

Forest Management Guidelines for Indiana Bat Habitat
Vermont Fish and Wildlife Department
June 2009

Purposes of Guidelines

These forest management guidelines are developed to provide Vermont's forest managers and landowners with appropriate forest management strategies to maintain and enhance habitat for the state and federally endangered Indiana bat. As written, the guidelines are designed to maintain and enhance Indiana bat habitat in Vermont as well as to prevent harming roosting bats during harvesting operations, *as part of a multiple use forest management approach that accommodates other common forest management goals.* Implementation of these guidelines may best be conducted by forest managers that have received some level of training or exposure to Indiana bat habitat requirements, including the identification of current and future potential roost trees. Where management goals are to be focused on Indiana bats and their habitat, foresters and landowners are encouraged to solicit input from the Vermont Fish and Wildlife Department or the Vermont Forests, Parks, & Recreation Department when designing such a forest management plan.

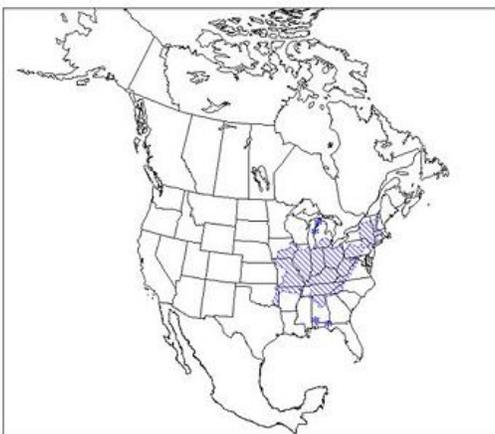
Indiana Bat Life History

The Indiana bat (*Myotis sodalis*) is a state and federally endangered bat the size of one's thumb and weighing less than three pennies (~ 7 grams). Like most bats in Vermont, Indiana bats are long-lived (> 20 years) and produce only a single pup each summer. Indiana bats are found throughout the central and northeastern United States.

Throughout its range, the Indiana bat occupies a patchy landscape of forest woodlots and agriculture. The bat roosts and forages at the edge of and within the forested portions of its range. As a result, forest management within its range is an important influence on the quality of the limited forest habitat available to the animal.



Photo courtesy John Chenger



Bat Conservation International

Fig. 1 Indiana bat and its range

Population Abundance and Distribution in Vermont

Research by the Vermont Fish and Wildlife Department, the U.S. Fish and Wildlife Service, and the Green Mountain National Forest since 2001 indicates that the Champlain

Valley of Vermont provides important summer range for Indiana bats. Female Indiana bats have been tracked from a New York hibernaculum containing over 9000 Indiana bats to several sites in the Champlain Valley, ranging from Orwell to Hinesburg. Since then, a total of 170 Indiana bats have been captured and banded in the Champlain Valley, 61 of which were fitted with radio transmitters to track their range and habitat use.

By 2008, a total of 10 maternity colonies have been identified in Vermont. These colonies occur in New England's only known summer maternity range, and include one of the largest known maternity colonies across the species' range. While average colony size across the species' range is 50 – 80 females, Vermont's known maternity colonies average 118 females. As a result, the Champlain Valley may have as many as 30 or more maternity colonies throughout the region.

Ensuing surveys have also captured male Indiana bats as far south as West Haven and east as Hinesburg. Surveys conducted outside of the known distribution, yet still within the Lake Champlain Valley and Valley of Vermont Biophysical Regions have not located any Indiana bat maternity colonies. Figure 2 illustrates the known distribution of Indiana bat maternity colony habitat in the state.

Recent hibernacula surveys have identified a small number (472) of Indiana bats in three caves/mines in the towns of Manchester, Dorset, and Brandon.

Figure 2 illustrates the known summer range, hibernacula habitat, and potential range of Indiana bats in Vermont.

The recent threat of White Nose Syndrome (WNS) on all 6 of Vermont's cave bat species further demonstrates the need for maintaining and enhancing Indiana bat habitat in the Champlain Valley. While the final implications of WNS on Indiana bat populations in Vermont are yet to be understood, the value and distribution of suitable habitat for the species is likely to be more important over time.

Endangered Species Status

The Indiana bat was first officially listed as federally endangered in 1967 (the bat was officially listed as one of Vermont's first endangered species in 1972), several years prior to the establishment of the federal Endangered Species Act (ESA). Since that time, Indiana bat populations declined from an estimated 675,000 to 380,000 animals in 2001. However, recent winter censuses indicate rangewide populations now approach 450,000 bats. It is notable that populations have declined in the southeastern United States, but have been stable or slightly increasing here in the Northeast. Furthermore, the Indiana bats found in the Northeast may be very important to the species recovery given two facts: 1) Vermont is at the species' northeastern-most edge of its range, and 2) Indiana bats in the Northeast appear to be genetically distinct from other portions of the species' range. Unfortunately, the very recent effects of WNS will likely set back most, if not all, of the population gains experienced by this species.

The bat is protected from taking (i.e., harming, killing, harassing) both at the federal and state levels. Although the Vermont endangered species law specifically exempts normal silvicultural practices, the federal Endangered Species Act does not. (Note: the Public Service Board Order regarding chip harvesting for energy does require endangered species takings and habitat to be addressed). The forest management activity most vulnerable to killing Indiana bats is the cutting of trees within which bats are currently roosting. There are numerous reports of northern long-eared bats found within felled trees and it is not unreasonable to assume that Indiana bats could experience the same fate. The following guidelines attempt to avoid any potential to kill Indiana bats and, at a minimum, should be incorporated into forest management of a given parcel.

Critical Habitats

The Vermont Fish and Wildlife Department recognizes two specific critical habitats that are important to the survival and productivity of Indiana bats: maternity colony habitat and hibernacula habitat. Descriptions of the two habitats are provided below.

It should be noted that the current, yet outdated, version of the federal Indiana bat Recovery Plan identifies and designates only hibernacula as a formally designated critical habitat afforded protection under the federal Endangered Species Act.

Maternity Colony Habitat: Until recently, little has been known about the summer habitat of Indiana bats. Female Indiana bats emerge from hibernation and travel, potentially great distances, to their summer range. Females emerge with stored sperm, and quickly become pregnant. The females appear to migrate to their maternity habitats, although they are initially more dispersed, and gather into larger maternity colonies as parturition approaches. In Vermont, maternity colony habitat appears to be focused in the southern portions of the Champlain Valley, where the lower elevations provide for warmer, drier summer seasons (Fig. 2).

Maternity colony habitat is comprised of two essential components – roost trees and suitable foraging habitat. Maternity colonies congregate in primary and secondary (the latter often termed “alternate”) roost trees where the bats “roost” under loose (i.e., exfoliating) bark. Bats from the same colony may use as many as 10 – 15 different roost trees within their home range. The primary roost trees are generally occupied by many bats (as many as 300+ in some cases). Research from Vermont (Britzke et al. 2006, Watrous et al., 2006) and elsewhere (USFWS, 2007) on the characteristics of primary and secondary roost trees indicate that they are:

- Live shagbark hickory or black locust trees, or dead or dying trees (in the earlier stages of decay) of any species
- Possess exfoliating bark under which bats roost
- Greater than 8-10 inches dbh
- Dominant or co-dominant in the forest stand
- Receive some level of direct solar radiation
- Generally within 20 feet of forested cover

Research across the Indiana bat's range demonstrates that while Indiana bats have been documented using over 30 tree species for roosting, there are particular tree species that develop quality characteristics of exfoliating bark. These species include, but are not limited to:

shagbark hickory (<i>Carya ovata</i>)	black locust (<i>Robinia pseudoacacia</i>)
American elm (<i>Ulmus americana</i>)	slippery elm (<i>Ulmus rubra</i>)
white ash (<i>Fraxinus americana</i>)	green ash (<i>Fraxinus pennsylvanica</i>)
quaking aspen (<i>Populus tremuloides</i>)	sugar maple (<i>Acer saccharum</i>)
white pine (<i>Pinus strobus</i>)	silver maple (<i>Acer saccharinum</i>)
red oak (<i>Quercus rubra</i>)	white oak (<i>Quercus alba</i>)

Research also indicates that roost trees are often clustered on the landscape, and may exist in areas having a good supply of snags. It is also noteworthy that directly after emergence from hibernation, female bats have been found to roost in trees as small as 8 inches dbh.

The other important element of maternity colony habitat is suitable foraging habitat where bats feed for insects. Radio telemetry work in Vermont suggests Indiana bats forage within approximately 2.5 – 2.75 miles of their roost trees, although much greater foraging distances have been observed in other states. There is little published information on the importance and characteristics of quality foraging habitat in and around the maternity roost trees. However, research does indicate that Indiana bats prefer to forage and travel along the forest-air interface of the forest canopy or along forest edges/hedgerows (USFWS, 2007). Open fields are generally avoided during foraging activity.

General forest bat research suggests that high quality foraging habitat is a relatively open stand condition below a main canopy of small sawtimber and larger size classes. Mature and over-mature uneven-aged stands that exhibit structural diversity and occasional gap openings can provide similarly high quality roosting and foraging habitat. In contrast, stand-wide sapling to pole size classes are less favorable as these limit bat flight and foraging to the stand edge or above the canopy. While it is not necessary for the entire parcel to be dedicated to suitable roosting and foraging habitat, it is important that these habitats are available in an interconnected network of forest patches and riparian areas.

Hibernaculum Habitat: Male Indiana bats do not congregate into such large colonies as females, and may not migrate as far from the hibernacula during the summer months. Males have been captured in the Champlain Valley, but little is known about their roost tree selection. A single transmittered male Indiana bat was tracked in Middlebury to numerous trees, each of which met the characteristics of maternity colonies. Most males tend to remain within 5-9 miles of the hibernaculum, and both males and females concentrate around the hibernaculum both in the fall during breeding season and in the spring prior to migration. This makes forestland proximate to hibernacula important for their survival. The closer a site is to the hibernacula, the more likely that it is used by a

concentration of male bats in the summer and concentrations of both sexes during the spring and fall.

Because Vermont's limited Indiana bat hibernacula are found in higher elevations and within more forested settings than the summer maternity colonies, bats residing near hibernacula (i.e., males in summer and both sexes in the spring and fall) may not have the same high quality habitat offered in the Champlain Valley. As a result, suitable roosting and foraging habitat in the vicinity of hibernacula remain important considerations, particularly as the bats gain critical fat reserves just prior to hibernation.

Individual hibernacula management zones have been delineated for each of the three caves/mines used by Indiana bats in Vermont. The three zones represent the likelihood of roosting Indiana bats based on both the distance from the hibernacula and the suitability of the habitat.

Forest Management Goals for Indiana Bats

Maternity Colony Habitat: Forest management activities within Indiana bat summer range should provide an interconnected network of forest blocks and riparian areas maintaining or enhancing an adequate long-term supply of large diameter dead and dying roost trees. A long-term supply of Indiana bat roost trees requires the retention of large diameter trees that serve as either current or future potential roost trees. Management activities must avoid harming or killing any Indiana bats in roost trees while conducting such activities.

Hibernaculum Habitat: Forest management activities within the two to three zones (depending on winter population size) specifically delineated for each hibernacula should maintain or enhance an adequate supply of large diameter dead and dying roost trees. In addition, forest management activities must avoid harming or killing Indiana bats while conducting such activities

The closer the site is to the hibernacula, the more sensitive management activities must be to maintaining an adequate supply of quality roost trees, foraging habitat, and avoiding harm to roosting bats. In addition, the greater the number of hibernating bats, the greater the distance from the cave/mine that forest management guidelines should be applied.

Forest Management Guidelines

There are three existing forest management guidelines for Indiana bats (Missouri Dept. of Conservation and the U.S. Fish and Wildlife Service biological opinions for both the Green Mountain National Forest and the State of Indiana) to serve as models for appropriate management guidelines. In addition, the publication *Forest Management & Bats* (Taylor 2006) addresses forest management for all species of bats at a national level.

Based on these models, the draft U.S. Fish and Wildlife Service Indiana bat recovery plan (USFWS, 2007), as well as information gained from research on Vermont's maternity colony habitat (Watrous et al., 2006), the following forest management guidelines are recommended for maintaining and enhancing Indiana bat habitat in Vermont.

Maternity Colony Habitat

Maternity colony habitat is defined as habitat used by a colony of reproductive female Indiana bats and comprised of roost trees (primary and secondary) and the colony's associated foraging habitat. Forest management goals should include the maintenance or enhancement of roost tree availability and foraging habitat.

Numerous maternity colonies have been documented throughout the Champlain Valley and it should be assumed that nearly all of the suitable range within the Champlain valley contains maternity colonies. Indiana bat surveys conducted in accordance with Vermont Fish and Wildlife Department's *Indiana Bat Survey Procedures and Guidelines* may be conducted to demonstrate that a particular site does not provide maternity colony habitat.

The following forest management guidelines refer to three subsets of roost trees that, together, assure the long-term availability of this habitat component. First, "*known roost trees*" are defined as roost trees documented to historically or currently support female Indiana bats. "Potential roost trees" are divided among (1) those trees currently exhibiting the characteristics of primary or secondary roost trees as described on page 3, but lacking any documentation of use by Indiana bats ("*current potential roost trees*") and (2) large diameter (>8 inch dbh) cull trees that do not currently possess exfoliating bark, but will likely do so in the coming years ("*future potential roost trees*").

Forest Management Guidelines for Indiana Bat Maternity Colony Habitat

1. **Assume presence of Indiana bats:** For all lands within the summer range for Indiana bats, it should be assumed that Indiana bats are either roosting and/or foraging on the property unless:
 - i. Bat surveys conducted in accord with *Indiana Bat Survey Procedures and Guidelines outside of known maternity colonies* (Fig. 3) do not demonstrate the presence of Indiana bats, or
 - ii. A habitat assessment concludes the site is not suitable for Indiana bat maternity colony habitat (see *Indiana Bat Maternity Colony Habitat Assessment Guide*).
2. **Restrict harvesting to hibernation period:** Harvesting of stands having trees greater than 8 inches dbh should occur between November 1 and April 1 when the bats are hibernating in caves/mines to avoid harming or killing roosting bats. Exceptions to this rule must be preceded by at least one of the following:
 - i. Indiana bat surveys conducted in accord with *Indiana Bat Survey Procedures and Guidelines* demonstrate that Indiana bats are not present on the site
 - ii. an inventory of potential roost trees is conducted as prescribed in *Inventory Methods for Potential Roost Trees* and all current potential roost trees are marked for retention

- iii. a forester trained in Indiana bat roost tree identification marks all current potential roost trees so that they will be retained and protected from damage during the harvest operation
3. **Conduct roost tree inventories:** Forest inventories should adequately survey the parcel to determine the supply and distribution of potential roost trees on the property and to identify potential roost trees to be maintained or enhanced. This work should be conducted as prescribed in Inventory Methods for Potential Roost Trees.
 4. **Maintain or enhance known and potential roost trees:** Forest management activities should maintain and/or enhance an adequate supply of known and current potential roost trees as prescribed below:
 - Maintain all shagbark hickory (unless thinning is prescribed to maintain vigor of shagbark hickories) and black locust trees (only those greater than 8 inches dbh for this species)
 - Maintain all known roost trees within which bats have been observed or documented roosting
 - Maintain an adequate supply of current potential primary and alternate roost trees of various species (with emphasis on the preferred roost tree species) exhibiting the characteristics of roost trees so that, in total, there exist:
 - 2 trees/acre less than 10 inches dbh
 - 4 trees/acre between 10 and 18 inches dbh
 - 1 tree/acre greater than 18 inches dbh

The number of current potential roost trees need not be distributed evenly throughout the parcel, but may be concentrated in areas having a slope, aspect, or position (i.e., forest edge) that enhances solar radiation as well as connectivity to suitable foraging habitat. When concentrations of large diameter, high quality current potential roost trees are enhanced through management (e.g., daylighting or girdling), then compromises in the average number of current potential roost trees in other stands in the parcel can be adjusted downward where other forest management goals may be emphasized.

If adequate roost tree numbers are not available, then a proportion (2–3/acre) of select cull trees (i.e., greater than 10 inches dbh) should be girdled to more quickly become current potential roost trees. If preferred, these densities can be concentrated on a limited acreage as described above or accompanied with openings or along forest stand edges to enhance solar radiation in order to achieve total potential roost tree target numbers.

- Maintain a supply of large diameter cull trees for long-term retention to serve as future potential roost trees, prioritizing for larger trees that are more dominant in the canopy.
- Maintain current stand conditions within tree height distance directly surrounding known roost trees, unless careful removal of adjacent tree(s)

shading the known roost tree can be conducted without damaging the roost tree. In particular, removal of adjacent trees shading some live shagbark hickory trees may be very effective in increasing solar radiation for many years.

- “Daylight” or create openings (on as many as 3 sides) adjacent to current potential roost trees, particularly live shagbark hickory trees greater than 12 inches dbh, leaving adequate canopy cover within 20 feet for bats to emerge into forest cover.
- Preclude openings (e.g., patch cuts) that result in clusters of potential roost trees or any potential roost tree greater than 18 inches dbh out in the open (greater than 20 feet from canopy cover).

5. **Provide suitable foraging habitat:** Forest management activities should maintain or enhance forest stand conditions and connectivity for the purposes of providing an interconnected network of suitable foraging habitat. Management activities should occur in such a manner as to:

- Avoid or minimize forest conversion and maintain forest connectivity among forest patches.
- Retain 25-foot forested buffers along streams, ponds, lakes, and wetlands, preferably interconnected to forest stands of suitable foraging habitat.
- Retain 25-foot forested hedgerows that connect forest stands of suitable foraging habitat.
- Maintain forest connectivity among a diversity of habitat types (i.e., forest blocks, wetlands, streams) to provide access to diverse suitable foraging habitat.
- When consistent with other forest management goals, allow for an adequate portion of the parcel to maintain mature forest conditions (trees greater than 18 inches dbh and snags with exfoliating bark) that provide adequate numbers of potential roost trees. Forest management activities should strive to provide a diversity of forest stand conditions that allow foraging along the canopy-air interface such as an open stand condition below the main canopy, vertical diversity (sapling to pole size classes) in scattered groups throughout the parcel, and no less than 60% crown closure.
- In managing oak-hickory and red maple-silver maple stands, Group Selection with area control (as described by Lamson and Leak, 2000) should be considered. This system is adaptable to the silvicultural requirements of these tree species and Indiana bat habitat requirements. Vertical diversity (sapling to pole size classes) is restricted to individual groups in a small portion of the stand.

Hibernacula Habitat

Hibernacula habitat is defined as the caves and mines used by bats for winter hibernation as well as the surrounding forested habitat serving as spring, summer, and fall roosting and foraging habitat for concentrations of Indiana bats. The precise area involved is delineated through hibernaculum-specific management zones.

Hibernacula habitat for each known cave/mine used by Indiana bats is delineated into one of three zones for forest management. The zone delineations are based on the likelihood of roosting Indiana bats based on the distance from the hibernacula, the size of the hibernating population of Indiana bats, and the suitability of the habitat. *In general, the following forest management guidelines currently apply to Zones 1 and 2 only, unless winter populations eventually exceed 1000 Indiana bats at a particular cave/mine.* The specific zone delineations for each of the hibernacula are shown in Figures 4 and 5.

Forest Management Guidelines for Hibernacula Habitat

Lands within Zone 1 (0 – 1 mile from hibernacula)

Lands within Zone 1 should be managed to preclude the potential to harm roosting bats, as well to maintain potential roost trees and suitable foraging habitat.

1. **Assume presence of Indiana bats:** For all lands within Zone 1, it should be assumed that Indiana bats are either roosting and/or foraging on the property.
2. **Restrict harvesting to hibernation period:** For all parcels within Zone 1, all harvesting of stands having trees greater than 8 inches dbh should occur between November 1 and April 1. The only exception to this restriction requires that a forester trained in Indiana bat roost tree identification marks all current potential roost trees so that they will be retained and protected from damage during the harvest operation.
3. **Conduct roost tree inventories:** Forest inventories should adequately survey the parcel to determine the supply and distribution of potential roost trees on the property and to identify potential roost trees to be maintained or enhanced. This work should be conducted as prescribed in Inventory Methods for Potential Roost Trees.
4. **Maintain or enhance known and potential roost trees:** For lands within Zone 1, forest management activities should maintain and/or enhance an adequate supply of known and current potential roost trees as prescribed below:
 - Maintain all shagbark hickory (unless thinning is prescribed to maintain vigor of shagbark hickories) and black locust trees (only those greater than 8 inches dbh for this species)
 - Maintain all known roost trees within which bats have been observed or documented roosting
 - Maintain an adequate supply of current potential primary and alternate roost trees of various species (with emphasis on the preferred roost tree species) exhibiting the characteristics of roost trees so that, in total, there exist:
 - 2 trees/acre less than 10 inches dbh
 - 4 trees/acre between 10 and 18 inches dbh
 - 1 tree/acre greater than 18 inches dbh

The number of current potential roost trees need not be distributed evenly throughout the parcel, but may be concentrated in areas having a slope, aspect, or position (i.e., forest edge) that enhances solar radiation as well

as connectivity to suitable foraging habitat. When concentrations of large diameter, high quality current potential roost trees are enhanced through management (e.g., daylighting or girdling), then compromises in the average number of current potential roost trees in other stands in the parcel can be adjusted downward where other forest management goals may be emphasized.

If adequate known or current potential roost tree numbers are not available, then a proportion (2–3/acre) of select cull trees (i.e., greater than 10 inches dbh) should be girdled to more quickly become current potential roost trees. If preferred, these densities can be concentrated on a limited acreage as described above or accompanied with openings or along forest stand edges to enhance solar radiation in order to achieve total potential roost tree target numbers.

- Maintain a supply of large diameter cull trees for long-term retention to serve as future potential roost trees, prioritizing for larger trees that are more dominant in the canopy.
- Preclude openings that result in clusters of potential roost trees or any potential roost tree greater than 18 inches dbh out in the open (greater than 20 feet from canopy cover)
- “Daylight” or create openings (on as many as 3 sides) adjacent to potential roost trees, particularly live shagbark hickory trees greater than 12 inches dbh, leaving adequate canopy cover within 20 feet for bats to emerge into forest cover

5. **Provide suitable foraging habitat:** Forest management activities should maintain or enhance forest stand conditions for the purposes of providing suitable foraging habitat. Management activities should occur in such a manner as to:

- Maintain forest connectivity among forest patches.
- When consistent with other forest management goals, allow for an adequate portion of the parcel to maintain mature forest conditions (trees greater than 18 inches dbh and snags with exfoliating bark) that provide adequate numbers of potential roost trees. Forest management activities should strive to provide a diversity of forest stand conditions that allow foraging along the canopy-air interface such as an open stand condition below the main canopy, vertical diversity (sapling to pole size classes) in scattered groups throughout the parcel, and no less than 60% crown closure.

Lands within Zone 2 (1 – 3 miles from hibernacula)

Lands within Zone 2 should be managed to preclude the potential to harm roosting bats, as well to maintain potential roost trees.

1. **Assume presence of Indiana bats:** For all lands within Zone 2, it should be assumed that Indiana bats are either roosting and/or foraging on the property.
2. **Restrict harvesting to hibernation period:** For all parcels within Zone 2, all harvesting of stands having trees greater than 8 inches dbh should occur between November 1 and April 1. The only exception to this restriction requires that a forester trained in Indiana bat roost tree identification marks all current potential roost trees so that they will be retained and protected from damage during the harvest operation.
3. **Conduct roost tree inventories:** Forest inventories should adequately survey the parcel to determine the supply and distribution of potential roost trees on the property and to identify potential roost trees to be maintained or enhanced. This work should be conducted as prescribed in Inventory Methods for Potential Roost Trees.
4. **Maintain or enhance known and current potential roost trees:** For lands within Zone 2, forest management activities should maintain and/or enhance existing and current potential roost trees:
 - Maintain all known roost trees, all shagbark hickory (unless thinning is prescribed to maintain vigor of shagbark hickories) and black locust trees, and an adequate supply of current potential roost trees so that, in total, there exist:
 - 2 trees/acre less than 10 inches dbh
 - 4 trees/acre between 10 and 18 inches dbh
 - 1 tree/acre greater than 18 inches dbh

The number of current potential roost trees need not be distributed evenly throughout the parcel, but may be concentrated in areas having a slope, aspect, or position (i.e., forest edge) that enhances solar radiation as well as connectivity to suitable foraging habitat. When concentrations of large diameter, high quality current potential roost trees are enhanced through management (e.g., daylighting or girdling), then compromises in the average number of current potential roost trees in other stands in the parcel can be adjusted downward where other forest management goals may be emphasized.

If these minimum roost tree numbers are not available, then a proportion (2-3/acre) of select cull trees should be girdled to more quickly become current potential roost trees. If preferred, these densities can be concentrated on a limited acreage as described above or if accompanied with openings or along forest stand edges to enhance solar radiation in order to achieve total potential roost tree target numbers.

Lands within Zone 3 (3 - 5 miles from hibernacula)

Lands within Zone 3 should be managed to provide suitable numbers of potential roost trees for hibernacula serving 1000 or more Indiana bats (*Note: currently no Vermont hibernacula support such population numbers*).

1. **Conduct roost tree inventories:** Forest inventories should adequately survey the parcel to determine the supply and distribution of potential roost trees on the property and to identify current potential roost trees to be maintained or enhanced. This work should be conducted as prescribed in Inventory Methods for Potential Roost Trees.
2. **Maintain or enhance known and current potential roost trees:** For lands within Zone 3, forest management activities should:
 - Maintain current potential roost trees so that, in total, there exist:
 - 2 trees/acre less than 10 inches dbh
 - 4 trees/acre between 10 and 18 inches dbh
 - 1 tree/acre greater than 18 inches dbh

Literature Cited

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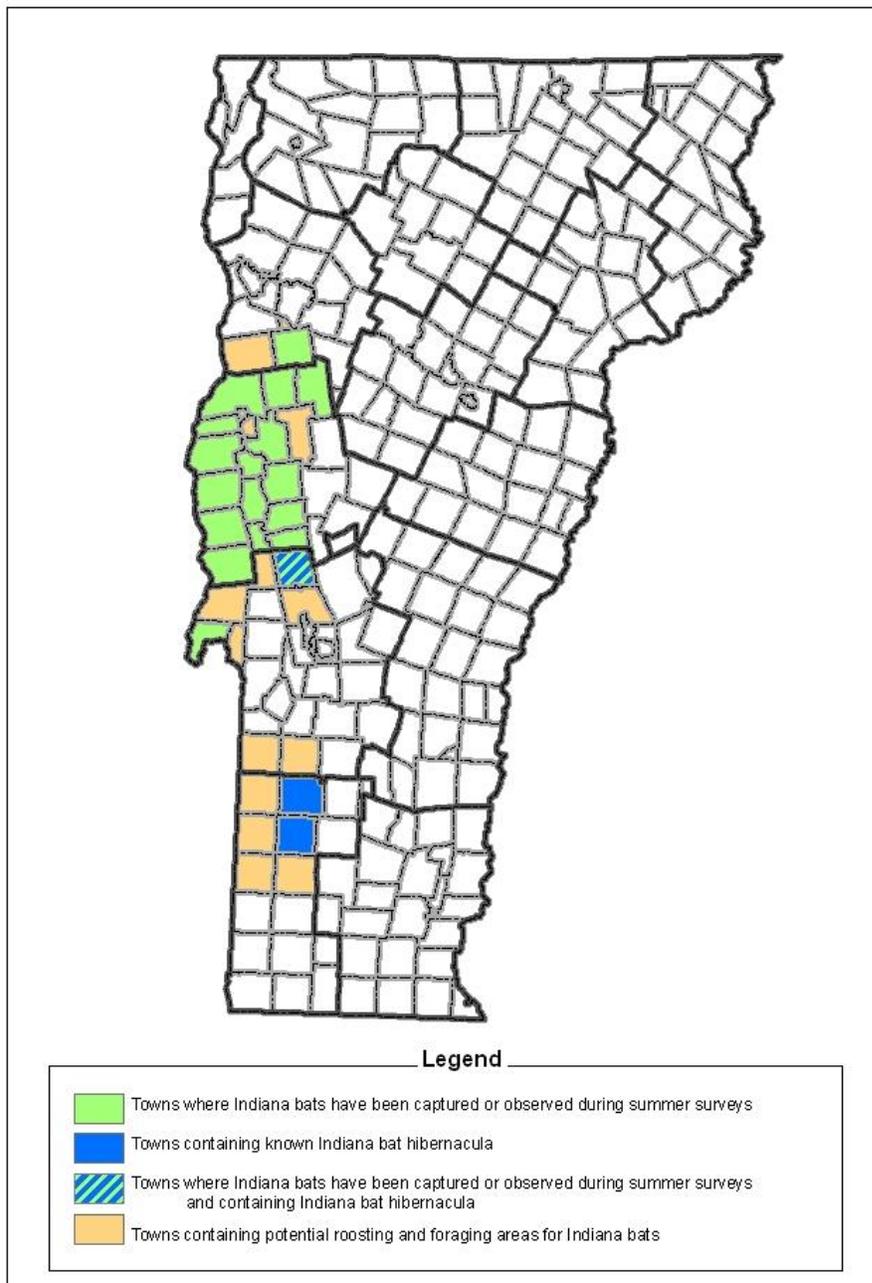
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Vermont's Indiana Bat Range



Updated 10/2007

Fig. 2. Vermont Indiana bat range by town.

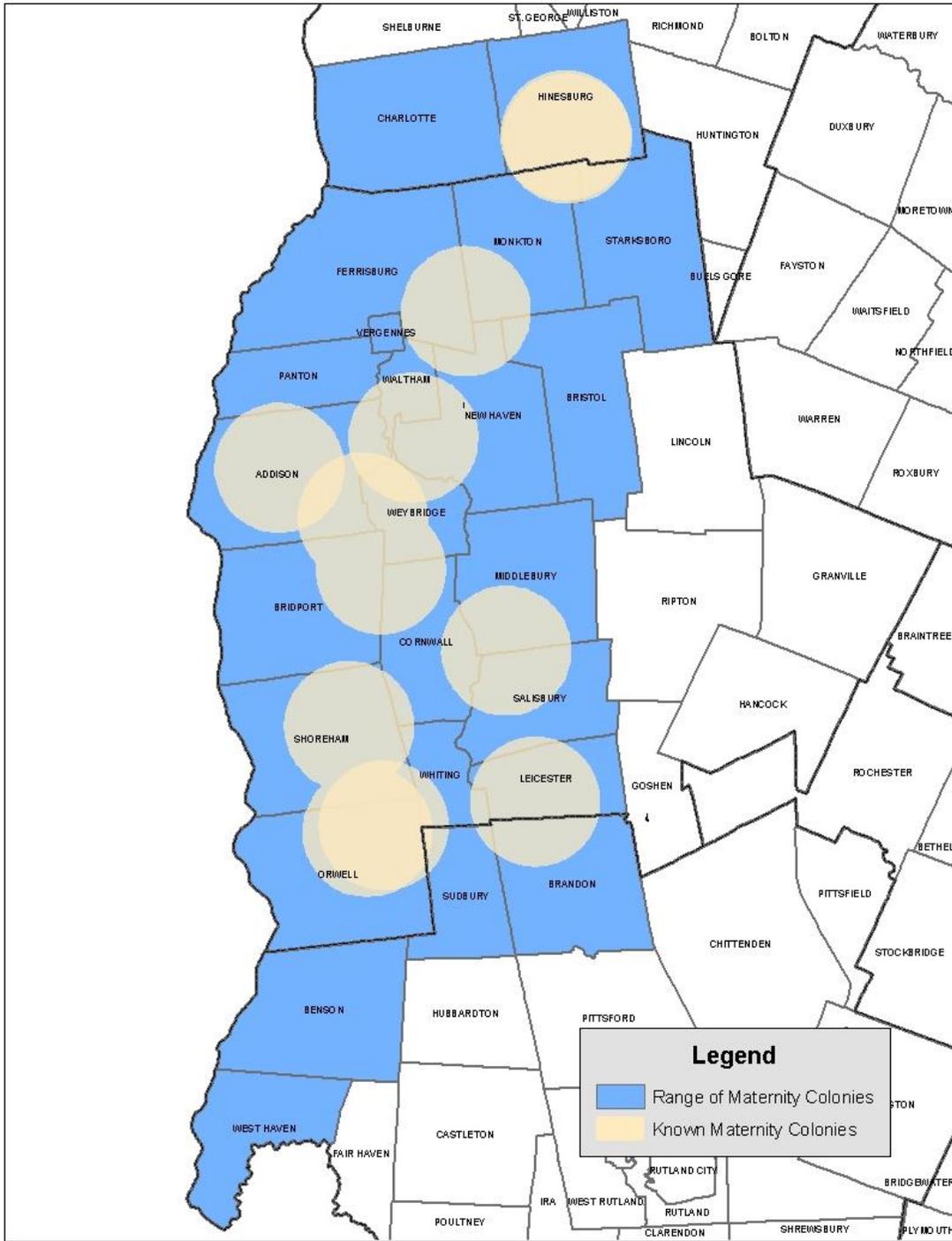


Fig. 3. Locations of known maternity colonies within the range of Indiana bat maternity colonies in Vermont.

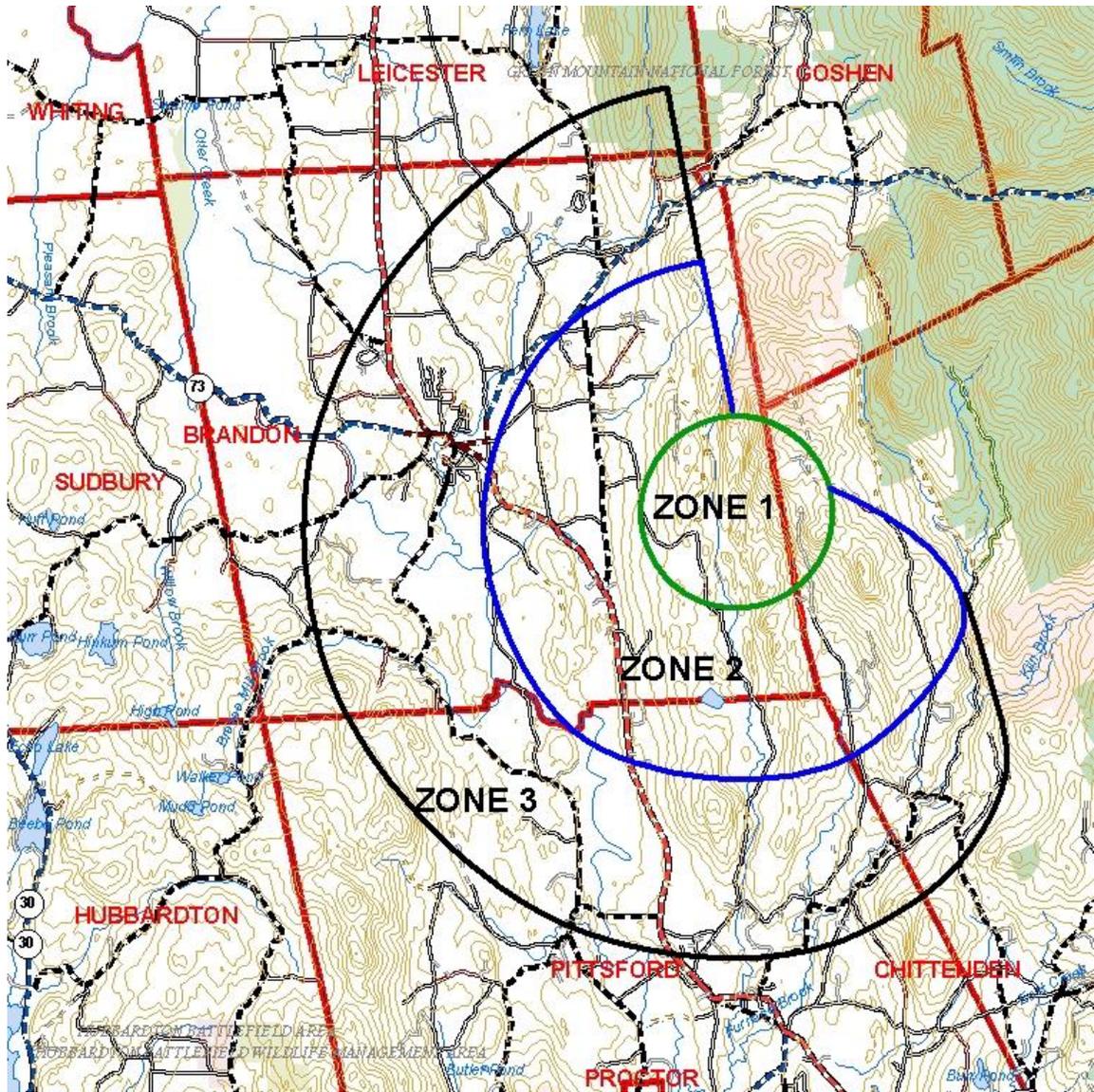


Fig. 4. Hibernacula Management Zones for Brandon mine. Currently, only Zone 1 and 2 apply.

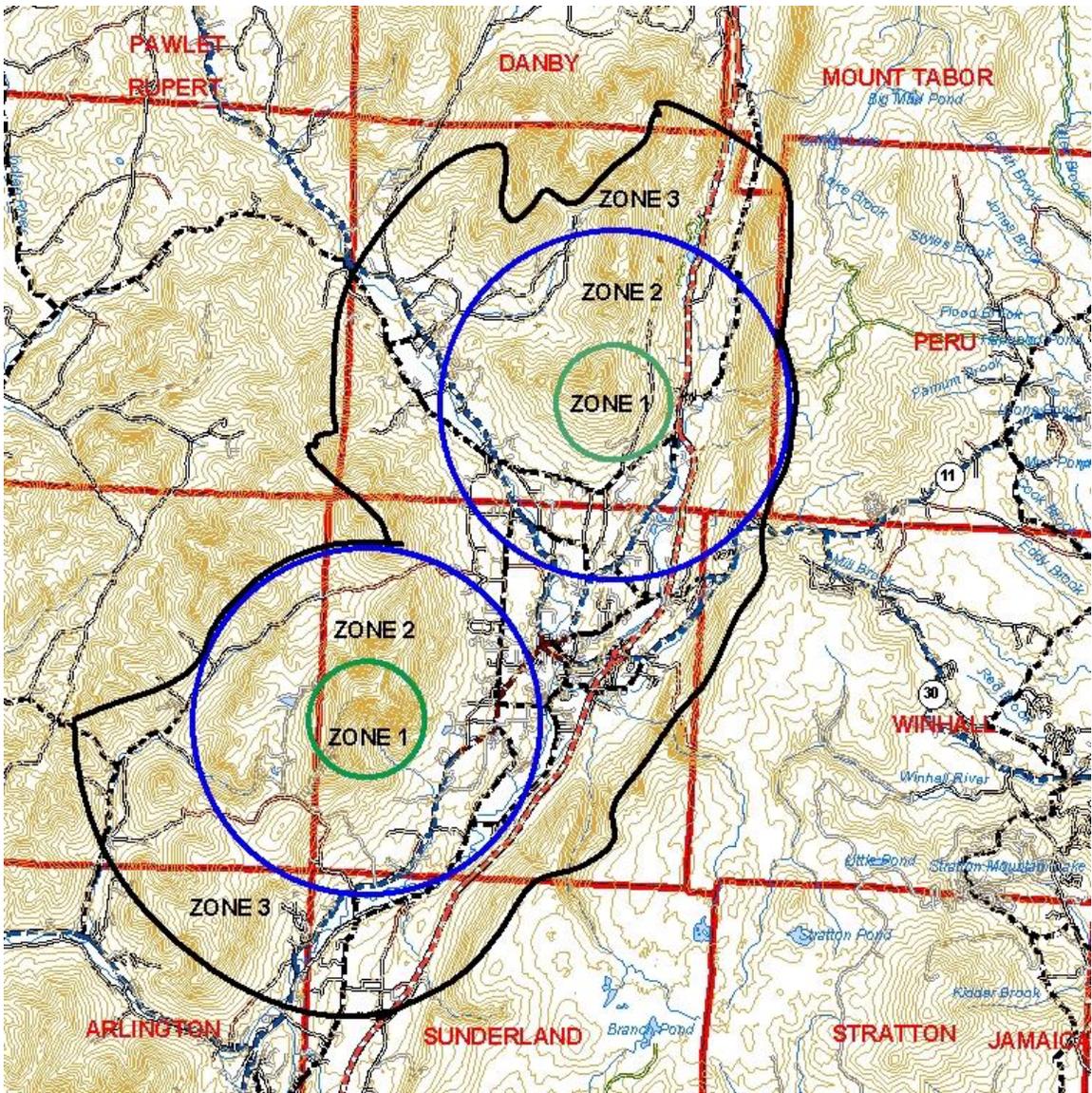


Fig. 5. Hibernacula Management Zones for Dorset and Manchester caves. Currently, only Zone 1 and 2 apply.

Indiana Bat Maternity Colony Habitat Assessment Guide

This guide serves as a preliminary screening tool to determine the suitability of a given site to provide roosting habitat for Indiana bat maternity colonies in Vermont. The guide is meant to identify sites that are not suitable for Indiana bat maternity colony roosting habitat, as well as to provide some guidance on the relative value of a site for Indiana bat maternity colonies.

Town:

Does the town fall within the known and potential range of Indiana bats in Vermont (see Figure 2)?

No: Not suitable habitat

Yes: Continue

Elevation:

Is the site below 1100 feet in elevation – a key threshold for suitable habitat?

No: Not suitable habitat

Yes: Continue

Current Potential Roost Tree Availability: Circle One

What is the availability of dead or dying trees with loose bark or crevices?

Low (0)

Medium (1)

High (2)

Presence of Shagbark Hickory: Circle One

What is the availability of live or dead, dying shagbark hickory trees?

Absent (0)

Low (1)

Medium (2)

High (3)

Diameter Sizes of Potential Roost Trees: Circle One

< 8 inches DBH

0

8–12 inches DBH

1

12–18 inches DBH

2

> 18 inches DBH

3

A total value of 0 for the above criteria indicates that the site is not suitable as roosting habitat for Indiana bats, and seasonal restrictions on timber harvesting need not apply.

Average Stand Diameter:

What is the acreage of stands having an average diameter of 8 inches or more dbh? diameters on the site?

0 acres: 0 points

1-10 acres: 1 point

11-30 acres: 2 points

> 30 acres: 3 points

Slope:

What is the approximate slope of the general site?

0-5%: 0 points

6-10% 2 point

> 10 % 3 points

Aspect:

What is the general aspect of the site?

North: 0 points

East, South, or West: 1 point

The following points provide a relative value of the suitability of the site to provide Indiana bat maternity colony habitat:

1 – 4 Points: Low Suitability

5 – 9 Points: Medium Suitability

10 or more Points: High Suitability

Inventory Methods for Potential Roost Trees

Revised from B. Moore (Upland Forestry) survey methods
at Bissonette Farm, Hinesburg, VT.

The purpose of the forest inventory is to capture data on several tree attributes that would adequately sample the number and distribution of potential (current and future) roost trees on a property. These data will be used to recommend forest management strategies to provide an adequate long-term supply of roost trees for Indiana bats.

The inventory will focus on several tree attributes that effectively identify current and future potential roost trees. Prior to the inventory, the forest will be divided up into stands that are small and unique enough to allow managers to effectively evaluate whether management activities are meeting ownership objectives. All inventory data will be collected and processed on the stand level (a stratified sample scheme).

At each inventory plot:

A 10 BAF prism point will be measured to collect overstory tree data. This plot will measure trees that are larger than 4.56" DBH and of commercial timber species.

Attributes to be sampled for identifying potential roost trees are:

- a) Tree species
- b) Diameter at breast height (1" DBH classes)
- c) Tree condition (AGS, UGS, OR SNAG)
 - a. AGS = the potential for the tree to develop a 12' sawlog within the first 16' of the bole and that is not considered a high risk tree due to reasons such as excessive lean, poor health, or micro site conditions.
 - b. UGS = any live tree not meeting the AGS definition
 - c. SNAG = any tree that is dead, standing, and greater than 4.5' tall
- d) Current Potential Roost Tree (yes or no)
 - a. Yes = a tree exhibiting all of the following characteristics;
 - i. Live shagbark hickory, or dead or dying trees (in the earlier stages of decay) of any species
 - ii. Possess exfoliating bark or a crevice
 - iii. Greater than 8 inches dbh
 - iv. Greater than 12 feet tall
 - b. No = any tree not meeting the definition of a current potential roost tree
- e) Future Potential Roost Tree (yes or no)
 - a. Yes = a tree exhibiting all of the following characteristics;
 - i. Unacceptable growing stock or snag that possesses bark that is not exfoliating
 - ii. Greater than 8 inches dbh
 - b. No = any tree not meeting the definition of a future potential roost tree

The resulting information should enable forest managers to determine the number of current and future potential roost trees per acre throughout the forest parcel, including their species, diameter, and condition. Data by plot will also allow for mapping the distribution of current and future potential roost trees within the stand.