

BIOLOGICAL OPINION

of the

PROPOSED LAND RESOURCE MANAGEMENT PLAN HOOSIER NATIONAL FOREST, INDIANA ~2006~

**Submitted to the U.S. Fish and Wildlife Service
July 1, 2005**

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**Biological Opinion submitted to the U.S. Forest Service  
January 3, 2006**

Prepared by:  
Michael J. Tosick  
U.S. Fish and Wildlife Service  
Bloomington Field Office  
620 S. Walker St.  
Bloomington, IN 47403  
812.334.4261 x 218

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## **INTRODUCTION**

This document transmits the United States Fish and Wildlife Service's (Service) biological opinion based on our review of the Hoosier National Forest's 'Proposed Land and Resource Management Plan' (Forest Plan, or Plan) and projects predicated upon it, and its effects on the Indiana bat (*Myotis sodalis*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). The Forest Plan was submitted by The USDA Forest Service, Hoosier National Forest (HNF) and was received at the Service's Bloomington, Indiana Field Office (BFO) on July 7, 2005 along with a letter requesting us to initiate formal consultation regarding effects on the Indiana bat (*Myotis sodalis*).

This Biological Opinion (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 Programmatic Biological Assessment of the Hoosier National Forest Land and Resource Management Plan (2006);
- (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 Michael Tosick also visited several of the planned timber harvest areas, as well as several areas with known roost trees, in order to better evaluate the proposed Forest Plan. A complete administrative record of this consultation is on file at the Service's Bloomington, Indiana Field Office.

The Service will implement an appended programmatic consultation approach to the HNF Revised Forest Plan. Program-level consultation analyzes the effects of the Forest Plan as a whole. Specifically, we evaluate how the overall goals and objectives of the Forest Plan will affect the landscape in terms of Indiana bat conservation, and the anticipated impacts that may occur from implementing the proposed management actions for future projects. The second level of consultation will occur at the project level. For each project proposed, the Forest Service and the Service will evaluate the specific impacts associated with the project and tally any take that is anticipated to occur.

As future projects are developed, HNF will provide the Service with project-specific information that:

- (1) describes the proposed action, the area, and the species to be affected, including map(s) showing the proposed action area;
- (2) identifies the applicable standards and guidelines that will be implemented;
- (3) identifies the Forest's determination of effect on affected species for the proposed project and associated action area;
- (4) includes a statement confirming whether this project is in full compliance with the standards and guidelines and other conservation commitments made in the Forest Plan; and
- (5) includes a cumulative tally of incidental take that has occurred since the adoption of the 2006 Forest Plan, including a map showing the cumulative incidental take action areas.

Upon receiving this information, the Service will:

- (1) confirm that all species that may be affected are identified,
- (2) assess how the action may affect the species, including ensuring the level of effect is commiserate with the effects contemplated in the Program-level biological opinion, and
- (3) verify the tally the cumulative total of incidental take that has occurred to date under the Forest Plan.

During the review if it is determined that an individual project is not likely to adversely affect listed species, we will complete our documentation with a concurrence letter that refers to the Program-level biological opinion and specifies we concur that the project is not likely to adversely affect listed species. If it is determined that a project is likely to adversely affect listed species, the Service and Forest Service engage in formal consultation for the specific project. Project level formal consultation culminates with the Service providing a biological opinion that is appended to the Program-level biological opinion.

## **CONSULTATION HISTORY**

On September 14, 1984 the Service issued a Biological Opinion on the Proposed Land and Resource Management Plan for the Hoosier National Forest. A non-jeopardy opinion was included for the Indiana bat, gray bat (*Myotis grisescens*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*), however no Incidental Take Statement was included since it was concluded that no take would occur.

On July 30, 1990 the U.S. Department of Interior responded to the Hoosier National Forest request for comments on the Draft Environmental Impact Statement for proposed amendments to the Hoosier National Forest Land and Resource Management Plan (Forest Plan). Within that response was a discussion of the federally-endangered Indiana bat, gray bat, bald eagle, and pink mucket pearly mussel (*Lampsilis orbiculata*). The Peregrine falcon was not included because it

did not occur within the Hoosier National Forest at that time. It was concluded that the Forest Plan had adequate measures to protect the bald eagle and pink mucket pearly mussel. A number of guidelines were recommended for implementation to avoid take of the Indiana bat and gray bat. The Forest Plan amendment included those recommendations and stated that, "No destruction or adverse modification of critical habitat and no actions likely to adversely affect any federally-listed species will occur as a result of National Forest management decisions." The amendment and its included recommendations concluded consultation.

On April 17, 2000 the BFO received the request from the Forest Service initiating formal consultation for the continued implementation of the Forest Plan, as amended. A Biological Assessment was included with that request and it considered the federally-endangered Indiana bat, gray bat, bald eagle, and eastern fanshell mussel (*Cyprogenia stegaria*). The pink mucket pearly mussel was not included in that request because species experts believe, and the Service concurs, that the mussel is extirpated from within the proclamation boundary of the Hoosier National Forest.

During meetings and telephone conversations in October 2000 the Service advised the Hoosier National Forest that formal consultation under Section 7 of the Endangered Species Act on the continued implementation of the Forest Plan would not be necessary due to this statement in the Forest Plan: "No destruction or adverse modification of critical habitat and no actions likely to adversely affect any federally-listed species will occur as a result of National Forest management decisions."

On October 20, 2000, BFO received a letter from the Hoosier National Forest stating that since the Forest Plan was amended in 1991 Indiana bats have been captured on the Hoosier National Forest. That letter concluded that: "Based on this new information, we have found in the Biological Assessment that continued implementation of the Forest Plan may affect - likely to adversely affect individual Indiana bats using the Hoosier National Forest. We plan on amending the Forest Plan to incorporate the reasonable and prudent measures we expect to be developed from our formal consultation. When we amend the Forest Plan, we will modify the above statement to make it consistent with the Biological Assessment." Based on this information the Service agreed to complete the Biological Opinion.

On December 29, 2000, the BFO submitted the Biological Opinion stemming from the October 20, 2000 letter from the Forest Service. It was determined that the proposed action items, including road maintenance, trail maintenance and developed recreation facility management would not result in the alteration of Indiana bat habitat except for the need to remove hazard trees between April 15 and September 15. Hazard tree removal results in one or very few trees being cut from any one location within an otherwise forested landscape. It was determined that take of Indiana bats from this activity can only occur if a tree is cut when bats are present, between April 15 and September 15. Therefore, the determination was made that if trees are removed outside the time period when bats are present, the activity is not likely to adversely affect the Indiana bat.

On July 7, 2005, the BFO received the request from the Forest Service initiating formal consultation for the implementation of the newly crafted Hoosier National Forest Land and

Resource Management Plan. A Programmatic Biological Assessment (BA) was included with the requests and it considered the federally-endangered Indiana bat, gray bat, rough Pigtoe pearly mussel (*Pleurobema plenum*), and fanshell mussel, along with the federally-threatened bald eagle. Within the Forest Service's BA, only the Indiana bat received a "may affect, and is likely to adversely affect" determination; the other four species all received a "is not likely to adversely affect" determination. BFO concurred with these determinations for reasons described in the BA, and entered into formal consultation with the Forest Service on the Indiana bat and the proposed Hoosier National Forest Land and Resource Management Plan. A letter was sent on August 3, 2005 from the BFO notifying the Forest Service of the initiation of formal consultation. Accordingly, a deadline was set for November 20, 2005 (135 days from the date letter was sent) for the BFO to complete a Biological Opinion on the Hoosier National Forest Land and Resource Management Plan.

On November 4, 2005, the BFO received additional correspondence from the Forest Service requesting two major changes, and two clarifications in regard to their draft plan. The two changes were: increasing the hardwood even-aged management acreage from 5 to 10 acres per area in Management Area 2.8 (total even-aged management acreage does not change); and allowing mineral extraction and exploration with no surface occupancy in Crawford Uplands and Brown County Hills Ecotypes in Management Areas 2.8 and 3.3. The two clarifications were: defining snag and leave trees; and clarifying between early successional forest and early successional grass and shrublands. Initially, the BFO informally requested a full-schedule restart (135 days) in order to incorporate the changes into the Biological Opinion; however, in working together to meet Forest Service deadlines, the BFO and the Forest Service agreed to extend the due date for the BFO's Biological Opinion by five days (November 25, 2005).

## **BIOLOGICAL OPINION**

The action considered in this biological opinion is the implementation of the newly developed Hoosier National Forest Land and Resource Management Plan. Detailed descriptions of the proposed actions are provided in the Biological Assessment (Programmatic Biological Assessment of the Hoosier National Forest Land and Resource Management Plan, January 26, 2005); these descriptions are hereby incorporated by reference.

The purpose of the Forest Plan is to guide all natural resource management activities on the HNF to meet the objectives of federal law, regulations, and policy. The Forest Plan describes the landscape goals for the Forest for the next 10 years. To achieve the desired future conditions for the Forest and to reach these goals, various management activities will be applied. Thus, the Forest Plan identifies and describes the specific management actions that will be used. These management actions will be paramount in achieving the eight (8) overall goals identified within the Forest Plan. The management actions serve as tools, or mechanisms, that will allow the goals to be achieved. In effect, the goals are the "what", while the management actions are the "how".

## **FOREST SERVICE GOALS AND OBJECTIVES – FOREST PLAN**

*Conservation of Threatened and Endangered Species' Habitat* – Maintain, protect or improve the habitat for threatened and/or endangered species by working toward the goals and objectives of Federal recovery plans and management direction in the Forest Plan. One basic goal, or strategy, is to design projects in a manner that ensures management activities will not adversely affect habitat of threatened and/or endangered species.

*Maintain and Restore Sustainable Ecosystems* – The evolution of natural ecosystems over time provides variety in our natural world, and thereby provides the diversity needed in species and habitat to be resilient in the face of environmental disturbances. To be sustainable, each ecosystem must include viable populations of its component species. The main goal within this section is to restore and maintain plant and wildlife species and their habitat through varied resource management methods, including: emphasis on native plants and animals; tree stand maintenance focused on corridor availability and connectivity; protection of cave resources; use of prescribed fire; improve hydrologic connectivity and aquatic ecosystems; and the control and prevention of non-native invasive species.

*Maintain and Restore Watershed Health* – This goal reaffirms the historic mission of the Hoosier National Forest, as one of the driving forces in its establishment was to stabilize and restore eroding lands and to protect watersheds from sediment. The Hoosier National Forest will restore water quality and soil productivity to improve the condition of those watersheds impacted by past land use practices.

*Protect Cultural Heritage* – The goal of protecting heritage resources in order to share their respective values with society, as well as contributing relevant information and perspective to natural resource management. Goal(s) will be carried out through: identification and evaluation of resources; investigation, interpretation, and preservation of resources; interactive recreation; and proactive law enforcement.

*Provide Visually Pleasing Landscapes* - Forest management activities, roads, and facilities are to blend with their natural settings. With design, timing and care, minimal disturbance and disruption of the natural setting will occur. Long-term visual goals are not necessarily negated by short-term disruption of visual character.

*Provide Recreation Use in Harmony with Natural Communities* – The Forest fills a much-needed niche in Indiana by offering recreational experiences not readily available in a manner that is balanced with protecting the Forest's natural resources. Tangible results of this goal will be recreational opportunities such as long-distance trails for hiking, biking, or horseback riding, wilderness access, and water-based activities.

*Provide Useable Landbase* – The Forest strives to provide a landbase for biological diversity, recreational opportunities, management efficiency, and increased public access. The Forest is committed to acquisition and exchange programs to consolidate NFS lands and to protect significant cultural resources, areas of historical interest, and unique habitats.

*Provide for Human and Community Development* – The Forest meets certain individual, community and national needs such as clean water, minerals, recreational opportunity, timber, and wilderness values. The Forest contributes to local economies and provides commodities, products and services to people and local communities. Components of this goal will include: reduction of wildfires; provision of interpretive services; provision of a balance of forest products; and support of regional tourism development.

## DESCRIPTION OF THE PROPOSED ACTIONS

The Hoosier National Forest Land and Resource Management Plan includes the following management activities that may cause Indiana bat habitat modification and/or species harm and will occur over the next ten years:

**Figure 1.**

| <b>MANAGEMENT ACTIVITY</b>                   | <b>Forested Acres Affected</b> | <b>DESCRIPTION OF ACTIVITY</b>                                                    |
|----------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------|
| <b>Timber Harvest</b><br>(6,820 total acres) | 1,020                          | Hardwood clearcut harvest*                                                        |
|                                              | 1,000                          | Pine clearcut harvest**                                                           |
|                                              | 760                            | Hardwood shelterwood harvest                                                      |
|                                              | 80                             | Pine shelterwood harvest                                                          |
|                                              | 2,850                          | Hardwood group selection                                                          |
|                                              | 1,110                          | Hardwood single-tree selection harvest                                            |
|                                              | 600 trees                      | Hazard-tree removals (as required)***                                             |
| <b>Sanitation Harvest</b>                    | X                              | As needed to protect forest resources from potential pathogens                    |
| <b>Hardwood Salvage Harvest</b>              | 5,000                          | Response to strong wind, tornado, and other natural disturbance damage            |
| <b>Pine Salvage Harvest</b>                  | 1,200                          | Response to strong wind, tornado, and other natural disturbance damage            |
| <b>Timber Stand Improvement</b>              | 4,500                          | Includes grapevine removal; follows initial harvest                               |
| <b>Prescribed Fire</b>                       | 20,000                         | Manage plant communities for wildlife habitat improvement and forest regeneration |
| <b>Wildfire Suppression</b>                  | 500                            | Containment of naturally occurring wildfires                                      |
| <b>Forest Openings Maintenance</b>           | 825                            | Harvest of single trees to maintain existing openings                             |
| <b>Trail Construction / re-Construction</b>  | 2.5                            | 65 miles of new and re-constructed trails                                         |
| <b>Special Use Permits</b>                   | 300                            | Utility right-of-ways; re-issues and new****                                      |

| <b>MANAGEMENT ACTIVITY</b>                  | <b>Forested Acres Affected</b> | <b>DESCRIPTION OF ACTIVITY</b>                                                                                      |
|---------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------|
| <b>Road Construction / re-Construction</b>  | 267                            | 147 linear miles; includes maintenance, new construction and temporary roads                                        |
| <b>Construction of Landings</b>             | 75                             | Tree clearings for log landings in uneven-aged management                                                           |
| <b>Parking Lot / Trailhead Construction</b> | 45                             | Includes new construction and re-construction                                                                       |
| <b>Timber Operation Accidents</b>           | 1,000 trees                    | Estimates 1,000 trees lost due to inadvertent circumstances; for example, skidding of trees outside designated area |
| <b>Wetland Construction</b>                 | 25                             | Levee or dike construction                                                                                          |
| <b>Recreation Site Enhancement</b>          | 35                             | Site expansion, vista clearing, maintenance, or utility line installation                                           |
| <b>Herbicide Treatment</b>                  | 4,000                          | Control non-native/invasive species, re-establish native vegetation, control vegetation at recreation sites         |

- \* Hardwood clearcut areas will be limited to a maximum of 10-acres in MA 2.8.
- \*\* All clearcut areas will be limited to a maximum of 10-acres, except in Management Area 3.3, where the maximum size is extended to 40-acre tracts.
- \*\*\* Involves removal of hazard trees in the vicinity of trails, roads, or recreation sites. Approximately 600 trees are estimated within this management activity.
- \*\*\*\* Tree removal will not reflect total acreage, as individual permits involve limited acreage over linear features that are typically sparsely forested, including existing roads.

## **FOREST SERVICE STANDARDS AND GUIDELINES**

Within the Proposed Land and Resource Management Plan the Forest Service has adopted standards and guidelines that will help in the protection of the Indiana bat from both direct negative fitness consequences and habitat loss.

**Standards** – Actions that *must* be implemented in order to achieve Forest goals and objectives. Deviation from a standard requires an amendment to the Forest Plan.

Standards relevant to *conservation of threatened and endangered species habitat* include:

- Evaluate lands affected by change of ownership and evaluate management activities to avoid or minimize effects on Federally-designated threatened and endangered species habitat.
- Identify lands with known threatened or endangered species habitat as a top priority for acquisition.

Standards relevant to *Indiana bat hibernacula* include:

- Establishment of quarter-mile radius zone around each known hibernacula within the Forest. The zone will be designed according to the specific area in order to take into account likely flight paths, foraging habitat and likely swarming areas. New construction is prohibited in this area.
- Maintenance and promotion (considering private land ownership) of at least 70 percent forest canopy cover within a radius of one mile of known Indiana bat hibernacula. Timber harvest should be conducted within this zone strictly during hibernation and will utilize *only* single-tree or group selection techniques.
- Implementation of prescribed fire within a five-mile zone around hibernacula will only occur when bats are not likely to be swarming or staging. Burns will be conducted only under conditions that will reduce or eliminate smoke dispersing into hibernacula.
- Develop management goals and directives (conservation plan) for each known hibernaculum at micro-topographical level, taking into consideration current conditions and future restraints and/or challenges.

Additional *cave* and *karst* feature standards:

- No timber harvest or prescribed burn within 200-feet of cave entrances, sink holes, swallow holes or streams flowing into such known areas.
- No discharge of drilling mud into karst hydrological system(s).
- No disturbance on slopes greater than 30% adjacent to cave entrances without the use of mitigation measures.
- No promotion of caves for general use to public without protective measures.
- No seismic surveys within 200 feet of known cave passages or conduits.
- No disclosure of cave locations.
- Cave management will be integrated into general land management practices.
- Inventories and evaluations of caves will be performed in accordance with the Federal Cave Resources Protection Act.
- All caves and karst features shall be excluded from leasing and mineral activities, and no drilling will occur within the boundaries of ant cave.

Standards relevant to *Indiana bat maternal roosting habitat* include:

- Maintenance of large, mature trees in harvest areas. At least three (3) live trees per acre greater than 20 inches diameter at breast height (DBH) (leave trees will be located along edges of the harvest area or in clumps to maximize their benefit to bats) of these species: silver maple (*Acer saccharinum*); bitternut hickory (*Carya cordiformis*); shellbark hickory (*Carya laciniosa*); shagbark hickory (*Carya ovata*); white ash (*Fraxinus americana*); green ash (*Fraxinus pennsylvanica*); eastern cottonwood (*Populus deltoides*); white oak (*Quercus alba*); northern red oak (*Quercus rubra*); post oak (*Quercus stellata*); black locust (*Robinia pseudoacacia*); American elm (*Ulmus americana*); and slippery elm (*Ulmus rubra*).
- If stand has no trees greater than 20 DBH, at least 16 live trees per acre will be retained through harvest, including the largest specimens of the preceding preferred species list.

- Shellbark and Shagbark hickories will not be harvested or manipulated for the purpose of timber stand improvement, unless the density of trees of these two species combined exceeds 16 trees per acre. If present, at least 16 live shagbark and shellbark hickory trees (combined) greater than 11 inches DBH *must* be maintained per acre.
- Retention of all hazard trees that have characteristics of a potential maternal roost tree unless they are a safety concern.
- Consultation will occur with the USFWS any time a hazard tree is identified as being used by bats.
- Firewood cutting permits will clearly state that standing dead trees must be identified in the Forest Service permit in order to be harvested. Standing dead trees *must* be identified and designated by Forest Service personnel to be included in the permit.
- Demolition of any abandoned buildings will *only* occur after all buildings are inspected to confirm the absence of maternal roosts. If a roost is located, then all activity will be delayed until the roost is vacated and suitable roosting structures have been provided.

Standards relevant to *Indiana bat foraging habitat* include:

- Maintenance of at least a 60 percent canopy cover (stand-by-stand basis) when conducting uneven-aged harvest or hardwood timber stand improvements. Design of boundaries will be irregular in shape so as to enhance foraging area for bats.

**Guidelines** – Actions that should be implemented in order to achieve Forest Service goals and objectives. Deviation from a guideline does not require an amendment to the Forest Plan, but the rationale must be disclosed in the project decision documents.

Guidelines relevant to *conservation of threatened and endangered species habitat* include:

- Determine and implement management activities that will maintain and improve habitat features for threatened and endangered species.
- Locate new activities away from areas that might jeopardize<sup>1</sup> any threatened or endangered species or their habitat.

Guidelines relevant to *caves* and *karst* features:

- Cease drill activities when voids are discovered within 300-feet of the surface.
- Protect caves and karst features from road sediment.
- Examine and inventory each cave and karst feature.
- Restore cave and karst hydrological systems choked by non-natural causes.
- Take corrective action if damage to karst or other resources exists and is likely to continue.
- Cave entrance gates will only be used as last resort if no other protective alternative is practical and/or available.

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<sup>1</sup> Quoted from the Forest Service's "Proposed Land and Resource Management Plan"; not necessarily the same meaning as taken from the Endangered Species Act

- No marking of caves so as to promote or dissuade use.

Guidelines relevant to *Indiana bat maternal roosting habitat* include:

- When possible, the removal of hazard trees will be delayed until between September 15th and April 15th, the likely hibernating period of the Indiana bat.
- All personnel tasked with the removal of hazard trees will attend training with a biologist to learn how to identify potential maternal roost trees.
- When even-aged management is conducted, leave trees will be left along the edges of clearcuts or in large clumps (1/10th acre) to maximize their benefit to bats.
- Assessment of the availability of suitable primary maternal roosts during the planning phase of single tree or group selected timber harvest. If potential primary roosts are located, gaps will be created at the tree's borders through harvest design to improve their suitability as roost trees.
- When there are not at least three standing dead trees greater than 11 inches DBH per acre during single-tree or group selection harvest, consider girdling live trees.
- In the event that an occupied primary roost is located on Forest land, a zone will be designated extending in a radius of 300 feet from the known roost. Land management activities will be prohibited within this zone during the active period (April 15<sup>th</sup> – September 15<sup>th</sup>) of the Indiana bat.
- Restriction of prescribed burns within a one-mile radius of occupied roosts during active period.

Guidelines relevant to *water resources* include:

- When conditions are favorable, creation of shallow water extensions of existing waterholes and ponds to enhance insect diversity and abundance for bats will be promoted.
- Constructed ephemeral and vernal wetlands will be provided in forested uplands or along ridgetops to serve as additional water sources for bats. When possible, abandoned roadways that may serve as flight corridors will be utilized for the location of constructed upland wetlands.

## **BRIEF ANALYSIS OF MANAGEMENT ACTIONS WITH SPECIAL REFERENCE TO *MYOTIS SODALIS***

***Timber Harvest*** - The Hoosier National Forest plans on using both even-aged and uneven-aged harvest management to meet forest objectives.

*Even-aged techniques* (including clearcutting) are appropriate where a single-aged stand is desired, or to give desirable shade-intolerant species, such as oaks and hickories, a competitive edge over shade-tolerant species, such as beech and maple. Furthermore, even-aged harvests may result in within-stand canopy closures of below fifty percent, thereby creating early-successional forests (0-9 year age class). Early-successional forests provide an abundance of herbaceous annual and perennial plants which support varied insect communities, and in turn

provide an available food bank for a host of animals, including bats. Cavity trees and standing dead trees (snags) are not removed under even-aged harvest unless they pose a safety hazard to the public or to timber harvest operators, thereby protecting primary, secondary, and potential<sup>2</sup> Indiana bat roosting habitat. Although the overall imprint of even-aged management upon the landscape would be minimal, creation of early-successional areas may result in the short term loss of potential alternate roosts and the loss of potential foraging areas for the Indiana bat.

The availability of alternate roosts is not a limiting factor within the Hoosier National Forest, so this effect is not substantial. Primary roost recruitment will be impacted within even-aged harvest areas, although primary roost recruitment on the edges of these harvest units may improve due to increase of solar exposure. Callahan (1997) and MacGregor, et al (1999) both found that primary snag selection greatly favored high solar exposure.

In regard to pine harvest, the primary objective of even-aged management, specifically clearcuts, is to re-establish native hardwood forest types. Pine harvests will remove most, if not all, of the pines in a stand while leaving residual hardwoods, and snags. Specific to bats, pine plantations provide poor foraging habitat when compared to hardwood riparian areas, forest edges, and canopy gaps. Consequently, the removal of pines is equivalent to the removal of relatively poor foraging habitat for the purpose of re-establishing a forest type of superior quality. Furthermore, pine snags, when compared to native, deciduous snags, offer substantially less roosting habitat for Indiana bats, especially when the ephemeral nature of pine snags is considered. Kiser and Elliot found that, in Kentucky, roosts were located predominately in medium-sized hardwood snags within small forest openings or canopy gaps (1996). However, also in Kentucky, MacGregor, et al. (1999) reported that male Indiana bats roosted in pine-dominated forests during the autumn.

*Uneven-aged techniques* typically maintain the appearance of continuous forest canopies and a gradient of tree ages within stands. The principal objective of uneven-aged harvest will be to promote structural diversity within hardwood stands. Contrary to even-aged harvest methods, uneven-aged harvest will favor the regeneration of shade-tolerant species such as American beech (*Fagus grandifolia*) and maple (*Acer spp.*).

Uneven-aged techniques include group selection harvest and single-tree harvest. Group selection harvests will be limited to 3-acres, or less. The size of a group selection harvest is generally defined as approximately twice the height of the surrounding trees; therefore, harvest size will be determined at the site-specific project level. Uneven-aged harvests, whether by single-tree method or group selection, will reduce canopy closure, mimicking natural gap formation in old growth forests, resulting in multiple age classes of trees within stands. The creation of small canopy gaps, as a result of these harvest techniques, will likely improve foraging habitat, as reduced crown closure is considered suitable habitat for the Indiana bat. Although harvest by either method will remove potential alternate roosts, the availability of these roosts are likely non-limiting on the Hoosier National Forest.

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<sup>2</sup> Primary roosts are trees that are used by more than 30 bats on more than one occasion; alternate roosts are used by fewer individuals; potential roosts have the characteristics of primary or alternate roosts, but are not used. All three roost types are essential to meet maternity requirements of *Myotis sodalis* (Callahan, et al 1997).

**Salvage & Sanitation Harvest** – Salvage and sanitation harvests are similar in that they are used in order to limit the spread of disease and insect infestation, remove dead or damaged trees, and respond to areas affected by fire and/or storm damage (wind, ice, etc.). Salvage and sanitation harvest will likely reduce canopy closure, thereby improving potential foraging habitat. Furthermore, potential roost trees will likely be more available and abundant in these areas since dead or damaged trees are often synonymous with snags.

**Prescribed Fire** – The Hoosier National Forest proposes to conduct prescribed burns over 20,000-acres within the initial decade of the proposed Forest Plan. Prescribed fire will be used to improve wildlife habitat, enhance forest regeneration, and to manage fuel loads. Burns are conducted under conditions that result in low-intensity fires, generally burning only ground cover, shrubs, and trees with dbh < 2 inches. Wildfire Suppression also involves burning sections of the forest in order to contain the wildfire; 5,000-acres are proposed within the initial decade. Although smaller in size, these smaller burn areas will react in the same manner as the larger prescribed burn areas, and will therefore have similar effects on Indiana bats and their habitat.

Use of prescribed fire may improve forage and roost habitat for forest bats. Insect biomass, although initially reduced in burn area, will subsequently increase as the re-growth of herbaceous vegetation occurs. This is likely related to nutrient release and the resulting increase in herbaceous forage quality. Roosting habitat will also likely improve in the long-term, since few snags will be lost under low-intensity fires, and a small number of new snags will be created.

## **STATUS OF THE SPECIES – (*Myotis Sodalis*)**

The Indiana bat is a species that continues to decline since being listed as an endangered species in 1967. Recovery of this species faces several challenges and there are multiple biological reasons why the outlook for this species may be unfavorable. The well-documented philopatric<sup>3</sup> behavior of Indiana bats suggests that loss of roosting habitat alone can have adverse consequences (Kurta and Murray 2002; Gumbert et al. 2002). Healthy female bats start breeding their first fall and can produce one pup per year for up to 14-15 years (Humphrey et al. 1977). However, this current reproductive capacity has been insufficient to offset mortality rates over the last 40+ years, therefore, Indiana bat populations have plummeted.

**Description and Distribution** - The Indiana bat is a medium-sized bat (head and body length that ranges from 41 to 49 mm), closely resembling the little brown bat (*Myotis lucifugus*) but differing in coloration. There are no recognized subspecies. The Indiana bat has been found in 27 states throughout much of the eastern United States (USFWS 1999). More specifically, NatureServe (2004) describes its range as going from eastern Oklahoma, north to Iowa, Wisconsin, and Michigan, east to New England and south to western North Carolina, Virginia, and northern Alabama. It is virtually extirpated in the northeastern United States. The Indiana bat is migratory, and the above described range includes both summer and winter habitat. Major populations of this species hibernate in Indiana, Kentucky, and Missouri, with smaller

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<sup>3</sup> Characterized by staying put; offspring do not disperse; exhibiting site fidelity; the drive or tendency of an individual to return to, or stay in, its home area.

populations reported in Alabama, Arkansas, Georgia, Illinois, Maryland, Mississippi, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia. The majority of maternity colonies are located in the glaciated Midwest. 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. More than 85% of the entire known population of Indiana bats hibernates in only nine caves.

**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 (IDNR unpublished, NatureServe 2002). 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, sugar maple (*Acer saccharum*), shagbark hickory, shellbark hickory, bitternut hickory, green ash, white ash, eastern cottonwood, northern red oak, post oak, white oak, shingle oak (*Quercus imbricaria*), slippery elm, American elm, and sassafras (*Sassafras albidum*) (Rommé et al. 1995). At one site in southern Indiana, black locust 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 numbers becoming substantial by 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). 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 (BLA 2003). Swarming continues for several weeks and copulation occurs on cave ceilings near the cave entrance during the latter part of the period. (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. 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 (NatureServe 2002). Like other cave bats, the Indiana bat naturally arouses at intervals of 7-14 days (Dr. John Whitaker, Jr. – personal communication) 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 Winter and in early April as bats emerge (USFWS 1999).

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 miles 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.

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 males. The timing of annual emergence may vary across their range depending on latitude and annual weather conditions. Shortly after emerging from hibernation, females become pregnant via delayed fertilization from the sperm that has been stored in their reproductive tracts through the winter (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 north for the summer, although other directions have been documented (USFWS 1999). A stronger homing tendency has been observed along a north-south axis, than the east-west direction in release studies (NatureServe 2002). Females can migrate hundreds of

miles north of the hibernacula. In spring staging, males have been found almost 10 miles from their hibernacula (HNF 2000). Less is known about the male migration pattern, but many males summer near the hibernacula (Whitaker and Brack 2002).

**Energy Balance** - Bats, like all animals, must maintain a positive energy balance. Bats face energetic challenges in balancing their need to regulate their body temperatures to remain active and build up fat reserves for migration, reproduction, and hibernation against the costs of maintaining a high body temperature. Factors that exacerbate these energetic challenges can substantially impact reproductive success and survival of individuals.

Maintaining their energy budget is exacting under normal conditions, especially for reproductive females. Indiana bats must give birth, feed their young, and obtain sufficient body mass to migrate back to their hibernacula within a 4 month period. Increased energy is needed to elevate biosynthesis<sup>4</sup> to support processes such as pregnancy and lactation. During pregnancy and lactation, changes to body composition are needed (e.g., develop mammary tissue and increases in the size of the stomach and liver to process increase in food intake). Also, both pregnancy and lactation involve the direct transfer of energy from the parent to offspring in the form of sugars, protein, and fats for growth. Lactation, in particular, is costly in terms of energy consumption. (Racey and Entwistle 2000).

Responses to unpredictable perturbations<sup>5</sup> exacerbate the energy demands of the exposed individuals beyond what is required to maintain homeostasis during their normal activities. Animals have limited options for meeting this increased energy demand and maintaining homeostasis. Increasing food intake is a first response to increased energy needs. However, sometimes it is not possible or energy-efficient to compensate for the increase energy demand. In these situations, bats may enter into torpor. While in a torpor state, the heart and metabolic rates decrease, body temperature decreases, and chemical reactions within the body slow thereby reducing energy and thermoregulatory needs.

Although torpor is a physiological state that allows bats to compensate for adverse conditions, it has consequences. Slowing metabolic processes retards reproductive processes such as milk production and spermatogenesis, and as further explained below, delays in reproductive stages may affect survival and reproductive potential of such individuals. Additionally, during torpor, bats rely on stored fat to maintain a lower body temperature (Lyman 1970). Fat reserves are essential for successful migration, reproduction, and hibernation. If torpor is prolonged, fat reserves will decline and the time available for restoring these critical reserves is also reduced. Thus, torpor is a mechanism to help bats cope with adverse conditions, but it must be used judiciously.

Extended torpor periods ultimately lead to less time to forage, which means less time to obtain fat reserves. Lower body mass may compromise their ability to successfully migrate to their hibernacula and survive hibernation. Torpor, which lowers body temperatures and slows metabolic processes and chemical reactions (associated with maintaining adult physiology and young development), reduces energy demand. Slowing these processes, however, also slows

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<sup>4</sup> Formation of a chemical compound by a living organism

<sup>5</sup> Small change in a physical system

embryonic growth, thus extending time to parturition<sup>6</sup> (Racey 1973). Similarly, torpor reduces milk production (Wilde et al. 1995, Wilde et al. 1999), thereby reducing the nourishment available for pups and slowing postnatal growth (Racey and Entwistle 2000). Both scenarios can limit the time available for maternal recovery and fat accumulation post-weaning. Delays in migration departure could subject bats (both young and adults) to unfavorable winter conditions along the way.

Similarly, extended torpor periods severely limit the energy income that bats require to maintain pre- and postnatal young. Delay in pre- and postnatal development can also affect juvenile survival and reproductive potential. Slowed growth rates during pregnancy and lactation may mean later weaning dates and smaller young, both of which affect juvenile survival (Ransome 1989). Later weaning dates leave less time for young to perfect their flying and foraging skills, which in turn, affects their ability to maintain their body condition and store fat and obtain adequate strength to successfully migrate in the fall. Further, as a minimum fat-to-lean mass ratio may be needed to successfully reproduce, delays in weaning time may also, in a similar manner, affect the future reproductive potential of juveniles.

To maintain homeostasis under extreme situations, females may be forced to reabsorb or abort their embryos or to abandon their non-volant young. Prenatal development and length of gestation in bats varies in response to temperature and food availability (Racey 1973, Tuttle and Stevenson 1982). When food is insufficient to support a continued pregnancy, a trade-off is necessary between maternal survival and her future reproductive potential and that of her current offspring (Wasser and Barash 1983).

***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) constitute 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). 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.).

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<sup>6</sup> Act, or process, of giving birth

**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). 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 50° F (10° C) or below (USFWS 1999). Mid-winter temperatures range from 39 to 46° F (4 to 8° C) (USFWS 1983b); however, recent data in Indiana has recorded increased use of hibernacula ranging from 41 to 44.5° F (5 to 7° C) (Brack, Jr. per. comm.). Only a small percentage of caves available meet these temperature requirements (Brack et al. 2003). 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: little brown bats (*Myotis lucifugus*) and eastern pipistrelles (*Pipistrellus subflavus*); northern long-eared bats (*Myotis septentrionalis*); and gray bats (*Myotis grisescens*), big brown bats (*Eptesicus fuscus*), and silver-haired bats (*Lasionycteris noctivagans*) (Brack et al. 2003).

**Habitat: Female Summer Roosting Habitat** - 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). 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 hibernation, 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 nearly always 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. In trees, cavities may be rarely used and crevices are occasionally 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 old forests with large trees, scattered canopy gaps, and open understories (USFWS 1999, HNF 2000). 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). Several roosts have been located near lightly traveled, low maintenance roads (HNF 2000), 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; living species of hickories and large white oaks with shaggy bark. Cottonwoods are probably one of the best tree species for the purposes of roosting. 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, cottonwood, Green ash, oaks, and hickories may provide habitat 4-8 years (USFWS 1999).

Indiana bat roosts are ephemeral and frequently associated with dead or dying trees. Most roost trees may be habitable for only 2-8 years (depending on the species and condition of the roost tree) under natural conditions. Gardner et al. (1991) 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. 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). 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. Shagbark hickories are good alternate roosts because they are cooler during periods of high heat and tight bark shields the bats from rain (USFWS 1999). Weather has been found to have profound influence on bat behavior and habitat use (Humphrey et al. 1977).

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). Female Indiana bats have been documented using roost trees as small as 5.5 inches (USFWS 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 exposure 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 with characteristics 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.

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, northern myotis (*Myotis septentrionalis*), little brown myotis, Indiana bat, and eastern pipistrelle. 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 roost (Kiser et al. 2002).

***Habitat: Male Summer Roosting Habitat*** - 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 too 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 (HNF 2000). 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 are 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). 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 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. (1991) 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).

### **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. 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 the loss of a maternity colony on a National Forest. The reasons for this are likely two-fold. First, the conservation measures (i.e., standard and guidelines) and 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. Second, monitoring has not been carried out to the extent that the take of a maternity colony would likely be captured if it did occur.

*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, none of these biological opinions and associated incidental take statements anticipated the loss of a maternity colony. Required monitoring for 3 of these projects (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 the long life-span, 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 consultations has resulted in adverse 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.

***Range-wide Status*** - Historically and currently, the Indiana bat geographic range encompasses 27 states, with the majority of records from the Midwest. Although there is no administrative record, it is believed that the species was listed because of observed declines in numbers. 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, extensive staining left on the ceilings of several historic hibernacula, and other paleontology-based evidence (Toomey et al. 2002). There is also other evidence indicating that Indiana bat

numbers were once much higher. Based on a deposit of bones, it is estimated that a minimum of 300,000 Indiana bats were killed by a flood in Bat Cave, Edmonson County, Kentucky in 1937 (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.

Hibernacula counts at a sample of known hibernacula began in 1960 and were repeated at approximately 10-year intervals. Beginning in the early 1980s, biennial counts at several known hibernacula were conducted, and in 2001, a concerted effort to track numbers at all known and accessible Priority 1 and 2 and most of Priority 3 hibernacula began. In 2002, the recovery team leader, using these data and host of assumptions (e.g., similar methodologies over time and among hibernacula, using current densities to estimate past numbers at newly found caves, assuming unchanged densities at hibernacula no longer accessible, etc.) compiled population estimates at 10-year intervals. Despite the many limitations associated with the dataset, Clawson's (2002) compilation shows a marked decline in estimated numbers over time. Estimated Indiana bat numbers declined each decade since 1960: ~883,300 Indiana bats in 1960/1970; 678,700 in 1980; 473,500 in 1990; 382,300 in 2000/2001. However, population data compiled by King (U.S. Fish and Wildlife Service) shows an increase in 2003 and 2005, as the range-wide population was estimated at 392,893 and 458,332 for those years, respectively. Upon further analysis, Clawson found that the decline was not evenly distributed across the winter range. The population in the southern portion of the range decreased an estimated 80% in the 40 years from 1960 to 2001, with the largest declines observed in Kentucky and Missouri hibernacula. In contrast, the population in the northern Midwest and Northeast increased by 30%. Clawson also indicated that the last estimated inter-decadal hibernation count suggests that the rate of decline has slowed. From 1960/1970 to 1980, the estimated population numbers decreased by 23 percent; from 1980 to 1990 by 30 percent; and from 1990 to 2001 by 19 percent.

The results from the 2001 to 2005 biennial counts suggest that at least for this 5-year period, the extreme decreases observed in each previous decade may not occur this decade. From 2001 to 2003 and 2003 to 2005, increases (4.2% and 16.7%, respectively) in the estimated numbers were observed (King). Although the observed increases are encouraging, we are uncertain of what the future population trend will be and vulnerability of the current population.

***Indiana Status*** - 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, and 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. Declines in specific caves were attributed to improperly designed cave gates and excessive visitation; as these problems were rectified, the population of those caves increased.

In regard to summer populations, less is known since it is much more difficult to locate a maternity colony, or a singly roosting male, when compared to locating and counting bats within a hibernaculum. Furthermore, it is very difficult to estimate population numbers from singly captured individuals; it should be noted that the capture of a pregnant, lactating or post-lactating

female, or juveniles, is an indication of reproduction in the immediate area. Brack et al (2004) found that although wooded habitats are plentiful on the HNF, no evidence of reproduction was found. They concluded that, although this does not preclude the presence of maternity colonies on the HNF, they are apparently less abundant than in other portions of the range. During summer, adult males frequently remain geographically close to winter hibernacula (Whitaker & Brack 2002), and Brack et al (2004) captured six (6) adult males during summer netting on the HNF. It is likely that these males also hibernate on or near the HNF.

Whitaker and Brack (2002) concluded that more Indiana bats hibernate in Indiana than in any other state, and that it is likely that more Indiana bats spend the summer in Indiana than in any other state. Females disperse from hibernacula, generally northward, and form maternity colonies throughout most of Indiana and southern Michigan, and possibly in Ohio and Illinois, as well. Based on Whitaker and Brack's estimated maternity colony size (80 adult females), there are enough females hibernating in Indiana (103,305 +) to form 14 maternity colonies in each of the 92 counties, if evenly distributed.

## **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 Area and the present effects within the Action Area 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 Hoosier National Forest.

The Action Area includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). 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 Action Area is not limited to the "footprint" of the action, but rather encompasses the biotic, chemical, and physical impacts to the environment resulting directly or indirectly from the action.

The Action Area for the Forest Plan is the area that encapsulates the reach of all the direct and indirect environmental impacts of the project. That is, the area in which the biotic, chemical, and physical impacts to the environment that are anticipated to occur. The Action Area for the Forest Plan will encompass the entire HNF proclamation boundary plus lands one mile outside of the proclamation boundary for HNF lands that abut the boundary.

The area directly affected by the action is the HNF property where all management activities will occur. The HNF is comprised of 199,150 acres within a 644,130 acre proclamation boundary in nine (9) southwestern and southern Indiana counties: Brown, Monroe, Lawrence, Jackson, Martin, Orange, Crawford, Dubois and Perry. The proposed Forest Plan only covers management activities to occur on the existing 199,150-acres.

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 will vary depending upon the methods and equipment being used or operated, but 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). The proposed I-69 “new terrain” expansion, if implemented, will be routed through a portion of the Action Area. 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. Thus, the Action Area encompasses the entire proclamation boundary and extends out 1 mile around the perimeter of that boundary.

### **Myotis sodalis within the Action Area**

A potential Indiana bat maternity colony was discovered by a HNF biologist in the Celina Lake Campground during an evening emergence survey of a hazard tree (a dead American elm, *Ulmus Americana*) on 4 August 2005 (personal communication with Clark McCreedy, HNF 2005). Approximately 30 bats were counted as they emerged from beneath sheaths of loose bark on the snag. Some fecal pellets (i.e., guano) were collect and submitted for fecal DNA analysis to determine what species of bat was roosting in the tree. The DNA analysis was completed in November 2005, and it was discovered that these were Indiana bats. This snag was located over a campsite and was later felled by Forest staff after September 15<sup>th</sup> as allowed within the current BO. This maternity colony is located within Management Area 3.3, which will utilize even-aged timber harvest techniques to convert this section of Forest from pines to native hardwood species. It is likely that no direct harm was done to this roosting population, or to individuals, since the tree was felled after September 15<sup>th</sup>, and biologists conducted emergence counts up to several days before the tree was felled, confirming that bats were no longer using the tree as a roost.

Brack and Whitaker (2002) did find that evidence of reproduction (pregnant, lactating, post-lactating females or juveniles) was spread evenly amongst counties around the state, although the only county (out of nine counties) where females were captured that contains portions of the HNF was Martin County, with four occurrences. It is likely that these females were part of the same maternity colony, since they were all captured within close proximity to one another. Males were distributed more in the southern counties of the state, and captured within five (5) counties containing portions of the HNF (with 14 occurrences total): Monroe; Lawrence; Martin; Crawford and Perry. This leads to the conclusion that in regard to summer habitat, the HNF might be more limiting to female bats than to male bats.

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. The first reproductive (post-lactating) adult female Indiana bat to be captured on the HNF was captured 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 led 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. Monitoring of the roost was conducted in 2004 from the date of its discovery until all bats had departed in the fall of 2004. Nearly 90 bats were documented using this roost. (Clarke McCreedy, pers. comm.) Monitoring was begun initially in the spring of 2005, but the tree was eventually lost in a windstorm in early summer 2005. Rocket boxes were installed as potential replacements by HNF biologists.

Prior to these and other recent surveys in southern Indiana, it was known that adult male Indiana bats could be found throughout Indiana in summer, but it was unclear if southern Indiana supported maternity colonies of Indiana bats. 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 Indiana, which includes the Hoosier National Forest, during the summer (Brack 1983, Brack et al. 1987); however, the number of records is growing. 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 and 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 (3D/I 1998). Tyrell and Brack (1990) reported that there are records for reproductive females or juveniles in Knox, Martin, and Ripley counties. In 2004, extensive mist netting along the proposed corridor for I-69 led to the discovery of approximately 13 “new” Indiana bat maternity colonies between Indianapolis and Evansville. Collectively, these records provide evidence that southern Indiana is clearly within the maternity range of the Indiana bat.

Based on the capture of male and female Indiana bats on the Tell City District of the HNF and other recent evidence of Indiana bat presence in southern Indiana the Service concurs with the BA’s conclusion that Indiana bats may be present in all suitable habitat within the Hoosier National Forest. Furthermore, the Service believes that based on the evidence provided here, the relatively limited geographic coverage of mist netting efforts on the HNF, and the expansive acreage of suitable habitat on the Forest, that it is reasonable to assume that additional maternity colonies of Indiana bats are present on the HNF and may be utilizing roosting and foraging habitat throughout the Forest.

The Indiana Natural Heritage Database (July 2003), maintained by the Indiana Department of Natural Resources (IDNR) Division of Nature Preserves, lists a total (hibernacula and summer roosts) of 57 recorded Indiana bat occurrences within southwestern Indiana. These occurrences range in time from 1896 to 2001, with a majority recorded after 1990.

Indiana bats hibernate in caves and mines (hibernacula) across their range that meet their narrow temperature requirements (3 to 6°C). Within the HNF, two caves, Bluff House Cave and Gypsy Bill Allen Cave, are known to contain hibernating Indiana bats (Brack and Dunlap, 2003). In 2003, a single hibernating Indiana bat was found within Bluff House Cave, and 250 hibernating Indiana bats were found within Gypsy Bill Allen Cave. There is no designated critical habitat on

the HNF. The closest Priority One<sup>7</sup> hibernacula are Ray's Cave in Greene County (18 miles from HNF) and Twin Dome Cave in Harrison County (10 miles from HNF). Wyandotte Cave in Crawford County (8 miles from HNF) is a Priority Two<sup>8</sup> hibernacula. Ray's Cave and Wyandotte Cave are listed as critical habitat for the Indiana bat. In addition, there are seven (7) other Priority Two hibernacula between one (1) and ten miles from the HNF. Since there are a number of Indiana bat hibernacula within ten miles of the HNF, and the Indiana bat is a relatively wide-ranging species, it is probable that many parts of the HNF are used by male Indiana bats for roosting and foraging in the spring and fall. Additionally, because a majority of the Action Area lies outside the HNF, and is held and managed by private entities, it is not known how many more hibernacula exist within the Action Area on private property. However, it is likely that since much of the area is similar topographically, there are likely unknown hibernacula within the Action Area, outside the HNF.

## **EFFECTS OF THE ACTION(S)**

The appended-programmatic approach incorporated herein incorporates two levels of analysis. The first level of analysis evaluates the actions and effects at the program level, or how the overall goals of the Forest Plan will affect the species across the landscape and over the long term. The second level of analysis evaluates the actions and effects at the management level, or how specific future actions (projects) may affect the species. Analysis will include a discussion of direct and indirect effects of each management action to the listed species.

One factor that makes it difficult to analyze potential effects to Indiana bats is the abundant uncertainty surrounding the species. There is much that is unknown about the Indiana bat life history. Although we know Indiana bats select hibernacula based on winter temperature ranges, and roost trees mostly because of abundance of solar exposure, it is still not known how readily adaptable they are when their selected hibernacula or roosts are altered and/or degraded. Migration routes and stop-over areas are also largely unknown. Home range sizes vary greatly across the overall range of the species. Interspecific and intraspecific competition for resources with other bats is also largely unknown, although limited information exists, at least anecdotally. Threats from pesticides and other chemicals are also uncertain. However, it is possible to glean likely effects from certain forest management actions by applying what we do know about roost selection, hibernacula selection and activity periods, for instance.

### **Effects of the Implementation of the 2006 Forest Plan Goals and Objectives**

The goals of the 2006 Forest Plan include: (1) conservation of threatened and endangered species habitat; (2) maintain and restore sustainable ecosystems; (3) maintain and restore watershed health; (4) protect cultural heritage; (5) provide visually pleasing landscape; (6) provide recreation use in harmony with natural communities; (7) provide useable landbase; and (8) provide for human and community development. These goals have been described in a previous section.

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<sup>7</sup> Hibernation sites with recorded populations of more than 30,000 bats.

<sup>8</sup> Hibernation sites with recorded populations between 500 and 30,000 bats.

Maintaining, enhancing or restoring sustainable ecosystems, including open woodlands, closed woodlands and upland forest will likely create diverse habitats suitable for roosting and foraging Indiana bats. Timpone (2004) suggests that Indiana bats may respond positively to habitat enhancement that opens the canopy, increase forest edge, and creates/maintains snags.

The protection and conservation of soils, watersheds and water quality will likely benefit Indiana bats by providing clean water for drinking and healthy aquatic systems that produce healthy aquatic prey items. LaVal (1980) and Krusac and Mighton (2002) assert that Indiana bats need drinking water that is not degraded. This management goal should provide for clean water.

The remaining goals, protecting cultural heritage, providing visually pleasing landscapes, providing recreation in harmony with natural communities, providing a useable landbase, and providing for human and community development, are all geared towards providing for multiple uses and users across the Forest. All of these actions provide for the maintenance or creation of a diversity of habitats that may become or will remain suitable for roosting or foraging Indiana bats. Per the Standards and Guidelines, suitable roosts must be maintained in all harvests on the Forest including regeneration harvests (i.e. clearcut, shelterwood, salvage, etc.).

We believe that the overall goals and objectives of the 2006 Forest Plan for the HNF are consistent with the habitat needs of the Indiana bat. Suitable roosting and foraging opportunities will be maintained across the HNF with the implementation of this plan. However, there are effects associated with implementing the Forest Plan that must be considered.

### **Effects of Implementation of the Types of Management Actions Proposed to Accomplish Forest Plan Goals and Objectives**

Although the overall goals of the proposed action are expected to have beneficial effects for the Indiana bat, the means by which the Forest will achieve their goals may unavoidably cause short-term adverse effects to this species. Direct and indirect effects to the Indiana bat could occur with the implementation of the 2006 Forest Plan. Direct effect is defined as actions that cause immediate negative response in individuals, including, but not limited to, causing the death of individuals. Indirect effect is defined as actions that cause a secondary negative response in individuals, including rising to the level of death of individuals. An example of direct take is a maternity roost tree being felled with bats present, causing varied individual responses, including death to individuals. An example of indirect take is the felling of a maternity roost tree in the inactive season causing varied individual responses; including returning migrating female bats extension of too much energy in locating a new roost tree so as not to have the required energy to support pregnancy, and therefore causing the individual to abort the unborn pup. Each management action has been analyzed separately as to its likely effects on Indiana bats and their habitat and is included in this section.

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

- proximity of the action to known species locations and designated critical habitat;
- distribution of the disturbances and impacts (e.g. a linear corridor);

- 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?

In general, implementation of the Forest Plan management activities that require the clearing or disturbance of trees will remove or alter Indiana bat habitat. Indiana bat summer habitat consists of three functional habitat elements: roosting areas, foraging areas and travel corridors. Persistence and availability of all three is essential for the continued viability of the individuals using the area.

Before analyzing the direct and indirect effects to Indiana bats stemming from habitat modification, it is necessary to consider the local topography and land-use patterns on some areas of the Hoosier National Forest and on adjacent private lands. The HNF contains a diversity of land types, including river bottoms, floodplains, ridges, valleys, wetlands and lakes. The land type that we are most concerned with in regards to Indiana bat habitat (roosting, foraging and travel corridor) is broad forested stream valleys. These areas in South Central Indiana have proven to be the most biologically productive on the HNF and on adjacent private lands, as evidence from various wildlife surveys (including Indiana bats) and the fact that these areas are heavily developed agriculturally. An Indiana bat maternity colony has been documented in a broad stream valley with a wide forested plain on private land directly adjacent to the HNF. This existing condition of fragmentation results in a delicate balance for the Indiana bat in regard to available habitat and habitat needs. Any forest management in existing forested stream valleys adjacent to non-forested private land will need to be scrutinized as to their potential effects on Indiana bats and their habitat. Only slight effects in these already heavily fragmented landscapes could have direct (if undertaken in the active season) and/or indirect effects rising to the level of individual take.

Cutting an Indiana bat roost tree when bats are present in the tree is likely to result in some individuals being directly injured or killed (direct take), however, to date, this has not occurred on the Hoosier National Forest. Loss or alteration of habitat, whether it occurs in the summer or winter, can also affect individuals (indirect take). Although habitat alterations may result in long-term improvements to Indiana bat foraging and roosting habitats, we will focus here on some of the likely negative effects stemming from this practice. This is not an attempt to discount the possible positive effects, but rather concentrate on those possible effects that are likely to cause a negative response by Indiana bats. As previously noted, female Indiana bats establish traditional summer ranges which they return to annually (site fidelity). Habitat loss or alteration may result in a change of some or all portions of their traditional roosting areas, foraging areas or travel corridors. Additionally, the specific demographics of the individuals exposed will also affect the response. As explained in the life history section, females form maternity colonies during the summer. These colonies depend upon a fairly restrictive microhabitat (e.g., large roost trees with sloughing bark, high solar exposure, diversity of microclimate options, closely juxtapositioned to produce foraging areas, etc.). Males, on the

other hand, roost singly or in small groups, and thus not as confined. As such, alterations and loss of habitat may more easily cause fitness consequences for reproductive females and pups than male bats.

As stated before, many of the management activities proposed in the 2006 Forest Plan will likely have positive long-term effects on Indiana bats and their habitat. Most of the activities focus on opening up small forest gaps and clearing understory, both advantageous for bats in regard to foraging habitat and roosting habitat. Also, since management activities are limited in Management Area 2.4 (riparian corridors) to forest-opening maintenance, single-tree harvest, group harvest, prescribed fire and salvage and/or sanitation harvest, these areas will likely remain as quality travel corridor habitat for bats. Furthermore, the proposed Standards and Guidelines will protect trees exhibiting roost-tree characteristics, as well as hickory species preferred as live roosts for Indiana bats. However, short-term negative effects are still plausible to male, female and juvenile bats.

If primary or high quality alternate roost sites are cut or degraded, we would not anticipate reproductive or survival consequences for male bats. However, loss of traditional roost sites may cause fitness consequences for females and pups. As maternity colony individuals require specific microclimate conditions, loss of suitable roost trees means that they would need to locate new roost sites. This may not be problematic in terms of their fitness if suitable alternate trees are readily available within or close to their traditional summer range. If, however, females are required to locate new roosts outside their traditional summer area, fitness consequences could occur. As explained in the life history section, the energy budget for reproductive females is delicate, especially in early summer. If females need to locate new roosting sites upon their return to the HNF after migrating from their winter hibernacula, they will need to expend additional energy from an already taxed energy budget. Weight loss and stress associated with hibernation, migration and pregnancy would be, therefore, magnified. This additional energetic stress could result in lower reproductive success (i.e., cause females to abort young) or lower survival of juvenile bats (i.e., substantially delaying parturition such that sufficient time for storing fat is prohibited).

Similarly, loss of travel corridors may indirectly cause fitness consequences to bats. Travel corridors that link foraging habitat to roosting habitat are essential to Indiana bat viability in an area. Kurta et al (2002) found that bats exhibited a preference to traditional travel corridors, even when their activity centers (foraging areas, roosting areas) changed; and using traditional travel corridors was favored even when shorter routes were available. Two aspects of corridors that seem to be particularly important are corridor cover and length. Loss of habitat used by individuals to move from their roosting habitat to their foraging habitat will require bats to find alternate routes. This is not likely to induce fitness consequences if suitable travel habitats are readily available. If, however, suitable travel corridors are lacking, this could lead to abandonment of their roosting or foraging area, which would lead to reproductive or survival consequences for those individuals exposed. As noted previously, travel corridors directly linked to riparian areas will be protected under the 2006 Forest Plan by limiting management activities to forest-opening maintenance, single-tree harvest, group harvest, prescribed fire and salvage and/or sanitation harvest. However, not all travel corridors are directly linked to riparian areas; and, although the three (3) management activities mentioned above are potentially less damaging

to roost tree availability and foraging habitat for bats than clearcuts and similar large-scale management activities, they still have the potential to cause short-term direct effects and long-term indirect effects to bats.

Lastly, loss or alteration of foraging habitat can lead to fitness consequences. Decreased foraging success can trigger a wide range of responses, including: (1) increased time spent foraging which results in increased risk of predation; (2) increased energy demand and a resulting imbalance of energy, resulting in increase in adult torpor<sup>9</sup> which can in turn lead to increased risks to juvenile bat mortality and decreased recruitment success; and (3) decreased adult body mass, which may cause a decline in recruitment and an increase in adult and pup mortality. We expect such responses to occur when traditional foraging habitat is lost or substantively degraded and alternate foraging habitat is not readily available. If other foraging habitat is available within close proximity to their roosting areas, we would expect short-term reductions in foraging success, but not to the extent that reproductive or survival consequences would occur. In the long-term, enhanced foraging habitat will benefit HNF bats as prey abundance will likely increase and bat energy exertion in locating prey will therefore decrease.

It is also important to note that alterations or loss in one essential habitat element could cause individuals to abandon an entire traditional summer area. It is also possible that alterations or losses in an essential habitat element that would not by itself induce fitness consequences may do so if alterations or losses in a second essential habitat element occur concurrently.

The quality of foraging habitat may be also be degraded due to erosion, and subsequent sedimentation of stream corridors, associated with these management activities. Sedimentation could affect the production of insects associated with aquatic habitats, which make up a portion of the prey base of Indiana bats. The likelihood and extent of these stressors occurring for each management activity are analyzed below.

An important consideration of philopatry<sup>10</sup>, or site fidelity, related to Indiana bats is that habitat suitability reductions may have substantial effects on the physical and reproductive fitness of individuals, and in turn the long-term viability of the species in a given range. For instance, it is anticipated that individual bats, or groups of bats, would abandon a traditional habitat if it were rendered unsuitable (from natural occurrences or human caused disturbances). However, it is not known how the bat(s) would respond if the quality or availability of their traditional habitat were only reduced. It seems likely that these traditional habitats would continue to be used, although offering less resource availability for the bat(s) over time. In these situations, the fitness of exposed individuals would likely reduce, as well. Some effects likely to occur from this sequence of events are: (1) reduction in either the quality or quantity of roosting sites; (2) slowed natal development; (3) increase in age of first reproduction; and (4) death. Furthermore, reduction in forage quality (reduction in prey base, increased foraging distances, etc) may slow fat accumulation for adults and young, thereby delaying migration and ultimately affecting reproductive success and possibly survival.

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<sup>9</sup> Lethargy; inactivity; a state of mental or physical inactivity

<sup>10</sup> Returning to the same area, year after year

Another important consideration of site fidelity is that Indiana bat presence may not be indicative of individual or overall species viability. As bats habitually return to their summer roosting and winter hibernating sites, presence alone does not equate that optimal, or perhaps even adequate, summer or winter habitat is available. Thus, we need to be cautious in formulating our conclusions about long-term viability for sites that have limited monitoring data.

### ***Timber Harvest***

Timber harvest is planned for up to 6,820-acres across the HNF over the next ten (10) years (682-acres per year). This represents approximately 3.5% of the total forest available for harvest per decade. Of these 6,900-acres, 2,020-acres (~1%) will be available for clearcuts, 920-acres (~.05%) will be available for shelterwood cuts, 1,110-acres (~.05%) will be available for single-tree cuts, and 2,850-acres (~1.4%) will be available for group selection cuts. Currently, 7% of the HNF (> 14,000-acres) is either non-forested or early successional (less than 9-years old). 48% (95,592-acres) of the HNF is old growth forest, or over 80-years old.

All timber harvest activities have the potential to directly or indirectly harm Indiana bats since the removal of an occupied (either primary or alternate), or potential roost tree is possible. Direct harm may occur by felling occupied roost trees. As indicated previously, bats especially non-volant pups, may be injured or killed if their roost tree is cut down. Indirect harm may occur when a maternity roost tree is cut during the inactive season, or when an alternate roost tree, not currently being used, is cut down during the active season. Site fidelity, for both summer range and hibernaculum, is well documented for Indiana bats (Brady et al. 1983, Kurta et al. 1993). Indiana bats are most susceptible in the spring when returning to traditional roosting and foraging areas, as their stored fat reserves are at the lowest during spring emergence and migration. Any added stress, including having to locate new roosts because of tree removal, degraded or otherwise altered foraging habitat, or changes to existing travel corridors can have negative consequences to both male and female Indiana bats during spring emergence, including affecting the reproductive success of females.

Although the Standards and Guidelines contained within the HNF Forest Plan are designed to greatly reduce exposure, they cannot guarantee complete elimination of exposure, and hence harm, either, directly or indirectly. Therefore, we anticipate for *some* timber activities (clearcut harvests, shelterwood harvests, hazard-tree removal, salvage harvest and sanitation harvest) that direct negative fitness consequences are possible during harvest activities conducted during the bats' active period; or that the results of those timber activities, if performed during inactive period, may have indirect fitness consequences as bats return to traditional foraging and roosting habitats. It is not anticipated that these direct and/or indirect effects will have fitness consequences at the population level. Strict adherence to standards and guidelines, pre-harvest surveys to determine roost availability and use, and the appropriate timing of timber harvest would greatly minimize any potential direct exposure of Indiana bats to injury and/or death from these actions.

Clearcuts – The removal of essentially all trees in a single operation. Within the HNF, clearcuts (2,020-acres total) will be carried out within two (2) management areas totaling 102,097-acres.

Clearcut sizes are limited to 10-acres per occurrence in MA 2.8 and 40 acres in MA 3.3. Although open forest is not the preferred habitat of Indiana bats, the relatively diminutive area associated with most clearcut harvests (10-acres) will not likely degrade available habitat within the HNF boundaries. Although larger clearcuts (40-acres) are proposed for Management Area 3.3, this area comprises only 13,178-acres of the entire HNF (6.6%). Management Area 3.3 is currently evenly characterized by non-native pine species and native deciduous species; Indiana bats do not typically favor pine species, compared to native deciduous species. Also, all snags possessing roost-tree characteristics, not deemed to be hazardous, will be retained in the clearcut area, as well as trees defined within the Standards and Guidelines section.

Over most of the species' range, Indiana bats have a preference for forests with old growth characteristics (i.e. large trees, scattered gaps and open understories) (Tyrell and Brack, 1990). Indiana bats tend to forage in the open understory, using both riparian and non-riparian woodlands. Although clearcuts remove aspects of old-growth forests, they also create edge habitat that bats will typically use for foraging. Brack (1983) observed most Indiana bat foraging occurred along habitat edges. It is reasonably certain that the interior of these created openings are not appropriate as Indiana bat foraging habitat, but the land area to be maintained in early successional-forest across the Hoosier National Forest is minimal (approximately 1.5%), and therefore not limiting in regard to Indiana bats. According to the HNF Forest Plan, old-growth forest ratio on the HNF will increase from 48% currently to 81% over the next 150-years.

Additionally, conversion of non-native pines to native hardwoods will ultimately, indirectly, benefit the Indiana bat. Currently, the over-stocked pine plantations on the HNF lack roosts for summering males, except where groups of pines have died and not yet lost their bark. Only two individuals have been observed using snags within these stands for roosts (HNF 2000). The conversion of pines to native hardwoods over a period of years will create more open conditions for foraging, produce more insects for feeding and provide more roost sites.

Due to the potential extent of habitat affected (10 – 40-acres), and the fact that the Standards and Guidelines do not prohibit this management activity during the Indiana bats' active period, we expect that both direct and indirect take is likely to occur; therefore, this management activity will be included in the incidental take statement.

Shelterwood Cuts - The removal of undesirable competition to promote the regeneration of target/desired species. Shelterwood cuts are proposed for 840-acres across the HNF, with 80-acres designated for pine stands. Shelterwood cuts open up small gaps in the forest canopy, allowing additional sunlight to reach the forest floor, as well as lower segments of existing trees. Brack (1983) noted that net sites where Indiana bats were captured had openings, or gaps, in the forest canopy, which leads to the conclusion that forest gaps are favored by Indiana bats when compared to closed canopy forests. This type of tree harvest is designed to promote regeneration of target species, including oaks, hickories and walnuts. Brack (1983) also observed that at the capture sites oaks and hickories dominated. From these observations, it is likely that shelterwood harvests will increase foraging habitat for the Indiana bat. There is a slight possibility that singly occupied (or small groups) roost trees will be felled, or that alternate roost trees will be felled. We expect that some direct and indirect take is anticipated for this

management activity; and this management activity will be included in the incidental take statement.

Single-tree Cuts - The removal of single tree(s) in order to mimic natural canopy gaps across 1,110-acres. Trees are removed from all diameter classes and edges/openings are not maintained. Single-tree harvests promote uneven-aged forest stands with both spatial and vertical diversity. Studies have shown that Indiana bats have a wide range in foraging height, anywhere from 2 meters to 30 meters (Humphrey, et al 1977); however, there is no conclusive evidence that bats selectively forage in specific strata within the forest canopy. It has been shown that gap creation increases forage and potential roost habitat for the Indiana bat (Brack 1983), so single-tree selective harvests will likely have a positive effect on Indiana bat habitat in the long-term. It is unlikely that this management activity, due to the diminutive area impacted in regard to habitat alteration(s) and the adherence to Standards and Guidelines, will result in direct or indirect take. This management activity will not be included in the incidental take statement.

Group Selection Cuts - The removal of trees periodically in small groups (less than 3-acres) across 2,850-acres in order to encourage uneven-aged forest stands. This harvest method creates forest openings, or gaps, which have been shown to be beneficial to Indiana bats (Brack 1983). It is unlikely that this management activity, due to the diminutive area impacted in regard to habitat alteration(s) and the adherence to Standards and Guidelines, will result in direct or indirect take. This management activity will not be included in the incidental take statement.

Hazard Tree Removals - The removal of trees that are considered hazardous to forest resources (buildings, roads and trails, Forest Service personnel, etc.) and/or forest visitors. Likely, these are dead or dying trees that are within a campsite, along a road, adjacent to a forest building or structure, or along a trail. Studies have shown that Indiana bats consistently roost in dead or dying trees (snags), or in live shagbark hickories (Humphrey, et al 1977). It is therefore potentially harmful to remove dead and dying trees, especially during the active period for the Indiana bat (April 15 to September 15). It can also be potentially harmful to remove known roost trees that become hazards outside the active period, since bats have demonstrated a “homing” pattern of returning to the same summer breeding areas each year (Gardner, et al 1991, 1996).

It is not known how Indiana bats rank snag characteristics, although they favor snags with abundant loose bark and available solar exposure for maternal roosts (Callahan, et al 1997). There is no targeted acreage for this harvest type, as it will be implemented “as needed”; however, 600 trees are estimated for removal over the next ten (10) years. All hazard trees are not potential roost tree, however. It is estimated that of the 600 trees targeted for removal over the next ten (10) years, less than 1% (<60) would have roost potential (personal communication with HNF wildlife biologist Cynthia Basile). The Standards and Guidelines state that all hazard trees displaying maternity roost-tree characteristics will be retained, unless they pose an immediate safety concern.

On the HNF, only one tree in the last 15 years slated for hazard-tree removal (approximate total of 1500 trees) has demonstrated characteristics of a roost tree (sloughing bark, solar exposure, cavities present) (personal communication with HNF wildlife biologist Cynthia Basile). The one tree, however, not only demonstrated characteristics of a roost tree, it was used as a roost tree by

Indiana bats (Celina Lake campground). This tree was removed after the September 15 “no-action” date.

Due to the fact that the Standards and Guidelines do not prohibit the felling of hazard trees in the summer, when they might be occupied by Indiana bats, some direct take and/or indirect take is expected from this management activity.

Sanitation Harvest - The removal of disease or insect-ridden trees for the purpose of improving overall health and quality of stand. This harvest type will most likely emulate single-tree and group selection cuts, and should have similar effects. There is no targeted acreage for this harvest type, as it will be implemented “as needed”. Due to the high degree of unpredictability and variability of these events, the Service cannot complete an adequate analysis of the effects of this activity prior to such an event. Therefore, sanitation harvests will be evaluated on a case by case basis at the project level. If anticipated effects are determined at that time to be consistent with effects from other timber harvest practices evaluated in this BO, then the Forest Service may deduct the sanitation harvest acreage from an existing incidental take category.

Salvage Harvest - The removal of dead, damaged or dying trees after major natural occurrence, like a wind storm. 5,000-acres of hardwood forest will be available as needed under this management activity, while 1,200-acres of pine forest will be available. Major natural occurrences, like windstorms or wildfire, create natural forest gaps and encourage shade-intolerant tree specie regeneration. Additionally, snags become more abundant after such occurrences. Short-term negative effects are possible in the form of unknown roost tree removal, foraging habitat alterations or travel corridor alterations.

Due to the potential extent of habitat affected, and the fact that the Standards and Guidelines do not prohibit this management activity during the Indiana bats’ active period, we expect that both direct and indirect take is likely to occur; therefore, this management activity will be included in the incidental take statement.

Timber Stand Improvement - The removal of invasive species or problematic species closely following initial timber harvest. This management action covers 4,500-acres, but includes areas that have already been harvested using other techniques listed above. This management activity will have only minor additional effects beyond the initial timber harvest. Due to the high degree of unpredictability and variability of these events, the Service cannot complete an adequate analysis of the effects of this activity prior to such an event. Therefore, timber stand improvement will be evaluated on a case by case basis at the project level. This management activity will be included in the incidental take statement.

Forest Opening Maintenance - The removal of single trees or small groups of trees from existing forest openings. Areas where this management practice will be carried out are currently open, so the overall change to existing conditions will be minor. This management practice may have short-term adverse effects on singly roosting Indiana bats or their preferred habitat, if management activities are conducted during the active period for bats. However, we do not feel this management activity will have long-term negative effects at the population level. It is unlikely that this management activity, due to the diminutive area impacted in regard to habitat

alteration(s) and the adherence to Standards and Guidelines, will result in direct or indirect take. This management activity will not be included in the incidental take statement.

Timber Operation Accidents – It is anticipated that an average of 100-trees per year will be damaged or knocked-over in response to timber operation accidents (these trees are not accounted for under any other planned timber management activity). Accidents can result from multiple unintentional practices, including skidding trees outside the timber harvest area, felling a target tree into a non-targeted tree, or accidentally bumping a non-targeted tree with harvest equipment. Of these 100-trees, it is reasonable to assume that a small percentage will have roost potential, or actually contain roosting bats. Although it is very difficult to predict how many trees will likely contain roosting bats, or have roosting potential, it is reasonable to assume that some take will occur. This management activity will be included in the incidental take statement.

### ***Fire Management***

Prescribed Fire - The use of fire as a management tool across 20,000-acres to increase wildlife habitat availability and promote forest regeneration. Historically, wild fires moved through natural ecosystems and cleared understories in order to make room for tree regeneration. Today, wild fires are not safe in most settings, but the use of controlled burns can be just as effective in promoting tree regeneration. In regard to bats, this management activity will create some forest gaps, create snags and help in the regeneration of oaks and hickories. As stated in previous sections, all three of these outcomes will benefit Indiana bat habitat in the long run. However, short-term effects are anticipated, in the form of foraging habitat modification, travel corridor modification, increased predation of fleeing bats, and smoke and/or fire affects. Foraging habitat and travel corridor changes will occur both from direct response to burns (i.e., roost trees and canopy burning) and from direct response to on-the-ground fire management activities (i.e., removing trees for fire breaks and access roads/lanes).

Indiana bats are very well-adapted to modifications to their habitat (Gardner et al, 1991), and they have responded to naturally occurring fires throughout their species' existence. It is reasonable to predict that adult Indiana bats would successfully flee from burn areas. However, there are several response-related negative direct effects that need to be considered. First of all, fleeing bats from a burn area would be susceptible to increased predation; secondly, if a maternity colony was located within a burn area, the females and non-volant<sup>11</sup> young (from May through June) would be susceptible to smoke and flames; and lastly, if burn area is located near hibernacula, smoke and noxious gases could become trapped inside caves and harm hibernating Indiana bats. Take is anticipated in response to the above listed likely responses.

Wildfire Suppression - The containment of naturally occurring fires is planned over 500-acres (50-acres/year) on the HNF. Possible effects to the Indiana bat from this management technique include the loss of habitat from tree clearing for fire breaks. Those potential effects described in the section above apply (prescribed fire) to wildfire suppression, as well. Some indirect take is anticipated from this management practice. Fire suppression involves creating fire breaks by removing trees and clearing accumulated ground litter, as well as burning out areas where the

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<sup>11</sup> Not yet able to fly

wildfire is anticipated to move. Indirect take can be anticipated from loss or alterations to roosting habitat, foraging habitat or travel corridors.

**Summary** – As stated before, there are positive effects expected in the long-term in regard to Indiana bat habitat resulting from fire management, such as increased solar exposure to roost trees and decreased understory coverage. However, there are short-term negative effects that must be considered, such as immediate decrease in prey base (insects), exposure to flames and smoke and alterations to foraging habitat, roosting habitat and travel corridors. In order to avoid Indiana bat responses rising to the level of take, prescribed fires should only be conducted when Indiana bats are not likely to be present in the area. The accepted active period for Indiana bats within their summer habitat is from April 15<sup>th</sup> to September 15<sup>th</sup>; however, fall swarming behavior and spring staging behavior are also active periods for the Indiana bat. Fall swarming typically occurs from early September to early November (Cope and Humphrey 1977). During this period, bats begin to congregate near hibernacula, continuing to roost and forage at night in the adjacent forest (within 5-miles). This is a very important time for Indiana bats, as this is the time when the majority of the year's copulations occur (Cope and Humphrey 1977); also, Indiana bats forage in order to gain the extra weight needed for their winter hibernation (Kiser and Elliot 1996). In the spring, bats begin to emerge in early April and exhibit similar behavior before migrating to their traditional summer roosts, including some late copulation. Male bats have been documented staying near hibernacula for the duration of the summer. It is imperative that prescribed burns do not occur within five (5) miles of known hibernacula during fall swarming and spring staging behavior (as stated in the Standards and Guidelines of the 2006 Forest Plan), as this is a critical time for Indiana bats (Kerth et al 2003). It is our opinion that prescribed fires occurring between April 15 and September 15 in the entire Action Area, or within 5-miles of hibernacula during fall swarming (September 1 to November 1) and spring emergence (April 1 to May 15), may have direct negative effects to Indiana bats.

### ***Construction, Upkeep and Permits***

Trail Construction/Reconstruction - This management activity represents miles of trail construction or reconstruction that require the removal of trees. Whenever possible, trails will be routed so as to retain all large trees. This management activity is planned for 65 linear miles over the next ten years; an estimated 1,625 trees greater than 3 inches DBH will likely be removed. This is roughly equivalent to 2.5-acres of tree clearing over ten years, based on approximate density of 681 trees per acre (Leatherberry, 2003).

Maintenance of trails beneath the forest canopy simulates conditions of open travel corridors above streams for bats traveling between roosts and foraging areas. This may marginally improve foraging habitat and provide travel corridors. Relocating trails, including re-contouring and re-vegetating the landscape, may locally reduce the number of sites for drinking water for the bats. Water resources are widely scattered across the HNF, so bats would likely expend little energy finding replacements for those lost during trail construction and maintenance. The potential loss of few potential roost trees along trails will cause bats to expend some additional energy locating new roosts. Although initial activities (tree removal) may cause short-term negative impacts to the Indiana bat in the form of added energy consumption, long-term effects

will benefit the species through the provision of added travel corridors and potential foraging habitat. No direct or indirect take is anticipated from this management practice.

Special Use Permits – This management activity represents forest acreage to be managed as right-of-ways for utilities, and includes existing and new permits. Activities are planned for 300-acres over the next ten (10) years (30-acres per year). Activities will mostly involve tree removal to protect utility lines and the like.

Removal of potential roost trees could affect Indiana bats by potentially directly harming bats roosting in those trees and by reducing overall roosting habitat within the area; however, this would have little to no effect to overall Indiana bat populations across the HNF and affected bats would recover quickly. Other possible short-term effects include added energy consumption of Indiana bats locating new roost trees. No direct or indirect take is anticipated from this management practice.

Road Construction/Reconstruction – This management activity involves tree removal and grading of slopes, and will affect 267-acres over the next ten (10) years (26.7-acres per year). Road construction may require the removal of a few potential roost trees, which could directly harm Indiana bats roosting in those targeted trees and by reducing overall roosting habitat in those areas affected. The loss of a few potential roost trees during road construction and maintenance will cause bats to expend some additional energy locating new roosts. In the long-term, conditions and availability of roost trees may be improved, by allowing increased sunlight for more suitable temperature levels for roost trees. Re-locating roads, including re-contouring and re-vegetating the landscape, may locally reduce the number of sites for drinking water for bats. Water resources are widely scattered across the HNF, so bats would likely expend little energy finding replacements for those lost during road construction and maintenance. Indiana bats may come into the road right-of-way for improved foraging conditions and improved roost sites, and roads may provide new travel corridors. No direct or indirect take is anticipated from this management practice.

Parking Lot, Tree Landing Area and Trailhead Construction – This management activity involves tree removal and possibly grading of slopes, and will affect 120-acres over the next ten (10) years (12-acres per year). Removal of potential roost trees will cause habitat loss and may force Indiana bats to expend additional energy in locating alternative roost trees. Additionally, direct harm might be a result as bats might be occupying trees that are felled. In the long-term, this management action is not likely to have a noticeable adverse effect on the overall population of Indiana bats across the HNF. No direct or indirect take is anticipated from this management practice.

Wetland Construction – This management activity involves building low-profile berms to contain water, and flooding previously dry areas, and will affect 25-acres over the next ten (10) years (2.5-acres per year). This management activity will likely benefit the Indiana bat by providing increased access to drinking water as well as increased insect abundance and consequent increased foraging habitat. Potential roost tree will likely develop at the edges and within created wetlands, as the increased water levels will likely kill or damage existing trees. No direct or indirect take is anticipated from this management activity.

Recreation Site Enhancement – This management activity involves site expansion, vista clearing, maintenance or utility line installation, and will affect 35-acres over the next ten (10) years (3.5-acres per year). Removal of potential roost trees will cause habitat loss and may force Indiana bats to expend additional energy in locating alternative roost trees. Additionally, direct harm might be a result as bats might be occupying trees that are felled. In the long-term, this management action is not likely to have a noticeable adverse effect on the overall population of Indiana bats across the HNF. No direct or indirect take is anticipated from this management activity.

Pesticides and Herbicides – This management activity involves applying pesticides and herbicides to HNF vegetation to manage pests and weeds, and will affect 4,000-acres over the next ten (10) years (400-acres per year). Local outbreaks of insects and diseases causing mortality in trees may lead to short-term improvement in foraging conditions and increase the number of available suitable roosts. However, if harmful insects and diseases are not controlled foraging and roosting habitat may become suboptimal leading to an overall decline in Indiana bat populations. Furthermore, targeted insects will include diurnal species such as wasps and bees, and will not affect nocturnal insects (moths, etc.) targeted as food items by Indiana bats. No take is anticipated from this management activity.

## **Summary**

The overall goals and objectives of the Revised Forest Plan are expected to be beneficial for the Indiana bat. The Standards and Guidelines proposed in the 2006 Forest Plan will greatly reduce potential exposure and risk to Indiana bats and it is evident that the Forest Service is dedicated to protecting both individuals and habitat on the HNF. There is little question as to the intent of the Forest Plan as a strategy to both enhance forest resources and protect the long-term viability of the wildlife contained within. We are confident that all management practices will be carried out with these intentions in mind. However, even with the best intentions and measures in place to reduce exposure and risk, some adverse effects to the Indiana bat through implementation of the Plan may result from loss of unknown roost trees, loss of potential roost trees, added stress to bats in locating alternative roost trees, added predation, short-term loss of foraging habitat and possible smoke damage to maternity roosts and hibernacula. We anticipate, however, that the Standards and Guidelines will greatly limit the extent to which these adverse effects will occur. We expect that it is reasonably certain that occupied roost trees could be removed during the summer period as a result of salvage harvest, hazard-tree removal or sanitation timber harvests. These actions may result in fitness consequences at the individual level (injury, death, etc.), but are not expected to have negative population-level consequences. Specifically, take of individual females is not anticipated to rise to the level of affecting the fitness of the maternity colony due to the few number of individuals to which exposure is anticipated. Likewise, take of single males is not expected to be detected at hibernacula or at the population level.

## 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 and state Highway Departments. 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.

However, the Indiana Department of Natural Resources 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 state Highway 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 Bloomington 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, if not thousands, of private landowners who own property within the nine-county area in which the HNF is contained. However, past trends on private properties within these counties offer 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 private use of caves that Indiana bats use for hibernating/swarming;
- Recreational use of occupied Indiana bat caves 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.

## CONCLUSION

After reviewing the current status of the Indiana bat, the environmental baseline for the action area, the effects of the 2006 Land and Resource Management Plan for the Hoosier National Forest, and the likely cumulative effects, it is the Service's *biological opinion* that the 2006 Forest Plan, as proposed, is not likely to jeopardize the continued existence of the Indiana bat. No critical habitat has been designated on the HNF, although a maternity colony and two small hibernacula have been discovered. The actions described herein, carried out with their accompanying Standards and Guidelines, will not likely affect these known areas in a destructive or degrading manner.

This conclusion is based on the following factors:

- Hibernating Indiana bats on the HNF are not likely to be adversely affected with the implementation of the 2006 Forest Plan;
- Approximately 250 Indiana bats are known to hibernate in caves on the HNF, and one of the caves had only one hibernating Indiana bat observed. The implementation of the Standards and Guidelines contained within the 2006 Forest Plan will greatly reduce or completely avoid the potential for adverse effects (i.e., injury, death or habitat loss) to occur within the Action Area;
- The probability of unknown occupied roost trees being removed through salvage harvest or hazard tree removal with the implementation of the 2006 Forest Plan is very small. If a tree was 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). Some individuals may be injured or killed. Since the HNF will not be cutting all of the suitable roost trees in any one area, it is likely that suitable (alternate and/or primary) roosts will remain available for the colony(s).
- With the implementation of the 2006 Forest Plan, it is likely that more optimal roosting and foraging habitat will be created on the HNF.
- In regard to male Indiana bats being harmed or killed while roosting in a tree targeted for harvest, 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. Any predation risk is considered insignificant. 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 within the Action Area.

- The range-wide rate of decline for the Indiana bat has slowed, and recent counts have shown for the first time in 60-years an actual increase in overall population. However, at this time we are unable to interpret the meaning and/or causes of these increases in terms of current population trends.
- The proposed action(s) will only reduce the fitness of individuals occurring within the Action Area, not the viability of hibernating populations in which these individuals belong. Therefore, the proposed action(s) are not likely to appreciably reduce the reproduction, numbers or distribution of Indiana bats range-wide.

## **INCIDENTAL TAKE STATEMENT**

Section 9 of the Act and Federal regulation under section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without exemption. Take is defined as harassment, harm, pursuit, hunting, shooting, wounding, killing, trapping, capturing or collecting, or attempting 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 as 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 Hoosier National Forest so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption of section 7(o)(2) to apply. The Hoosier National Forest has a continuing duty to regulate the activities covered by this incidental take statement. If the HNF (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the HNF must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(I)(3)]

### **Amount or Extent of Take Anticipated**

In this incidental take statement, we are evaluating the incidental take of Indiana bats that may result from the implementation of the 2006 Land and Resource Management Plan for the Hoosier National Forest (loss of roost trees and/or foraging habitat through various forest management

actions). The 2006 Forest Plan is a comprehensive plan level document that allows and guides, but does not authorize site-specific actions to occur. With the implementation of the 2006 Forest Plan (and all Standards and Guidelines within), we expect that some adverse effects to Indiana bats may occur. As such, *some* site-specific projects (i.e., salvage harvest, hazard-tree removal) conducted under the 2006 Forest Plan may result in adverse effects to individual Indiana bats that rise to the level of take. The Standards and Guidelines proposed substantially reduce the potential for adverse effects and incidental take to occur as a result of actions implemented under the 2006 Plan. Projects completed under the 2006 Plan that comply with all of the Standards and Guidelines and other project commitments detailed in the BA in many cases would not adversely affect the Indiana bat and, therefore, no incidental take would occur in those instances. However, as described within the Effects section, an unknown occupied roost tree could be removed, particularly during salvage harvest or hazard-tree removal. The likelihood of such instances is strongly influenced by the timing and the location of the activity within the HNF. At the program level, where projects details are not known, it is difficult to accurately predict how Standards and Guidelines will be applied. However, at the project level, where details such as micro-topography and specific harvest characteristics are known, application of all pertinent Standards and Guidelines can more accurately be assessed.

Incidental take of Indiana bats is expected to be in the form of injury or death or harassing. The intent of the Standards and Guidelines sufficiently limit summer season activities so that only occupied secondary roost or less important roost trees may be felled. These trees are likely to be occupied by either singly roosting males or few females. It is reasonable to assume that only a subset of these individuals will be directly taken through injury or death (Bellwood 2002) and that most of the individuals in occupied roost trees will escape. We anticipate that such a roost tree could be cut during any of the activities described previously in this BO. Although very difficult to predict with certainty, the occurrence of this, however, we believe is likely to be less than once per activity. For instance, it is likely that 60 hazard trees with roost tree characteristics will be targeted for removal over the next ten (10) years; this would equate to roughly 6-trees per year. Thus, we can anticipate that no more than four (4) occupied roost trees will be incidentally cut per year and between four (4) and twelve (12) individuals injured or killed each year.

As explained previously, we will monitor incidental take of Indiana bats as individual projects are completed where take is reasonably certain to occur. At the project level we will more precisely know the Indiana bat demographics within the project action area, how likely it is that they will be exposed to the project impacts and how they will likely respond to the exposure. Take will be tallied as the projects are implemented. Prior to implementing each project, we will ensure that the cumulative take does not exceed what was anticipated in the programmatic Incidental Take Statement.

To ensure that the impacts of take associated with future projects are appropriately minimized and that the exemption of incidental take is appropriately documented, the Forest Service and Fish and Wildlife Service will implement an appended programmatic consultation approach. Under that approach this programmatic Biological Opinion and Incidental Take Statement will exempt incidental take that result from the implementation of site-specific actions that result from the continued implementation of the 2006 Forest Plan. However, individual projects which have not yet been specifically identified and which impact Indiana bat habitat must be

individually reviewed to determine if they are consistent with the programmatic Incidental Take Statement's reasonable and prudent measures and associated terms and conditions, and to ensure that once specific projects are identified, site-specific impacts of the resulting incidental take are minimized. If an individual project is found to be consistent with the programmatic consultation it will be appended to this programmatic Biological Opinion and Incidental Take Statement, along with any project-specific reasonable and prudent measures and terms and conditions that are needed to fulfill the requirements of section 7(a)(2).

For site-specific projects, the Forest Service will supply the Service's Bloomington Field Office a description of the project that includes the project location, type of activity, total acreage to be disturbed and map(s) of the proposed project area with boundaries identified. When reporting the type of activity, it must directly correspond to one of the management activities outlined in the Incidental Take Statement (Figure 2). Each project proposal must report how the individual project increases the cumulative forested acres (or number of trees or miles) affected within each of the management activities listed in Figure 2 and report on the total acreage (or number of trees or miles) remaining in each management activity. A map illustrating all previous site-specific projects and accompanying incidental take should be included.

The letter requesting project-specific review must include the Forest Service's determination that the proposed project is consistent with this programmatic Biological Opinion and Incidental Take Statement and request that the proposed project be appended to this programmatic Biological Opinion.

Incidental take of Indiana bats is difficult to detect for the following reasons:

- The individuals are small and occupy summer habitats where they are difficult to find;
- Males and non-reproductive females may roost individually, which makes locating the species or occupied habitats difficult;
- Finding dead or injured specimens during or following project implementation is unlikely;
- The extent and density of the species within its summer habitat on the HNF is limited based on a lack of substantial survey efforts and capture data;
- Implementation will not affect all available habitats within the Action Area as a result of property (i.e., habitat, resources) management actions.

Since the number of Indiana bats that may be taken through the implementation of the 2006 Forest Plan cannot be accurately monitored, and it is unlikely that we would ever notice when an unknown occupied roost tree was cut, it is necessary estimate the level of take that may occur. We believe the level of take of this species can be monitored by tracking the level of habitat modification and adherence to Standards and Guidelines, and then estimating the number of individuals that will be affected. Specifically, if the Standards and Guidelines are not fully implemented, or if the current anticipated level of habitat loss is exceeded, we expect the level of incidental take to increase as well. Incidental take of individuals will be estimated using the number of acres provided in the following table.

**Figure 2. Annual estimated management activities on the HNF (expressed in acres).**

| <b>Activity</b>                | <b>Measure</b>                                    |
|--------------------------------|---------------------------------------------------|
| Hardwood Clearcut Harvest      | 102-acres                                         |
| Pine Clearcut Harvest          | 100-acres                                         |
| Hardwood Shelterwood Harvest   | 76-acres                                          |
| Pine Shelterwood Harvest       | 8-acres                                           |
| Hazard-tree Removal            | 60 trees                                          |
| Hardwood Salvage Harvest       | 500-acres                                         |
| Pine Salvage Harvest           | 120-acres                                         |
| Sanitation Harvest             | As Needed*                                        |
| Prescribed Fire                | 2,000-acres                                       |
| Fire Suppression               | 50-acres                                          |
| Timber Operation Accidents     | 100 trees                                         |
| <b>TOTAL YEARLY EXEMPTIONS</b> | 2956-acres; 60 hazard trees; 100 “accident” trees |

\* Since this management activity is proposed “as needed”, and harvest will be documented and tracked under one of the other incidental take categories.

### **Estimating Indiana bat Exposure and Take**

In 2005, 206,610 Indiana bats were documented to be hibernating in Indiana. For the purposes of this estimation, we assume that this number is evenly distributed between males and females. It is also assumed that this same number of bats will be found utilizing Indiana for their summer range (it follows that those bats which likely migrate from Indiana will be evenly replaced with bats migrating to Indiana).

From these assumptions so far, we likely have 103,305 female Indiana bats summering and forming roosting colonies in Indiana. The average number of female Indiana bats in a maternity colony has been estimated in previous literature (Whitaker and Brack 2002) to be 80, so, there are likely 1291 maternity colonies in Indiana. Whitaker and Brack assume equal distribution across all 92 counties in Indiana. However, this assumption does not take into account county size. For a more accurate distribution estimate, it is more valuable to quantify the average maternity roost colony range in terms of acreage. To do this, we must first convert the state of Indiana’s land mass into acres. Indiana is comprised of 36,420 square miles, or, at 640-acres-per-square mile, 23,308,800 acres. If we divide this number by the number of assumed maternity colonies (1291), we will have the average distribution of each maternity colony as 18,055 acres/colony. Now, by dividing the total area of the Action Area (~645,000) by this average colony acreage (18,055), we can estimate the likely number of maternity colonies contained within the Action Area. Based on these assumptions, we will likely find 36 maternity colonies within the Action Area. It is important to note here that the actual acreage contained within the HNF is substantially smaller, since the Action Area comprises the purchase boundary, or forest “potential”. The HNF is currently 199,150 acres; so, providing the same assumptions,

we will assume to have 11 colonies (199,150 / 18,055) dispersed throughout this current land configuration. Next, it is useful to break down the acreage in terms of individual bats. As noted above, there are typically 80 female bats in each maternity colony. As female Indiana bats can reach sexual maturity in their first year, we will assume that most of these 80 bats (70) will produce a pup each year. Therefore, each maternity colony will support 150 individuals. So, within the 36 assumed maternity colonies, there are an estimated 5400 bats in the Action Area. If we evenly distribute this population over the entire Action Area, each bat will inhabit approximately 119-acres (645,000 / 5400).

Unpublished Fish and Wildlife Service data suggests that female Indiana bats avoid un-glaciated, dry ridge habitats when locating maternity colonies. The HNF is predominantly un-glaciated. Maternity colonies in the un-glaciated portions of the state and HNF, are typically found only in stream valleys with broad forested floodplains such as in the case of the two known maternity roosts within, or adjacent to, the HNF at Oil Creek and Celina Lake. Therefore, when estimating presence on the HNF, it is necessary to adjust the numbers based on the topographical limitations in regard to maternity colonies. It is expected that a maternity is half as likely (50%) to locate on the HNF, so it is expected that on the HNF the *average distribution for females / juveniles is 238-acres*.

For males, who typically summer roost near their respective hibernacula, their preference for glaciated vs. un-glaciated topography is not as pronounced. This is verified through past surveys where male Indiana bats have been captured on both topographical regions. All the known hibernacula in the state of Indiana are located below the “mid-section” of the state; so in order to estimate male bat-density, we will only look at the southern portion of the state. This assumption is further validated through survey efforts showing a great scarcity of male Indiana bats in the northern portion of the state. By dividing the southern land mass (11,654,400 acres) by the number of male bats (103,305), we can determine the *average distribution of males across southern Indiana to be 113 acres/male*.

For management practices that are not expressed in terms of acreage, but instead in number of trees harvested, as in hazard tree removal and timber operation accidents, we will use a different approach. According to testimony from HNF biologists, it is estimated that less than one percent (1%) of targeted hazard trees will have roost-tree potential (Cindy Basile); we will use 1% for estimation purposes. In regarding timber operation accidents, it is reasonable to assume that this ratio will be less, since the accidents will not target hazard trees, which are more likely to have roost-tree potential. For timber operation accidents, we will use one-half of one percent (.5%) as the ratio of trees potentially having roost-tree characteristics.

The 2006 Forest Plan states that a total of 600 hazard trees (60 per year) will be removed over the next ten years. Each year, by using the 1% ratio, we can assume that .6 trees (1% of 60 trees) with roost potential will be removed. We cannot assume that every tree with roost potential will actually contain bats, so we must reduce this number to the likely number of potential roost trees that actually contain bats. For this estimation, we will assume that half the trees with roost potential actually contain bats. This equates to roughly one tree every three years. Finally, we need to estimate the likely number of bats that will negatively respond to the felling of their roost tree. Since the Standards and Guidelines clearly state that all hazard trees with roost tree

potential will be left standing until after September 15<sup>th</sup> (when possible), it is unlikely that bats will be present when these trees are felled. However, since it is possible that a few bats will remain behind past the September 15<sup>th</sup> date, we can assume that 3-6 bats will be exposed to the felling of their roost tree; this number, expressed in yearly terms, is 1-2 individuals.

The 2006 Forest Plan estimates that a total of 1000 trees (100 per year) will be knocked down or otherwise damaged due to timber operation accidents. Each year, by using the .5% ration, we can assume that .5 trees (.5% of 100 trees) with roost potential will be removed. Again, we cannot assume that every tree with roost potential will actually contain bats. We will assume that half the trees with roost potential contain bats. This equates to one tree every four years. Since accidents cannot be guaranteed to occur after September 15<sup>th</sup> or after April 15<sup>th</sup>, we will assume the potential number of bats present to be higher than in the hazard-tree example. We will assume 12-16 bats will be exposed if their roost tree is felled when they are present; this number, expressed in yearly terms, is 3-4 individuals.

We can now use these figures to estimate exposure and possible risk of take to individual bats, since all management activities are expressed in terms of acres affected (these estimates do not take into consideration possible long-term positive effects of these management activities):

**Figure 3. Indiana bat Exposure Estimates**

| <b>Management Activity</b>    | <b>Acres Affected (per year)</b> | <b>Number of Females/Pups Exposed</b>   | <b>Number of Males Exposed</b>          |
|-------------------------------|----------------------------------|-----------------------------------------|-----------------------------------------|
| Hardwood Clearcut Harvest     | 102                              | 0.43                                    | 0.90                                    |
| Pine Clearcut Harvest         | 102                              | 0.43                                    | 0.90                                    |
| Hardwood Shelterwood Harvest  | 76                               | 0.32                                    | 0.67                                    |
| Pine Shelterwood Harvest      | 8                                | 0.03                                    | 0.07                                    |
| Hazard Tree Removal           | 60-trees                         | 0.75                                    | 0.75                                    |
| Hardwood Salvage              | 500                              | 2.10                                    | 4.42                                    |
| Pine Salvage                  | 120                              | 0.50                                    | 1.06                                    |
| Sanitation Harvest            | as needed*                       | 1 per 238-acres                         | 1 per 113-acres                         |
| Prescribed Fire               | 2,000                            | 8.40                                    | 17.70                                   |
| Fire Suppression              | 50                               | 0.21                                    | 0.44                                    |
| Timber Operation Accidents    | 100-trees                        | 1.75                                    | 1.75                                    |
| <b>Total Yearly Estimates</b> | 2956-acres;<br>160 trees         | 14.92; 1 per 238-<br>acres San. Harvest | 28.66; 1 per 113-<br>acres San. Harvest |

\*No acreage has been estimated for this management practice; will be analyzed on a project by project basis.

The above table represents estimated bat exposure to management practices, but does not address bat response and possible negative effects. In order to estimate negative effects, it is first necessary to determine all the potential responses, both negative and positive. There are a range of responses generally agreed upon in regard to Indiana bats and management activities that alter habitat:

1. no response;
2. startled, increased respiration/heart rate;
3. death/injury of adults and/or offspring;
4. abandonment of roost site(s);
5. abandonment of forage area(s);
6. shift of focal roosting and/or foraging habitat
7. increased energy expenditures and decreased fitness (short-term);
8. decreased energy expenditures and increased fitness (long-term);
9. aborted pregnancy/reproduction failure (1 season);
10. increased torpor, delayed development/parturition, and/or delayed sexual maturation of young;
11. short-term reduction in colony reproductive rates (1-2 seasons post-management);
12. short-term reduction in colony size (2-3 seasons post-management);
13. long-term increase in colony reproductive rate;
14. long-term increase in colony size.

Of these fourteen (14) responses, six (6) of them are considered to be negative responses rising to the level of take (from the above list, numbers 3,7,9,10,11 and 12). In order to apply negative response to exposure rates, it is necessary to compute the likelihood of a negative response from the list presented above by dividing the full complement of responses by the number of negative responses ( $14 / 6 = 43\%$ ). Now, by multiplying the estimated number of bats exposed to a particular management practice by the corresponding rate of negative response, it is possible to estimate the likely number of bats that will be taken by a particular management practice.

**Figure 4. Indiana bat Take Estimates**

| <b>Management Activity</b>    | <b>Acres Affected (per year)</b> | <b>Number of Females/Pups Taken</b>    | <b>Number of Males Taken</b>           |
|-------------------------------|----------------------------------|----------------------------------------|----------------------------------------|
| Hardwood Clearcut Harvest     | 102                              | 0.18                                   | 0.39                                   |
| Pine Clearcut Harvest         | 102                              | 0.18                                   | 0.39                                   |
| Hardwood Shelterwood Harvest  | 76                               | 0.14                                   | 0.29                                   |
| Pine Shelterwood Harvest      | 8                                | 0.01                                   | 0.03                                   |
| Hazard Tree Removal           | 60-trees                         | 0.33                                   | 0.33                                   |
| Hardwood Salvage              | 500                              | 0.90                                   | 1.90                                   |
| Pine Salvage                  | 120                              | 0.22                                   | 0.46                                   |
| Sanitation Harvest            | as needed*                       | 1 per 102-acres                        | 1 per 49-acres                         |
| Prescribed Fire               | 2,000                            | 3.61                                   | 7.61                                   |
| Fire Suppression              | 50                               | 0.09                                   | 0.19                                   |
| Timber Operation Accidents    | 100-trees                        | 0.75                                   | 0.75                                   |
| <b>Total Yearly Estimates</b> | 2956-acres;<br>160 trees         | 6.41; 1 per 102-<br>acres San. Harvest | 12.34; 1 per 49-<br>acres San. Harvest |

\*No acreage has been estimated for this management practice; will be analyzed on a project by project basis.

## **EFFECT OF THE TAKE**

In the accompanying biological opinion, the Service determined that this level of expected take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

The amount of incidental take allowed here (2956-acres per year), as expressed in acres of habitat lost or altered, spread out over the forested portion of the HNF (187,201-acres) represents only 1.6% of affected habitat per year. This ratio decreases significantly when the entire Action Area (including private forests – 644,130-acres total) is considered. It is likely that additional forest management will likely occur on non-Forest Service properties within the Action Area; however, 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 according to the 2006 Plan.

## **REASONABLE AND PRUDENT MEASURES**

Within the Biological Assessment and the Forest Plan the land and resource management standards and guidelines for the Hoosier National Forest are documented. These standards and guidelines are sound forest management practices and benefit a variety of wildlife species, including the Indiana bat. However, the Service believes the following reasonable and prudent measures are necessary and appropriate to further minimize take of Indiana bats:

1. All tree removal activity will be closely monitored and reported on a project-by-project basis to ensure that impacts of incidental take associated with future proposed projects are appropriately minimized.
2. Further minimize impacts to roosting habitat by adequately monitoring active roosts before and after management activities occurring nearby.

## **TERMS AND CONDITIONS**

In order to be exempt from the prohibitions of section 9 of the Act, the Hoosier National Forest must comply with the following terms and conditions, which implement the reasonable and prudent measures, and outline required reporting/monitoring provisions. These terms and conditions are non-discretionary.

1. To reduce the possible impacts to Indiana bats due to loss or degradation of roosting habitat, the following is necessary:
  - Develop management goals and directives (conservation plan) for each known maternity colony at micro-topographical level, taking into consideration current conditions and future restraints and/or challenges.

- Perform emergence counts on all trees targeted for removal during the bats' active period (April 15 – September 15) that exhibit maternity roost tree characteristics.
2. Any dead bats located on the HNF, regardless of species, should be immediately reported to the BFO [(812)334-4261], and subsequently transported on ice to the BFO. No attempt should be made to handle any live bat, regardless of its condition; report bats that appear to be sick or injured to the BFO. The BFO will make a species determination on any dead bat or moribund bats found on the HNF.
  3. Include all Indiana bat Standards and Guidelines (2006 Forest Plan) into all contract language regarding timber harvest, transport or other activities associated with timber management activities or other tree-removal activities.
    - Conduct pre-harvest environmental meeting with contractors and their employees on-site before any activities associated with timber harvest and/or removal; emphasize strict adherence to Standards and Guidelines; discuss life history and habitat needs of Indiana bats; adequately describe roost tree characteristics and the critical role they play for bats, and the subsequent importance in avoiding these trees during harvest operations.

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. The Service anticipates that annually no more than 2956-acres of habitat will be lost or altered in accordance with the Incidental Take Statement contained within. If, during the course of action, this level of take is exceeded, such incidental take would represent new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

## **REQUIREMENTS FOR MONITORING**

To monitor the status of Indiana bats on the HNF and to monitor anticipated levels of take, the following is necessary:

- Monitor occupied Indiana bat hibernacula on the HNF to assess changes in population numbers, changes in microclimate, the effectiveness of protective structures currently in place, etc.
- Habitat use at all sites where Indiana bats are documented on the HNF should be characterized and quantified at both the local and landscape levels using GIS and/or other advanced computer software.
- Monitor the number of suitable roost trees available to the species on HNF using Forest Inventory Assessment (FIA) data once every five-years at a minimum.
- Monitor all incidental take as identified in this Biological Opinion on an annual basis.
- The results of all monitoring activities shall be provided to the BFO no later than January 31 of the following year.

- Provide personnel of the BFO an opportunity to conduct site visits to all parcels of the HNF in order to evaluate compliance of monitoring requirements. Site visits will be scheduled by mutual consent of the Service and personnel of the HNF.

Monitoring over time will ensure that the Standards and Guidelines incorporated into the Forest Plan are adequately protecting Indiana bats. In the long run, such monitoring will allow the Forest Service to evolve the Standards and Guidelines to be most effective; actions taken that are not effective may be dropped in favor of those found to be most effective. The overall goal of the Forest Plan in regard to Indiana bats is to reduce, or eliminate, take. Monitoring the effectiveness of the measures taken to do this will aid in developing future project actions and greatly reduce take to the species.

## **CONSERVATION RECOMMENDATIONS**

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

The Service recommends that the HNF implement the following conservation measures to benefit Indiana bats:

- Monitor the extent of use by Indiana bats on the HNF. Such monitoring should include the employment of currently accepted techniques used to gather information on the Indiana bat on the HNF. Prioritize the surveying to areas that have a higher probability of having Indiana bat use or more optimal habitat conditions.
- In order to develop information on the Indiana bat, cooperate with the Service, and any other interested agency(s), to complete studies on the effects of forest management activities on Indiana bats and their habitat. Once initiated, provide a copy of the annual results from this study to the Service's Bloomington Field Office.
- For successful implementation of the 2006 Forest Plan, conduct a workshop, in coordination with the Service, which will inform Forest Service personnel (including but not limited to biologists, planners, technical/service personnel, and timber and fire personnel) on the practical application of all standards and guidelines applicable to the Indiana bat. This workshop should include a section on writing complete site-specific biological assessments that correlate to this programmatic biological opinion and the programmatic biological assessment. In addition, continue to conduct training for employees of the HNF on bats occurring on the National Forest. Training should include sections on bat identification, biology, habitat requirements and sampling techniques.
- Conduct radio-telemetry study(s) of Indiana bats within the Action Area to assess their movements and habitat use relative to timber harvests.

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

### **REINITIATION NOTICE**

This concludes formal consultation on the implementation of the Hoosier National Forest Land and Resource Management Plan and projects predicated upon it, as outlined in the Biological Assessment. 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 continued implementation of the 2006 Forest Plan (and subsequent amendments) and projects predicated upon it may affect listed species in a manner or to an extent not considered in this opinion; (3) the continued implementation of the 2006 Forest Plan and projects predicated upon it is subsequently modified in a manner that causes an effect to listed species 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. Requests for reinitiation, or questions regarding reinitiation, should be directed to the BFO.

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