

**INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FORESTRY
RESOURCE MANAGEMENT STRATEGY FOR INDIANA BAT
ON
INDIANA STATE FORESTS
Revised April 2008**

The Indiana Division of Forestry (DoF) recognizes the potential to enhance Indiana bat habitat on its lands by implementing a comprehensive management strategy. Of the numerous species of bats native to Indiana, the Indiana bat (*Myotis sodalis*) is one of only two species that are designated as state and federally endangered (the gray bat [*Myotis grisescens*] is the other species).

Species Life History and Habitat

The Indiana bat is a migratory species that is found throughout much of the eastern half of the United States. During the winter, Indiana bats are restricted to suitable hibernacula (caves and abandoned mines) that primarily are located in karst areas of east-central United States. More than 82% of the range-wide population of Indiana bats occupy 22 “Priority One” hibernacula (i.e. hibernacula with current or historical populations of >10,000 individuals) (USFWS 2007). At least two of these “Priority One” hibernacula, and several non-Priority One hibernacula are located on or near DoF property. Based on censuses taken at all known hibernacula, the total Indiana bat population in the United States was estimated to be approximately 457,000 bats in 2005 (USFWS 2007).

Male and female Indiana bats are typically segregated in the summer. Most reproductive female Indiana bats begin to migrate from the hibernacula in April to form maternity colonies of up to 100 adults on roost trees. Less is known about male migration, but they presumably roost alone or in small bachelor colonies. Roosts are located under the loose bark of dead, dying or mature live trees and in tree hollows. The suitability of any tree as a roost site is determined by its condition (dead or alive), quantity of loose bark, solar exposure and location relative to other trees, and spatial relationship to water sources and foraging areas. A number of tree species meet the roost site suitability requirements of the Indiana bat; the most important characteristic is probably the presence of exfoliating bark with space for the bats to roost between the bark and the tree bole. Researchers have found Indiana bats roosting in a variety of tree species; the species shown in Table 1 are believed to have relatively high value as potential maternity roosts. Morphological characteristics of the tree, (i.e., dead, senescent, or severely injured from lightning strikes) make them suitable roost sites because the trees possess bark that is tenacious and springs away from the trunk upon dying.

Female Indiana bats typically arrive to their summer habitats in early April. During the early spring, a number of roosts may be used temporarily, until a roost with larger numbers is established. Most documented maternity colonies contain 100 or fewer adult bats. After grouping into nursery colonies, females give birth to one “pup” in late

June or early July. Young bats are weaned and capable of flight approximately one month after birth.

During the summer Indiana bats are known to use a number of alternate roost trees in addition to the 1-3 primary roost trees typically used. Primary roost trees are those that are most consistently used by members of a maternity colony. Alternate roosts are used by individuals or small numbers of bats and may be used intermittently throughout the summer or used only one or a few days (USFWS 2007). Forested floodplains and riparian areas were considered by early researchers to be primary roosting and foraging habitats used in the summer and these forest types unquestionably are important. More recently, however, upland forest has also been shown to be used by Indiana bats for roosting, and upland forest, old fields, and pastures with scattered trees have been shown to provide foraging habitat as well (USFWS 2007). While much is known about the Indiana bat, a comprehensive understanding of the summer needs of this species has yet to be attained.

Indiana bats feed on flying insects. The bats tend to forage among and adjacent to tree canopies of floodplain, riparian, and upland forests. They also forage over clearings with early successional vegetation, along cropland edges and wooded fencerows, and over farm ponds in pastures (USFWS 2007).

DoF Bat Management Strategy: Background Information

The recovery of the Indiana bat to where it is no longer endangered is ultimately dependent on maintaining protected hibernacula, appropriate roost trees and suitable mixed forest communities for foraging. Of Indiana's nearly 23 million acres, about 20%, or 4.5 million acres, are currently forestland. Before European settlement Indiana was about 85% forested and contained nearly 20 million acres of forestland. By 1900 that acreage had been reduced to less than 2 million acres of forest or only about 7%. Since 1900 active conservation efforts and changing economies have allowed the state's forests to recover to the current 4.5 million acre level.

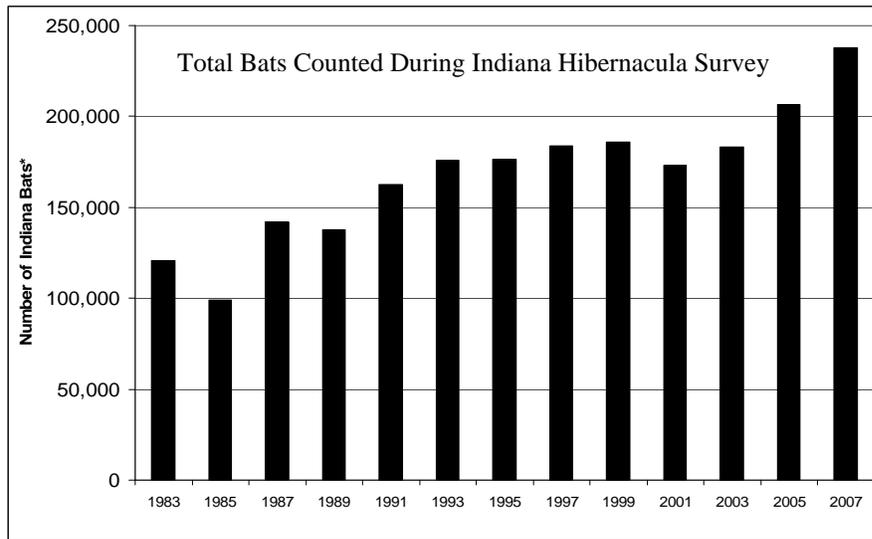
The Indiana Division of Forestry manages about 150,000 total acres. This acreage constitutes about 3.4% of the state's forest land and only about 0.7% of the total state land base. While the Division's holdings represent a small percentage of the state's totals they do represent some of the larger contiguous forest parcels remaining in the state as well as several Indiana bat hibernacula.

While there is limited information available about Indiana bat summer habitat use, there is a significant amount of long term information about Indiana bat hibernacula located within Indiana. The following excerpt from a recent population monitoring report (Brack et al. 2007) addresses the advantages and disadvantages of the very specific winter habitat needs of the Indiana bat and the encouraging results of Indiana bat population monitoring during the last 25 years.

“Seasonal aggregation of individuals during hibernation is important for two reasons. First, seasonal aggregations make the species extremely susceptible to man-made perturbations and natural catastrophes, and thus contribute to endangerment of the species. Second, the aggregations provide a unique opportunity to regularly census the entire population, and to monitor gains or

losses. Counting bats in hibernacula is relatively easy and inexpensive, and an effective way to monitor population levels.

When regular surveys began in 1981/82, nearly 150,000 Indiana bats hibernated in the state of Indiana. By 1985, the population was one-third lower – less than 100,000 bats. Numbers increased during the next seven surveys until 185,899 bats were found in 1999. At that time, there were more Indiana bats hibernating in the state of Indiana than at any time since regular surveys began. Much of the increase was due to increases at Ray’s and Wyandotte caves. In 2001, the number of hibernating bats decreased for unknown reasons, but has been increasing since [see graph, below]”.



*Data from Brack et al. 2007

Some of the noted increases in Indiana bats can be attributed to the installation of “bat friendly” gates on a number of hibernacula. The Division of Forestry has been actively involved, with several public and private partners in some of the gate installations. The Division of Forestry will continue to search for and survey potential hibernacula sites on DoF property.

Additionally, protection is afforded bats and other species that inhabit caves through the *Unlawful acts relating to caves statute (Indiana Code 35-43-1-3)*.

MANAGEMENT STRATEGY FOR STATE FORESTS

The Division of Forestry is adopting the following management strategy to provide guidance in the conservation and enhancement of Indiana bat habitat on Division property while implementing the best management practices for water quality.

Indiana’s forests are continually maturing. Both even-aged and uneven-aged forest management practices may be incorporated on Division managed lands. In addition to sustaining healthy forest communities, forest manipulation provides habitat for early successional forest wildlife species. The Division is concerned about maintaining, protecting, and restoring Indiana bat maternity and foraging habitat. The

Division is also obligated to provide habitats for early-, mid-, and late-successional wildlife. It is the Division's belief that tree harvesting, utilizing best management practices, on public lands is compatible with Indiana bat habitat management. In keeping with the findings of the U.S. Fish and Wildlife Service's *Indiana Bat Revised Recovery Plan* (2007) which is being implemented by other state natural resource agencies, the Division of Forestry will implement the following forest management strategies on its managed lands. Furthermore, as data become available, the Division will refine its management strategies to be consistent with the U.S. Fish and Wildlife Service's guidelines for the Indiana bat management, on non-federal lands.¹

Note: As referenced in these strategies the following definitions apply:

Tract -- An area of state forest, usually containing between 40 and 100 acres, with identifiable physical boundaries. Forest resource management decision-making is ordinarily done at the tract level.

Compartment -- A combination of several tracts, in close proximity to each other, ordinarily totaling 600 - 1000 acres. The compartment serves as the second tier spatial context for forest resource management decisions on state forests.

Landscape scale -- That portion of a state forest ownership, usually containing several compartments in close proximity to each other and many times containing significant private lands. These areas exhibit a similar suite of ecological conditions and management considerations.

Timber harvest -- Silvicultural practices which involve the cutting and extraction of multiple trees, from a designated area of the forest, resulting in the production of forest products and improved residual timber conditions.

1. In forests under active timber management, both even-aged and uneven-aged forest management practices may be used. Both practices provide habitats for early-, mid-, and late-successional wildlife species, including the Indiana bat.
2. Forest management practices that perpetuate hardwoods and maintain or create a diversity of age and size classes will be incorporated. Mature and over-mature trees will be well represented within all forest management compartments. As these large, old trees die and become snags, they will provide Indiana bats a continuous supply of potential roost sites. The management goal is to develop patchiness, vertical height diversity, and an adequate number of dead and dying trees within each forest management compartment.
3. In general, to ensure that best management practices can be used, no restriction on harvest dates on DoF managed land will be imposed in cases where proper precautions have been implemented to avoid impacting Indiana bats.
4. In Indiana landscapes with areas of large, contiguous, mature forest, overstory tree canopy cover will be maintained between 30 and 80% within forest management

¹ The per acre tree retention requirements will be implemented as an average for the entire "management compartment" and managed at the "tract" level.

compartments and understory tree density will be managed to promote openness, as appropriate within the overall management objectives of the compartment.

In forests under active timber management, maintaining overstory tree canopy cover between 30 and 80% with even-aged and uneven-aged forest management practices will create openings and edges and allow sunlight to reach snags and potential roost trees, thus improving the suitability of the habitat for maternity colonies. Opening the overstory tree canopy also will create foraging habitat as Indiana bats preferentially forage around and adjacent to tree canopies. Maintaining an open understory with forest management practices such as thinning or timber stand improvement (TSI) would remove obstacles to flight and make snags more accessible, allow sunlight to reach the trunks of snags, and allow bats to forage under the tree canopy.

5. The species of trees shown in Table 1 (below), whether dead, dying, or alive, have relatively high value as potential Indiana bat roost trees and will be encouraged for conservation, where practical.

Table 1. Trees found to have relatively high value as potential Indiana bat roost trees (from “Management Guidelines for Informal Section 7 Consultations on Indiana Bats within the State of Indiana”, USFWS Bloomington Field Office)

Tree Species	Scientific Name	Tree Species	Scientific Name
Shagbark hickory	<i>Carya ovata</i>	Sugar maple	<i>Acer saccharum</i>
Bitternut hickory	<i>C. cordiformis</i>	Silver maple	<i>A. saccharinum</i>
Shellbark hickory	<i>C. laciniosa</i>	White ash	<i>Fraxinus americana</i>
Northern red oak	<i>Quercus rubra</i>	Green ash	<i>F. pennsylvanica</i>
Post oak	<i>Q. stellata</i>	Slippery elm	<i>Ulmus rubra</i>
White oak	<i>Q. alba</i>	American elm	<i>U. americana</i>
Black locust	<i>Robinia pseudoacacia</i>	Eastern cottonwood	<i>Populus deltoides</i>

6. Indiana bats typically roost in trees ≥ 11 ” DBH within the oak-hickory, mixed hardwoods, and bottomland hardwoods cover types – often using the species listed in Table 1. Given this, DoF suggests that every effort is made to manage tracts using the compartment-wide live roost tree density targets shown in Table 2, with high priority given to the retention of the preferred species listed in Table 1.

Table 2. Compartment-level live roost tree density targets by diameter distribution, managed at the tract-level.

Diameter (DBH) Distribution	Live Roost Trees per Acre
TOTAL minimum live roost trees per acre ≥ 11 ”:	9
<i>Including</i> at least this many roost trees ≥ 20 ”:	3

7. Snags are an important resource for Indiana bats and other wildlife species; given this, ***it is recommended that whenever possible all snags are left standing during timber harvest operations.*** DoF suggests that every effort is made to manage tracts

using the compartment-wide density targets shown in Table 3 (below), particularly when snags must be felled (e.g., for safety). Since bats typically roost in larger snags, meeting or exceeding suggested compartment-wide densities of snags $\geq 9''$ DBH is especially beneficial. Snags are defined as standing dead or dying trees with $< 10\%$ live crown, ≥ 8 ft tall. Oaks, hickories, and ashes will be favored for retention as snags. Upper slopes and ridge tops will be targeted for snag retention.

Table 3. Compartment-level snag density targets by diameter distribution, managed at the tract-level.

Diameter (DBH) Distribution	Target Snag Density	
	Maintenance-level ^a	Optimal
TOTAL minimum of snags per acre $\geq 5''$:	4	7
Including at least this many snags per acre $\geq 9''$:	3	6
Including at least this many snags per acre $\geq 19''$:	0.5	1

^a approximates current system-wide density of snags

8. Whenever practical, retention of shagbark hickory and shellbark hickory as a forest component will be encouraged because of their value as potential roost trees.
9. When a human safety hazard, dead trees will be removed. Given this policy, special consideration will be given to the possibility of encountering Indiana bats. The best way to ensure that Indiana bats are not roosting in a tree when it is removed is to cut trees between **1 October and 31 March**, when Indiana bats are hibernating in inactive mines and caves (dates may be revised in accordance with U.S. Fish and Wildlife Service guidelines). If it becomes necessary to remove a dead tree between **1 April and 30 September** for public safety, efforts will be made to ensure that bats will not be harmed. Where practical, potential roost trees will be examined at dusk, when bats leave their roost tree to forage. Safety hazard, dead trees from which Indiana bats are observed emerging will not be cut during the summer months.
10. Within riparian corridors, a forested buffer strip will be maintained. The buffer will be a minimum of 100 feet on each side of perennial streams or rivers and a 50 foot buffer will be maintained on each side of intermittent streams (dashed blue-line streams), for at least 80% of the stream’s length. The DoF recognizes that some trees may need to be cut within a buffer strip. However, the integrity of the corridor will be maintained and only minimal cutting may occur after a thorough evaluation of the trees as potential roost sites. Tree planting or reforestation projects will be encouraged along riparian corridors.
11. Around all known “active” Indiana bat hibernacula, 20 acres (where ownership permits) of forest will be designated as an area where timber harvest will not occur. Corridors of tree canopy from the hibernacula to foraging areas will be maintained (where possible). [A known Indiana bat hibernacula will be considered “active” if any hibernacula survey within the previous six (6) years documented 10 or more Indiana bats present within the hibernacula.]

12. Within 5 miles of any Priority One or Priority Two (≥ 500 bats) hibernacula, a minimum of 10% of the Division of Forestry (DoF) ownership will be designated as an area where timber harvest will not occur. The number of snags and roost trees within this 5-mile area will be periodically monitored. Within the 5-mile area, in forests under active timber management, even-aged management and/or uneven-aged forest management practices will be used to maintain or create snags in a diverse age-size class distribution.
13. Dead trees with tight bark may be removed during salvage harvests as they offer little potential as Indiana bat roost trees. Because Indiana bats roost only in standing trees, trees that have fallen to the ground may be salvaged regardless of bark condition.
14. Construction projects or similar activities (including, but not limited to, construction/maintenance of roads, yards, and structures) on DoF properties that may impact Indiana bat habitat, will be assessed on a case by case basis. DoF personnel will first determine if suitable roost trees occur within the project limits, suitable trees include dead and dying trees of the species listed above with exfoliating bark, crevices, or cavities in upland areas or riparian corridors and living trees of the species listed above with exfoliating bark, cavities, or hollow areas formed from broken branches or tops. When suitable trees occur within the project limits, where practical, trees will be conserved as outlined for the Division's active timber management lands. In addition,
 - If suitable habitat occurs and trees must be cut, the DoF recommends cutting occur between **1 October and 31 March** (dates may be revised in accordance with U.S. Fish and Wildlife guidelines), or
 - If suitable trees must be cut during the summer months (**1 April through September 30**) efforts will be made to ensure that bats will not be harmed. Where practical, potential roost trees will be examined at dusk, when bats leave their roost tree to forage. Trees in which Indiana bats are actively roosting will not be cut.
 - Construction zone will be examined for potential Indiana Bat hibernacula.

This management strategy is based on current knowledge of Indiana Bat management and habitat requirements and may be modified to reflect new information as it becomes available.

Literature Cited

Brack, V., Jr., J. Duffey, K. Dunlap, T. Sollman, and J. Boyles. 2007. A 2006-2007 winter survey for Indiana bats (*Myotis sodalis*) in hibernacula of Indiana. An unpublished report for the Indiana Department of Natural Resources, Wildlife Diversity Section. Indianapolis, IN. 105 pp.

U.S. Fish and Wildlife Service (USFWS). 2007. Indiana bat (*Myotis sodalis*) draft recovery plan: first revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 258 pp.