
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MORGAN
VIGO
CLAY
FRANKLIN
OWEN
DECATUR
MONROE
BROWN
BARTHOLOMEW
SULLIVAN
GREENE
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JENNINGS
OHIO
LAWRENCE
SWITZERLAND
JEFFERSON
KNOX
DAVIESS
MARTIN
SCOTT
WASHINGTON
ORANGE
CLARK
PIKE
DUBOIS
FLOYD
GIBSON
CRAWFORD
HARRISON
VANDERBURGH
WARRICK
POSEY
SPENCER
PERRY
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E
S
Legend
County Boundary
Repro. Adult Female and/or Juv.
Adult Male or Non-Repro. Adult Female
Male of Unknown Age
Indiana Bat Hibernacula
State Boundary
Highways
2.5-mile Buffer of Repro. Record
5-mile Buffer of Hibernacula
Populated Area
0 10 20 30 40 50 60 70 80 90 100
Miles
Created by Andy King, U.S. Fish and Wildlife Service, Bloomington Ecological Services Field Office, 4/20/2005

# Appendix B:
# Effects Analysis Summary Table

## Tell City Windthrow 2004 Salvage Harvest

| Proposed Activity | Approx. Amount or Extent of Activity | Timing of Activity | # of Events/ Disturb-ances | Duration of Each Disturbance | Relevant/ Associated Stressor(s) to Bats | Are IBats Likely to be Directly and/or Indirectly Exposed to this Stressor? | Estimated Max. # of IBats being Exposed / Event | | | Likely Behavioral Responses of Individuals | Likely Physiological Responses of Individuals | Range of Effects on Local Maternity Colonies | Overall Impact to Local Pops. | Is Take of ≥1 Bat Reasonably Certain to Occur? | Form(s) of Take | Estimated Max. # of IBats that may be Taken by Activity / Stressor | | | | Surrogate Amount/ Units of Exempted Take |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Adult ♂ and/or Non-repro. ♀ | Repro. ♀♀ (4 colonies) | Juv. | | | | | | | Adult ♂ and/or Non-repro. ♀ | Repro. ♀♀ | Juv. | Combined Totals | |
| Maintain, Repair, & Construct Roads | Total of 34 miles = 35 acres (16 ac. for temp. roads) | may occur in summer | 1 | a linear disturbance,so duration at any one point will be short | loss of roosting habitat | yes | <<173 | <320 | <320 | 0,1,2,3,4,5, 6, | 0,1,2,4,7,11,12 | 0,4,6,13,14 | low | yes | k,w,h | 1 | 1 | 1 | | 34 miles / 35 acres (16 ac. for temp. roads) |
| | | | | | day-time noise | yes | <<173 | <320 | <320 | 0,1,2,3,4,6 | 0,1,7,11,12 | 0,4,6,13,14 | insignif. | no | - | 0 | 0 | 0 | 3 | |
| Salvage Timber Harvest: tree felling and skidding | Total of 2850 acres in ≈ 85 salvage units | may be year-round, but majority in summer | 1 | approx. 1 year | loss of roosting habitat | yes | 173 | 320 | 320 | 0,1,2,3,4,5, 6, | 0,1,2,4,7,11,12 | 0,4,6,13,14 | low | yes | k,w,h | 3. | 4 | 4 | | 2850 acres in ≈ 85 salvage units |
| | | | | | day-time noise | yes | 173 | 320 | 320 | 0,1,2,3,4,6 | 0,1,7,11,12 | 0,4,6,13,14 | low | yes | k,w,h,h2 | 1 | 2 | 2 | 16 | |
| Maintain / Create Fire Breaks | Unknown, but <20 ac. majority are pre-exisitng, so few new ones needed. | may occur in summer | 2x per burn unit with 2-4 yrs. inbtwn. | a linear disturbance… approx. 1 week per burn unit | loss of roosting habitat | yes | <<672 | <<320 | <<320 | 0,1,2,3,4,5, 6, | 0,1,2,4,7,11,12 | 0,4,6,13,14 | low | yes | k,w,h | 1 | 1 | 1 | | 20 acres |
| | | | | | day-time noise | yes | <<672 | <<320 | <<320 | 0,1,2,3,4,6 | 0,1,7,11,12 | 0,4,6,13,14 | insignif. | no | - | 0 | 0 | 0 | 3 | |
| Post-salvage Prescribed Fire | 5620 acres divided into multiple burn units (≈ 500 ac./ unit) | btwn. 15 Sep. and 15 Apr. "cool season" burns | 2x per burn unit with 2-4 yrs. inbtwn. | 1 day for each burn unit, but may be >1 mo. for the entire project area | fire / flames | no | 0 | 0 | 0 | n/a | n/a | n/a | insignif. | no | - | 0 | 0 | 0 | | 5620 acres divided into multiple burn units (≈ 500 ac./ unit) |
| | | | | | smoke / heat | no | 0 | 0 | 0 | n/a | n/a | n/a | insignif. | no | - | 0 | 0 | 0 | | |
| | | | | | +/- change in roosting habitat | yes | 672 | 320 | 320 | 0,6 | 0,7,8 | 0,6,15,16 | insignif. | no | - | 0 | 0 | 0 | 0 | |
| | | | | | +/- change in prey base | yes | 672 | 320 | 320 | 0,6 | 0,7,8 | 0,6,15,16 | insignif. | no | - | 0 | 0 | 0 | | |
| | | | | | | | | | | | | | | | Totals: | 6 | 8 | 8 | **22** | |

KEY:

| | | | |
|---|---|---|---|
| 0 | no response | 8 | ↓ energy expenditures / ↑ fitness (long-term) |
| 1 | startled: increased respiration/heart rate | 11 | aborted pregnancy/repro. failure (1 season) |
| 2 | death/injury of adults and/or offspring | 12 | ↑torpor, delayed development/partuition, and/or delayed sexual maturation of offspring |
| 3 | flees from roost during daylight → ↑predation risk | 13 | short-term ↓ colony reproductive rate (1-2 seasons post salvage) |
| 4 | abandons roost site(s) | 14 | short-term ↓ in colony size (2-3 seasons post salvage) |
| 5 | abandons foraging areas | 15 | long-term ↑ colony reproductive rate |
| 6 | shifts focal roosting and/or foraging areas | 16 | long-term ↑ colony size |
| 7 | ↑ energy expenditures / ↓ fitness (short-term) | n/a | not applicable |

| | |
|---|---|
| k: | kill |
| w: | wound |
| h: | harm |
| h2: | harass |

## Appendix B. (Continued)

Assumptions Used to Estimate # of ♂ and/or NR♀ IBats likely to be Exposed to Activities / Stressors

Rationale: The smallest activity area/home range of the 4 male IBats tracted on the HNF in 1998 was approx. 80 acres (82.3 ac.; Brack et al 2004). Assuming mist net surveys detected <100% of IBats present, then it's reasonable and very conservative to assume that 2 IBats (double) are focusing their roosting/foraging activity on every 80 acres of forest habitat.

Therefore, we assume a density of 16 adult male/NR adult females per sq.mile or every 640 acres…

Or… 1 male or NR female IBat/40 acres.

| Salvage Zones of Tell City Windthrow 2004 Salvage Harvest Project | # of 40-acre Subsections of Numbered PLSS* Sections that include any portion** of a Salvage Unit*** | # of Numbered PLSS Sections (1 sq. mile/640 ac.) where any portion** will have Rx Fire*** |
|---|---|---|
| U38 | 49 | 20 |
| Indian/Celina | 30 | 6 |
| Leopold | 33 | 6 |
| German Ridge | 61 | 10 |
| Total: | 173 | 42 |
| multipier | 1 IBat/40 acres | 16 IBats/sq. mile |
| Est. Total # of ♂/NR♀IBats Being Exposed: | **173** | **672** |

* Public Land Survey System (township, range, section)

** Conservatively overestimated affected area by assuming that entire Subsection/Section would be impacted.

*** Conservatively overestimated # of bats by assuming that all habitat within each Subsection/Section was suitable and occupied.

Assumptions Used to Estimate # of Reproductive♀♀ and Juveniles likely to be Exposed to Activities / Stressors

Using the same logic and assumptions made by Whitaker and Brack (2002)... In 2005 there were approx. 206,610 IBats overwintering in Indiana. If half of them were female, then there were 103,305 females. If all females that overwinter in Indiana hibernacula also spend the summer here, and maternity colonies average 80 females, and are evenly distrbuted across Indiana, then each of the 90 counties would have about 14 maternity colonies of 80 females or about 1,120 reproductive females per county. In reality, even distribution among Indiana's counties is unlikely. From relatively extensive mist net survey efforts completed on the HNF and adjacent areas as compared to other regions of Indiana to date, it appears that fewer maternity colonies occupy the relatively rugged, unglaciated portions of southcentral Indiana (i.e., on the HNF), than occur in the glaciated counties in the remainder of the state. Therefore, Crawford and Perry counties being unglaciated areas are likely to have fewer than 14 colonies of 80 bats each. We are assuming that Crawford and Perry counties have only half (50%) as many maternity colonies as glaciated counties in Indiana, therefore, there would be approximately 6 to 8 colonies in each of these counties or from 480 to 640 reproductive females.
The Windthrow 2004 Salvage project will only affect a relatively small portion of these counties, and therefore would only impact a portion of all colonies present in the counties.

To be conservative and to simplify our effects analysis, we are assuming that 1 maternity colony comprised of 80 adult females and their offspring, 80 juveniles (100% reproduction; after birth in mid to late June), is centrally located within each of the 4 Salvage Zones on the Tell City Ranger District. These assumption appears to be valid for at least one of the 4 zones, since the HNF staff have provided us with field and subsequent DNA evidence indicating that a maternity colony was present in summer 2005 at the eastern edge of most of the Indian/Celina Salvage Zone salvage units.

| Salvage Zones of Tell City Windthrow 2004 Salvage Harvest Project | # of Individual Salvage Units/Zone | Largest Salvage Unit in the Zone (acres) | Smallest Salvage Unit in the Zone (acres) | Aggregate Acreage Proposed to be Salvaged per Zone | Est. # of Repro. ♀ IBats (1col./zone) | Est. # of Juvenile* IBats (1col./zone) |
|---|---|---|---|---|---|---|
| U38 | 21 | 153 | 0.5 | 770 | 80 | 80 |
| Indian/Celina | 18 | 125 | 1 | 566 | 80 | 80 |
| Leopold | 20 | 274 | 1 | 635 | 80 | 80 |
| German Ridge | 26 | 105 | 0.6 | 879 | 80 | 80 |
| | 85 | | | 2850 | **320** | **320** |

* Conservatively assumes 100% reproductive success of adult females with parturition in mid to late June.