July 2022

Indiana Bat Project Review in Michigan

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I. BACKGROUND INFORMATION

The Indiana bat was listed as endangered under the Endangered Species Act (ESA) in 1967 due to episodes of people disturbing hibernating bats in caves during winter, which resulted in the death of substantial numbers of bats. Indiana bats are vulnerable to disturbance because they hibernate in large numbers in only a few sites, with major hibernacula supporting 20,000 to 50,000 bats. Several threats are believed to have contributed to the Indiana bat's decline, including the commercialization of caves, loss and degradation of forested habitat, pesticides and other contaminants, and most recently, the disease white-nose syndrome (WNS). For more information on the Indiana bat, including life history information, designated critical habitat, draft recovery plan, and 5-year reviews, please visit the USFWS Indiana Bat page.

Indiana Bat in Michigan

Indiana bats have been documented at many sites in Lower Michigan and are believed to range throughout the southern five county tiers, as well as parts of the thumb and the western coastal counties up to (and including) the Leelanau Peninsula (see range map below). Michigan is home to a single known Indiana bat hibernaculum: a hydroelectric dam in Manistee County (Tippy Dam). Although the dam supports about 20,000 hibernating bats, Indiana bats comprise less than 1% of the winter population. Research suggests that the majority of the Indiana bats that summer in Michigan migrate to hibernacula in adjacent states, such as Indiana and Kentucky.

Like their overwintering sites, Indiana bats exhibit strong fidelity to their summer home ranges; however, we do not have knowledge of all of these summering areas in Michigan. Therefore, unless presence/absence surveys conducted in accordance with U.S. Fish and Wildlife Service (Service or USFWS) Range-wide Indiana Bat Survey Guidelines indicate the probable absence of the species, Indiana bats are considered potentially present wherever suitable habitat exists within their range.

Range of the Indiana Bat in Michigan

Suitable Habitat for Indiana Bats

During the winter, Indiana bats hibernate in caves, mines, or similar structures. Most major hibernacula for the species are found in Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia, and critical (winter) habitat has been designated in these states. Michigan is home to a single known Indiana bat hibernaculum, and there is no designated critical habitat for the species in Michigan.

Suitable summer habitat for Indiana bats consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats, such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (including live trees and/or snags ≥5 inches in diameter at breast height (DBH) that have exfoliating bark and/or cracks/crevices), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

In summer, female Indiana bats form colonies of 60-80 adults and their young and roost together in networks of trees, including 1-3 primary roosts and multiple secondary/alternate roosts. Southern Michigan maternity roost trees are typically dead or dying trees in open areas exposed to solar radiation. Infrequently, Indiana bats are observed roosting in human-made structures, such as buildings, barns, bridges, and bat boxes. Suitable bridges and culverts include those located below the third county tier of Michigan and within 1,000 feet of suitable forested habitat that contain suitable roosting spaces (e.g., expansion joints, cracks/crevices). Suitable culverts are at least 4 feet (1.2 meters) high and 50 feet (15 meters) long.

Modeled Indiana Bat Habitat in Michigan

To better characterize potential habitat and focus Indiana bat conservation efforts, the Michigan Ecological Services Field Office developed a habitat suitability model within the species' Michigan range based on available summer occurrence data for the state. The model is available for download as a shapefile or KMZ here, and more information on the development of the model can be found in Appendix I. Additionally, the model has been integrated into our Information for Planning and Conservation (IPaC) website and tools, including our All-Species Michigan Determination Key.

We strongly encourage project managers, including Federal agencies and their designated representatives as well as proponents of non-Federal projects, to use the All-Species Michigan Determination Key (Dkey) to evaluate potential effects of proposed activities on the Indiana bat and other Federally listed species in Michigan. For more information on using IPaC and its consultation tools to conduct project reviews for Indiana bat and/or other listed species, please see our IPaC instructions for MI projects and our All Species Michigan Dkey Standing Analysis.

II. VOLUNTARY CONSERVATION MEASURES

Voluntary conservation measures that benefit the Indiana bat include protecting, creating, and enhancing mature forest, particularly hardwood/mixedwood stands containing standing snags, dying trees, midstory/understory flight space, and waterbodies such as streams, ponds, and forested wetlands. As Indiana bats are known to avoid traversing large open areas outside of migration, preserving wooded corridors (such as tree lines) can be extremely beneficial in connecting fragmented patches of suitable roosting/foraging habitat.

Conserving Indiana bat habitat likely benefits the Federally threatened northern long-eared bat (*Myotis septentrionalis*) and other native bat species, several of which are experiencing recent population declines as a result of WNS and/or other factors. As significant predators of nocturnal insects, including many crop and forest pests, bats are important to Michigan's agriculture and forests. For example, Whitaker (1995)[1] estimated that a single colony of 150 big brown bats (*Eptesicus fuscus*) would eat nearly 1.3 million pest insects each year. Boyles et al. (2011)[2] noted that the "loss of bats in North America could lead to agricultural losses estimated at more than $3.7 billion/year," and using their data for Michigan alone, we totaled the estimated value at over $500 million per year (assuming standard crop pest survival). Taking proactive steps to help protect bats may be valuable to agricultural and timber producer yields and pest management costs.

Continue to the following sections for ESA guidance on Federal and non-Federal projects in Michigan. For more information on the Indiana bat, including life history information, designated critical habitat, draft recovery plan, and 5-year reviews, please visit the USFWS Indiana Bat page.

III. ESA GUIDANCE: PRIVATE LANDOWNERS/NON-FEDERAL PROJECTS

The Service does not require private landowners to conduct surveys for ESA-listed bats on their lands in Michigan. However, the bats and the habitats where they are known to occur are protected by the ESA. Under Section 9 of the ESA, it is unlawful for any person to "take" an endangered species. The term "take" is defined as, "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." "Harm" is further defined to include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering."

In general, activities that impact suitable Indiana bat habitat have the potential to result in take. One of the most common activities impacting Indiana bat habitat is tree clearing during the summer season. The potential for incidental take of Indiana bats during tree removal or forest management activities (i.e., trimming, cutting, prescribed burning) can usually be avoided by scheduling these activities during the inactive, or dormant, season, when bats have departed from summer habitat to overwinter in caves, mines, or similar environments (October 1 through April 14 in most of the species' Michigan range). The inactive season for Indiana bats is slightly reduced within close proximity of hibernacula, as Indiana bats may remain active and utilize trees for roosting through the early fall near hibernation sites. Therefore, within 5 miles of Michigan's

[1]Whitaker, J.O. 1995. Food of the Big Brown Bat *Eptesicus fuscus* from Maternity Colonies in Indiana and Illinois. American Midland Naturalist 134(2):346-360.
[2]Boyles, J.G., P.M. Cryan, G.F. McCracken, and T.H. Kunz. 2011. Economic Importance of Bats in Agriculture. Science 332:41-42.

single known Indiana bat hibernaculum (Tippy Dam), we recommend scheduling tree removal activities during the period of November 1 through March 31.

As described in Section I, the Michigan Ecological Services Field Office recently developed a habitat model for the Indiana bat's Michigan range based on available occurrence data (available for download as a shapefile or KMZ here; more information on the model's development can be found in Appendix I). Outside modeled habitat, take is less likely, but could still occur if suitable trees are impacted when Indiana bats are present, particularly during the non-volant period or "pup season," when young of the year are unable to fly. To help avoid the potential for take of Indiana bats outside of modeled habitat and more than 5 miles from Tippy Dam, we recommend avoiding potential impacts to suitable trees (including cutting/trimming and prescribed burning) during the months of June and July. In addition to seasonally restricting tree cutting and burning of suitable habitat, we recommend applying the same location-specific seasonal restrictions to pesticide (including insecticide and rodenticide) application within suitable habitat to further minimize potential impacts to roosting and foraging bats. We recommend limiting herbicide applications in the active season to targeted application methods like spot-spraying, hack-and-squirt, basal bark, injections, cut-stump, or foliar spraying on individual plants.

As long as the scope of habitat removal is not significant enough to constitute "harm," effects to Indiana bats can be kept minimal or beneficial by avoiding the relevant sensitive seasons described above (and summarized below). The Michigan Ecological Services Field Office does not expect tree removal outside of the active season to cause harm via habitat loss if clearing does not exceed 10 contiguous[3] acres of modeled habitat and/or 20 contiguous acres of suitable forest. Projects that will exceed these acreage thresholds are encouraged to coordinate with the Michigan Ecological Services Field Office before proceeding with planned activities.

In summary, we recommend the following measures to help avoid the potential for take of Indiana bats in Michigan:

(1) Do not disturb known or potential hibernacula (e.g., natural caves, abandoned mines) within the species' range.

(2) Do not modify or remove a human structure (e.g., barn, house, or other building) known to contain roosting Indiana bats without coordinating with USFWS.

(3) Schedule activities[4] that may impact bats, potential roost trees[5] or bridges/culverts[6] during the inactive season for the project's location (see Table 1 below).

[3]Connected by 1,000 feet or less.

[4]Activities that could impact suitable roost trees include tree cutting, trimming, or clearing, prescribed burning, and pesticide application.

[5]Suitable roost trees include live trees and/or snags ≥5 inches dbh that have exfoliating bark or cracks/crevices.

[6]Suitable bridges and culverts include those located below the third county tier of Michigan and within 1,000 feet of suitable forested habitat that contain suitable roosting spaces (e.g., expansion joints, cracks/crevices). Suitable culverts are at least 4 feet (1.2 meters) high and 50 feet (15 meters) long

(4) Within suitable habitat, limit active season herbicide application to targeted methods like spot-spraying, hack-and-squirt, basal bark, injections, cut-stump, or foliar spraying on individual plants.

(5) Limit tree clearing to the extent possible. If more than 20 contiguous[7] acres of forested habitat and/or more than 10 contiguous acres of modeled Indiana bat habitat must be removed at any time of year, we recommend coordinating with the Michigan Ecological Services Field Office. Additionally, avoid fragmenting or eliminating forested corridors, such as tree lines, the loss of which could functionally impair much larger blocks of suitable habitat.

Table 1. Recommended dates for avoiding reasonable certainty of taking Indiana bats

Proposed Activity	Location	Recommended Activity Dates	Recommended Avoidance Dates
(1) Cutting/trimming/ of potential roost trees[8]; (2) Prescribed burning within potentially suitable habitat or if flames/smoke will reach potential habitat; and/or (3) Pesticide application and/or aerial/nontargeted herbicide application	Within 5 miles of Tippy Dam	November 1 through March 31	April 1 through October 31
	Within modeled summer habitat and more than 5 miles from Tippy Dam	October 1 through April 14	April 15 through September 30
	Outside of modeled summer habitat and more than 5 miles from Tippy Dam	August 1 through May 31	June 1 through July 31
Removal/modification of an existing bridge or culvert suitable for day-roosting Indiana bats[9]	October 1 through April 14		

Permits and authorizations are required whenever incidental take of Indiana bats is will occur. If your project is likely to result in take of Indiana bats, please contact the Michigan Ecological Services Field Office to determine if a permit pursuant to the ESA is warranted. For general information about take permits, visit our USFWS permits page.

As a means to determine the likelihood of take, project proponents may be interested in documenting whether potential modeled or unmodeled habitat is, in fact, occupied by Indiana bats. In such cases, presence/absence surveys conducted in accordance with current USFWS

[7]Connected by 1,000 feet or less.
[8]Suitable roost trees include live trees and/or snags ≥5 inches dbh that have exfoliating bark or cracks/crevices.
[9]Suitable bridges and culverts include those located below the third county tier of Michigan and within 1,000 feet of suitable forested habitat that contain suitable roosting spaces (e.g., expansion joints, cracks/crevices). Suitable culverts are at least 4 feet (1.2 meters) high and 50 feet (15 meters) long.

Range-wide Indiana Bat Survey Guidelines (and also available via IPaC) can inform project-specific conservation measures and the need for a permit.

Please note that projects that require State permits or authorizations that implement Federal laws or are supported by Federal funds (e.g., Clean Water Act, transportation projects) may have additional requirements under or similar to Section 7 of the ESA, as described in the following section: IV. ESA GUIDANCE: FEDERAL PROJECTS.

As described in Section I, we strongly encourage project managers, including private landowners and proponents of non-Federal projects, to use the All-Species Michigan Determination Key in IPaC to evaluate potential effects of proposed activities on Indiana bats and other Federally listed species in Michigan. The All-Species Michigan Dkey allows users to quickly check whether their project qualifies for automated effects determinations for listed species and habitats. For more information on using IPaC and its consultation tools to conduct project reviews for NLEB and/or other listed species, please see our IPaC instructions for MI projects (PDF).

IV. ESA GUIDANCE: FEDERAL PROJECTS

Section 7 Consultation

Under the ESA, requirements for Federal projects (i.e., projects funded, authorized, permitted, or implemented by a Federal agency) are different than requirements for wholly private or otherwise non-Federal projects. The ESA mandates all Federal departments and agencies to conserve listed species and to utilize their authorities in furtherance of the purposes of the ESA. Section 7 of the ESA, called "Interagency Cooperation," is the mechanism by which Federal agencies ensure the actions they conduct, including those they fund or authorize, do not jeopardize the existence of any listed species.

Federal agencies must request a list of species and designated critical habitat that may be present in the project area from the Service via our Information for Planning and Consultation (IPaC) website. Then they must determine whether their actions may affect those species or critical habitat. If a listed species or critical habitat may be affected, consultation with the Service is required.

The Service developed IPaC to help streamline the ESA review process. IPaC can assist users through the section 7 consultation process when a Federal agency authorizes, funds, permits, or carries out an action. For further information on obtaining an official Species List through IPaC and using available assisted Determination Keys, see our IPaC instructions for MI projects (PDF).

Please note that Section 7 or similar obligations may also apply to State permits or authorizations that implement Federal laws or projects that are supported by Federal funds (e.g., Clean Water Act, transportation projects).

For general guidance on Section 7(a)(2) obligations for Federal projects, see our ESA Section 7 Consultation page.

IPaC Determination Keys

Determination Keys (Dkeys), available through the Service's Information for Planning and Consultation (IPaC) web site, are logically structured sets of questions designed to assist users in determining if a project qualifies for a pre-determined consultation outcome based on existing programmatic consultations or internal USFWS standing analyses. Qualifying projects may generate USFWS concurrence letters instantly through IPaC. Dkeys provide consistent and transparent outcomes, and significantly reduce the time to complete consultation for qualifying projects.

Two Dkeys are currently available for evaluating the effects of Federal projects on Indiana bat in Michigan: The All-Species Michigan Dkey, and the FHWA, FRA, FTA Programmatic Consultation Dkey for Transportation Projects. As described in Section II, we strongly encourage project managers, including Federal agencies and/or their designated non-Federal representatives, to use IPaC, and in particular the All-Species Michigan Determination Key, to evaluate potential effects of proposed activities on Indiana bats in Michigan. For additional details on using Dkeys and other IPaC tools, see our IPaC instructions for MI projects.

Evaluating Effects to Indiana Bats

The Michigan Ecological Services Field Office has established a consistent and transparent process for evaluating potential effects of Federal actions on the Indiana bat, based on existing Service guidance and relevant literature, available Michigan survey data, and expert elicitation. This process is outlined below as well as in an internal standing analysis developed to support our All-Species Michigan Determination Key.

As described in Section I, the Michigan Ecological Services Field Office recently developed a habitat suitability model for the Indiana bat's Michigan range based on available species presence data. (The model is available for download as a shapefile or KMZ here, and more information on the model's development can be found in Appendix I). We have slightly modified our recommendations for avoiding adverse effects to Indiana bats based on whether projects overlap with modeled habitat (see below).

Within the species' Michigan range, we do not expect Federal actions to rise to the level of adverse effects to Indiana bat when the following conditions are met[10]:

- The action area does not contain any known or potential hibernacula (including natural caves, abandoned mines, or underground quarries).
- The action will not remove/modify a human structure (barn, house or other building) known to contain roosting Indiana bats.

[10]Projects that do not meet these conditions may still be able to avoid adverse effects to Indiana bat but warrant project-specific review and considerations.

- Tree clearing/cutting/trimming does not impact any potential roost trees[11]; OR, if suitable roost trees must be cut/trimmed, it is done so during the applicable recommended season (see Table 2 below).

- Tree clearing does not exceed 20 acres of contiguous[12], forested habitat and/or more than 10 acres of contiguous modeled Indiana bat summer habitat and does not fragment a connective corridor between two or more forest patches of at least 5 acres.

- Prescribed burning does not clear >20 acres of contiguous forest or 10 acres of modeled Indiana bat habitat and is conducted during the recommended applicable season (see Table 2).

- If burning in non-suitable habitat adjacent to suitable forest when Indiana bats may be present (e.g., grassland or scrub/shrublands near mature forest), flame height and smoke are kept to a minimum.

- Application of pesticides (including insecticides and rodenticides) and/or aerial/nontargeted herbicide application is restricted to the applicable recommended season (see Table 2).

- Application of herbicides follows the label and is limited to targeted methods like spot-spraying, hack-and-squirt, basal bark, injections, cut-stump, or foliar spraying on individual plants or conducted during the applicable recommended season (see Table 2).

- Removal/modification of an existing bridge or culvert suitable for day-roosting Indiana bats[13] does not result in the permanent loss of known or potential roosting spaces and is conducted during the inactive season (October 1 through April 14).

- Projects that include temporary or permanent lighting of roadway(s), facility(ies), and/or parking lot(s) apply the following conservation measures:

    (a) When installing new or replacing existing permanent lights, use downward-facing, full cut-off lens lights (with same intensity or less for replacement lighting); or for those transportation agencies using the BUG system developed by the Illuminating Engineering Society, the goal is to be as close to 0 for all three ratings with a priority of "uplight" of 0 and "backlight" as low as practicable.

    (b) Direct temporary lighting away from suitable habitat when bats may be present.

[11]Suitable roost trees include live trees and/or snags ≥5 inches dbh that have exfoliating bark or cracks/crevices.
[12]Connected by 1,000 feet or less.
[13]Suitable bridges and culverts include those located below the third county tier of Michigan and within 1,000 feet of suitable forested habitat that contain suitable roosting spaces (e.g., expansion joints, cracks/crevices). Suitable culverts are at least 4 feet (1.2 meters) high and 50 feet (15 meters) long.

Table 2. Recommended dates for avoiding adverse effects to Indiana bats

Proposed Activity	Location	Recommended Activity Dates	Recommended Avoidance Dates
(1) Cutting/trimming of potential roost trees[14]; (2) Prescribed burning within potentially suitable habitat or if flames/smoke will reach potential habitat; and/or (3) Pesticide application and/or aerial/nontargeted herbicide application	Within 5 miles of Tippy Dam	November 1 through March 31	April 1 through October 31
	Within modeled summer habitat and more than 5 miles from Tippy Dam	October 1 through April 14	April 15 through September 30
	Outside of modeled summer habitat and more than 5 miles from Tippy Dam	August 1 through May 31	June 1 through July 31
Removal/modification of an existing bridge or culvert suitable for day-roosting Indiana bats[15]	October 1 through April 14		

If the above conditions are met, projects may be able to complete Section 7 consultation through our IPaC All-Species Michigan Determination Key and/or through informal consultation with the Service outside the Dkey. If these conditions cannot be met, please contact our office for additional site-specific review regarding your project.

Note that these conditions are only necessary if Indiana bats are present. Prior to conducting a project, including tree clearing or burning, surveys can be done to determine if Indiana bats are present or likely absent from the action area. See our Range-wide Indiana Bat Survey Guidelines for more information. In the absence of site-specific survey data, adherence to the above conditions should appreciably reduce the potential for adverse effects.

In addition to habitat assessments and presence/probable absence surveys, bridge/culvert assessment can be conducted to determine whether a suitable bridge or culvert is occupied by bats. See these Guidelines for more information. If a bridge/culvert has been inspected for signs of roosting bats (guano, urine staining, bat vocalizations, and/or bats) during the summer roosting season (May 15 through August 15), and no bats or signs of bats were observed, work on the bridge/structure can proceed at any time of year.

[14]Suitable roost trees include live trees and/or snags ≥5 inches dbh that have exfoliating bark or cracks/crevices.
[15]Suitable bridges and culverts include those located below the third county tier of Michigan and within 1,000 feet of suitable forested habitat that contain suitable roosting spaces (e.g., expansion joints, cracks/crevices). Suitable culverts are at least 4 feet (1.2 meters) high and 50 feet (15 meters) long.

V. MICHIGAN ECOLOGICAL SERVICES FIELD OFFICE CONTACT INFORMATION

Please contact the Michigan Ecological Services Field Office for more information on potential impacts to Indiana bats or other Federally listed species as a result of any projects occurring in Michigan.

U.S. Fish and Wildlife Service
Michigan Ecological Services Field Office
2651 Coolidge Road, Suite 101
East Lansing, MI 48823
Phone: 517-351-2555
Fax: 517-351-1443
TTY: 1-800-877-8339 (Federal Relay)
e-mail: EastLansing@fws.gov

Appendix I: Development of a Habitat Suitability Model for the Indiana Bat (*Myotis sodalis*) in Michigan

In 2018, the Michigan Ecological Services Field Office contracted with Dr. Eric McCluskey of Grand Valley State University to develop a habitat model for the Indiana bat in Michigan. A shapefile and KMZ of the model are available for download here: Indiana Bat Habitat Model

To develop the model, we compiled all available Indiana bat summer capture (foraging) and roost occurrence data and applied a 500-m spatial filter as a minimum distance between occurrence records to minimize overemphasis of habitat importance based on clusters of individuals. After filtering the occurrence data, 44 locations remained (20 capture and 24 roost locations). We developed models using capture and roost occurrences separately as well as with all occurrences combined to determine which model was best suited for identifying foraging and roost habitat.

Due to the small number of occurrences, we used an ensemble of small models (ESM) approach that permits more predictor variables to be used by running each pairwise combination of variables and then weighting these final models in an ensemble. The ESMs were run in the R package ecospat. Presence only modeling requires the selection of background area from which background points will be randomly sampled to compare to the occurrence data. The background area should represent parts of the landscape that are accessible to the focal organism. We created a convex hull around our occurrence data using ArcMap, a polygon formed by connecting straight lines between points. We then buffered this convex hull by 25 km to include areas beyond the known core distribution of Indiana Bat in southern Michigan that should be physically accessible and may have undetected presences. We set background point selection for this entire buffered area except for within 5 km of Indiana Bat occurrences where background points are most likely to unintentionally represent true presences.

We selected predictor variables by removing the worse performing variable from highly correlated pairs (>0.75) using the 'corSelect' function from the fuzzySim R package. Then we then used Maxent's internal variable importance (permutation importance) and jackknife measures to determine which of the remaining variables were important to retain for separate capture and roost models. We selected two model types, Artificial neural network (ANN) and Maxent, for the ESMs. We compared five runs for each model type with the capture, roost, and combined datasets using area under the ROC curve (AUC) and true skill statistic (TSS). We then calculated the Boyce Index value using ecospat to compare the ANN and Maxent models from each dataset in their ability to identify capture and roost locations. We used Boyce Index as the primary assessment metric as it allowed for comparisons across all three model types for capture and roost data.

Based on the Boyce Index assessment, we selected the Maxent presence-only roost model as the strongest fit model. Using the 10th percentile threshold, we converted the model output to a binary raster. The binary raster was then converted to a shapefile using non-simplified shapes. Because considerable portions of the modeled habitat contained clearly non-suitable cover types, particularly near highly developed urban areas, we further refined the model by clipping the binary shapefile by the most recent available National Land Cover Database (NLCD 2019) data. Land cover categories excluded ("Clipped") from modeled habitat included open water, perennial ice/snow, developed (low, medium, and high intensity), and barren land (sand, rock, clay).

To further refine the model output, we created a grid of five-acre hexagons for Michigan's Lower Peninsula using the "Generate Tessellation" tool in ArcPro 2.9. Five acres was selected as the

patch size based on available literature and data suggesting that Indiana bats are unlikely to occupy an isolated forest stand of less than five acres. The hexagon layer was then "Clipped" to the Indiana bat range. The total acres of modeled Indiana bat habitat were summarized by hexagon using the "Summarize Within" tool. Hexagons with less than one acre of habitat were then removed. These small model fragments were typically isolated from other modeled hexagons, likely artifacts of imprecise raster data, and were considered unlikely to provide sufficient habitat to support roosting Indiana bats. Hexagons containing more than one acre of modeled habitat were retained, helping to fill gaps and buffer edges among smaller but closely connected modeled patches and increasing the overall acreage of modeled habitat within the species' range.

The remaining hexagons were then aggregated using the "Dissolve" tool allowing for multipart features. The "Summarize Within" tool was run again to obtain acres of modeled habitat within each hexagon cluster. We then ran a "Near Neighbor" analysis to identify forest patches that were greater than 1,000 feet from forested areas to remove isolated patches unlikely to be used by roosting Indiana bats. We removed hexagons that were more than 1,000 feet from their nearest neighbor and that contained less than five acres of modeled habitat. These isolated forest patches are considered unlikely to support roosting Indiana bat due to their insufficient size and distance from other suitable, modeled areas.