

Section 7 Consultation: Evaluating Potential Impacts to Indiana bats (*Myotis sodalis*)

U.S. Fish and Wildlife Service, Reynoldsburg, Ohio Ecological Services Field Office

Purpose of this Document

The purpose of this document is to assist Federal Agencies, applicants, and their consultants in evaluating potential impacts to Indiana bats resulting from actions subject to section 7(a)(2) of the Federal Endangered Species Act of 1973, as amended (ESA). This document also describes how biologists at the Reynoldsburg, Ohio Ecological Services Field Office of the U.S. Fish and Wildlife Service (Service) analyze Indiana bat impacts when providing technical assistance to Federal Agencies and applicants, and when reviewing endangered species effect-determinations. This document is not intended to address all possible project situations, nor act as official Service Policy. It is meant to address commonly asked questions, and help Federal Agencies, applicants, and their consultants anticipate and plan for common situations that arise during section 7 consultation for the Indiana bat. Each Federal Action subject to section 7(a)(2) consultation must be closely evaluated on its own merits, and the set of situations presented in this document does not contemplate all potential projects or Service comments.

Introduction

The Indiana bat is a challenging species to conserve. Three primary reasons for this include: 1. It is potentially present in every county in Ohio during the summer months. 2. It is a difficult species to locate, and its presence can only reliably be verified through mist-net surveys and in-hand identification. 3. The vast majority of projects subject to section 7(a)(2) consultation have at least some potential to affect suitable Indiana bat habitat.

In addition to the three items listed, the life history requirements of the Indiana bat are not entirely defined, which leads to some uncertainty in implementing appropriate management activities for conservation of the species. In cases where this uncertainty is present, Service biologists are mandated by Congress to provide the benefit-of-the-doubt to listed species, and therefore make decisions that err on the side of the species (H.R. Conf. Rep. No. 697, 96th Cong., 2d Sess. 12, 1979). Federal Regulations require that Service biologists and all Federal Agencies use the best available scientific and commercial information when making decisions regarding endangered species, including current information available regarding life history. The following is a basic life-history summary of the Indiana bat.

The Indiana bat annual cycle includes 4 major phases: winter hibernation, spring migration, summer maternity period, and fall migration/swarming. Generally, Indiana bats hibernate from October through April (Hall 1962; LaVal and LaVal 1980), depending upon local weather conditions. Bats typically form large, single-layer clusters on cave ceilings in densities ranging from 300-499 bats per square foot (Clawson et al. 1980, Stihler 2005). Hibernation facilitates survival during winter when prey is unavailable. However, the bat must store sufficient fat to

support metabolic processes until spring. Substantial risks are posed by events (e.g., human disturbance) during the winter that interrupt hibernation and increase metabolic rates (Johnson et al. 1998).

After hibernation ends in late March or early April, most Indiana bats migrate to summer roosts. Female Indiana bats emerge from hibernation prior to males. The period after hibernation and just before spring migration is typically referred to as “staging,” a time when bats forage and a limited amount of mating occurs (Hall 1962, Cope and Humphrey 1977). Most bats leave their hibernaculum by late April. Migration is stressful for the Indiana bat, particularly in the spring when their fat reserves and food supplies are low and females are pregnant. As a result, adult mortality may be highest in late March and April (Thomson 1982).

Summering Indiana bats typically day roost under exfoliating bark of trees in riparian, bottomland, and upland forests. In summer, male bats roost individually or in small groups and either remain near their winter hibernaculum (some actually may occasionally use their hibernaculum as their summer day roost instead of trees) or disperse throughout the range. In contrast, reproductive females form larger groups referred to as maternity colonies, which can be far removed from hibernacula areas. Roost trees are most often snags (i.e., dead trees) with variable amounts of exfoliating bark, which allow bats to roost between the bark and bole of the tree. However, live, shag-barked trees (e.g., *Carya ovata*) are also used, as well as some trees with cavities and crevices. Because snags of a wide variety of tree species are used for diurnal roosts including maple (*Acer* spp.), hickory (*Carya* spp.), ash (*Fraxinus* spp.), oak (*Quercus* spp.), elm (*Ulmus* spp.), pine (*Pinus* spp.), hemlock (*Tsuga canadensis*), and others (Menzel et al. 2001, Kurta et al. 2002, Britzke et al. 2003), it seems that bats select roosts based on their structure rather than species of tree. Maternity colonies typically consist of at least one relatively large roost tree (>22 cm dbh) with loose, exfoliating bark and a high-degree of solar exposure, whereas solitary males are much less constrained and can use much smaller trees (>6.4cm; Menzel et al. 2001, Gumbert 2001). Predominately, Indiana bat roost sites are in trees, however, a few males and maternity colonies have been documented roosting in bat boxes (Carter 2002) and other man-made structures (e.g., an old church attic, a barn, and a wooden high-power pole; Butchkoski and Hassinger 2002, Cheng 2003, Hendricks et al. 2004).

Most summer days/nights, adult females may form multiple roosting subgroups, spread among different trees within the colony’s roosting area, thus forming what appears to be a fission-fusion type of society resembling those of some cetaceans, primates, and other colonial bat species (Kerth and König 1999, Kurta et al. 2002, Willis and Brigham 2004). Because females frequently switch roost sites (Kurta et al. 2002; and males for that matter, Brack et al. 2004), a maternity colony may use 18 or more roost trees in a single season (Barclay and Kurta 2004). Maternity colonies usually contain 100 or fewer adult female bats although colonies larger than 300 have been reported (Whitaker and Brack 2002). The fission-fusion society of these bats causes roosting numbers to fluctuate unpredictably at individual roost trees, so estimating actual size of an entire “colony” is very difficult; typically requiring multiple emergence counts to be conducted simultaneously by different observers stationed at all known roost trees.

Females each give birth to a single young between mid June and early July and young Indiana bats are volant (i.e., capable of flight) within a month of birth. They spend the latter part of the

summer foraging to accumulate fat reserves for the fall migration and hibernation. Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas from year to year (Kurta and Murray 2002). Traditional summer sites 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 area is lost or degraded.

Because Indiana bat roost sites are ephemeral, a continuous supply of currently suitable and future roost trees are needed within a colony's traditional summer area for the colony to persist in the area over time. 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. Bats move among roosts within a season and when a particular roost becomes unavailable from one year to the next.

Indiana bats eat terrestrial and aquatic insects while foraging in forested stream corridors, upland and bottomland forests, and over impounded bodies of water at night (Whitaker 1972, Lee 1993, Murray and Kurta 2002). Indiana bats tend to avoid vast open spaces, so wooded corridors linking roosting sites with foraging areas are important in areas where forests are fragmented (Murray and Kurta 2004).

After the summer maternity period, Indiana bats migrate back to traditional winter hibernacula. 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 (Cope and Humphrey 1977). Autumn "swarming" occurs prior to hibernation. During swarming, bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day (i.e., they continue to use trees near the caves as their day roosts). The swarming period is a critical period in their annual cycle. During this time they forage to build up their fat reserves to sustain them through winter hibernation and they mate. By late September, many females have entered hibernation, but males may continue swarming well into October. Females store sperm through the winter and delayed fertilization occurs in the spring (Thomson 1982).

Consultation

Consultation with the Service is required any time a discretionary Federal action "may affect" listed species. To determine if a project may affect the Indiana bat, answer the following question:

Will the project affect any habitat suitable for the Indiana bat?

Suitable habitat consists of:

- a. **roosting habitat**- live, dead, or dying trees with exfoliating bark, split tree trunk, split branches, holes, cracks, crevices, or hollow trunks or branches
- b. **foraging habitat**- within and on the edges of wooded areas. Frequently associated with streams, floodplain forests, forested wetlands, and impounded water bodies

- c. **travel corridors**- areas that link roosting and foraging habitat, including open-understory forest, wooded fence-rows, and open paths through wooded areas, including streams, trails, and small roads with canopy cover.
- d. **hibernacula**- caves or underground mines.

If any of the above habitat types are present at the proposed site, it is possible that Indiana bats are also present, and an appropriate determination at this point is that the project “may affect” the Indiana bat, and consultation with the Service is required. If no habitat suitable for the Indiana bat is present, a determination of “no effect” is likely appropriate. If the Federal action agency determines that an action will have “no effect” on listed species, then consultation on that action is not required. The Federal agency should document the justification for a “no effect” determination in its administrative record.

If suitable habitat is present at the proposed site, the applicant or Federal Agency should first contact the Service to determine if the project is within a five-mile radius of a known record for one or more Indiana bats. If the proposed project is within this radius, proceed to the section below entitled: “Consulting on Projects Within 5 Miles of Known Records.” If the project area contains caves or underground mines that may be suitable Indiana bat hibernacula (see Appendix B for guidance on characteristics of suitable hibernacula), the applicant or Federal Agency should contact the Service for guidance on how to proceed. If the project is not within 5 miles of a known record and does not contain a potential hibernaculum, the applicant or Federal Agency should choose one of the following:

1. Conduct surveys to determine presence or probable absence of Indiana bats- See “Conducting Surveys” section below

or

2. Assume that Indiana bats are present in the action area (Because the Service is mandated to give the benefit-of-the-doubt to listed species, we will assume that Indiana bats are present until relevant data indicate otherwise)- see “Assuming Presence” section below

Conducting Surveys

Surveys for Indiana bats usually consist of mist-netting surveys. Service-approved mist-netting survey techniques are included in Appendix A. Mist-net surveys may only be conducted by individuals with a federal permit to conduct such work, and may only be conducted between May 15 and August 15 for detection of Indiana bat summer use. Surveyors should always contact the Service to get input on designing and conducting each survey to ensure proper level of effort (this is a general requirement of their permit). In general, mist-net surveys for Indiana bats following the approved guidance listed in Appendix A are usually effective in determining the presence or probable absence of Indiana bats. Failure to capture Indiana bats during a mist-net survey, however, does not absolutely confirm their absence. Because absence is not

automatically confirmed through negative mist-net surveys, Service biologists must carefully interpret negative survey results to evaluate potential impacts to Indiana bats.

1. What happens if a mist net survey following approved guidelines does not result in capture of one or more Indiana bats?

It can be assumed that Indiana bats are either not present or are present in low densities.

2. What does this mean for my project?

Clearing the site during the winter (September 15 – April 15) is normally adequate in avoiding adverse effects.

3. What if the mist net survey did not detect Indiana bats, and the project proponent would like to clear suitable habitat during the summer (April 15 – September 15)?

In instances where suitable habitat is present, clearing during the summer season (April 15-September 15) is highly discouraged. Clearing during the summer can result in direct take (e.g., killing or harming) of Indiana bats when they are present in a given area, even if they are present in low densities (as indicated by a negative mist-net survey). The Service will consider proposals for summer clearing on a case-by case basis. In analyzing the results of a survey in which no Indiana bats are captured, to determine if summer cutting might result in take, Service biologists will consider the following:

- bat species diversity and numbers of individuals detected in the mist net survey
- size of action area
- habitat quality in action area
- juxtaposition of habitat components in the action area and surrounding landscape
- results of any previous surveys in the area

In addition to the above, supplemental data may be collected concurrently with a mist-net survey that can assist Service biologists in determining the likelihood of Indiana bats in the project area. These include:

- Results of emergence surveys conducted on suitable roost trees (see question #6 below)
- Evaluation of overall bat activity through ultrasonic bat detector(s)

By evaluating all of the factors listed above, Service biologists can make a better evaluation of the project site to determine potential presence of Indiana bats in the project area. Negative survey results in areas with only marginal Indiana bat habitat may be more conclusive than those with high-quality habitat. In addition, we would expect that Indiana bats are more likely to be present in an area with a large number and diversity of other bat species than in areas with low numbers of only one or two common species. This is because a large number and diversity of bats would indicate an overall suitability of the area for bats.

When choosing whether to conduct a mist-net survey for Indiana bats (vs. assuming presence), an applicant/Federal Agency should keep in mind that there is no guarantee that the Service will be able to concur that summer clearing will not result in adverse effects in cases where mist-net surveys did not capture any Indiana bats. When the Service considers all other pertinent variables (e.g., size and scope of project, quantity and quality of habitat, etc.), we often still recommend that trees be cleared only between September 15 and April 15.

4. What happens if one or more Indiana bats are captured during a mist-net survey?

The applicant and Federal Agency would then consult with the Service to determine what measures could be implemented to avoid adversely affecting Indiana bats. If adverse effects could not be avoided, or minimized so that they are insignificant or discountable, formal consultation with the Service would be required.

5. How long can negative mist-net survey results be applied to a specific project?

Generally, if you wish to use negative mist-net survey results as part of a justification for summer cutting (April 15-September 15), results would only be appropriate to use for the current season. Although female bats exhibit high site-fidelity, circumstances can and will cause them to relocate. In addition, males are less philopatric than females, and can have greater variability in roost locations from year to year. Therefore, it is possible that Indiana bats may move into an area after mist-net surveys detected no individuals. Because of this, in most cases, the Service would only rely on negative results from the current summer season as part of a justification for no adverse effects from summer cutting. Negative mist-net surveys are often used as justification that winter cutting will result in no adverse effects to the Indiana bat. The period of time that negative survey results may be relied on for such a determination may vary, however, depending on many of the variables listed in item 3 above. The Service will consider all these variables when evaluating whether negative survey results can be relied upon in subsequent years for making a determination that winter cutting will not result in adverse effects.

6. What is an emergence survey?

An emergence survey is a type of survey for bats that can be useful in determining if bats are roosting in individual trees. General protocol for emergence surveys is described in Appendix C. The Service should always be contacted prior to conducting emergence surveys, to provide input on the appropriateness of the technique for individual sites. A Federal permit is not required to conduct emergence surveys, although the surveyor must be a biologist familiar with bats. An emergence survey cannot determine the species of bat(s) occupying a particular roost tree. Emergence surveys are often used in one of two ways.

- To complement mist-net surveys, as described in #3 above
- To evaluate whether individual trees may be cut in the summer, in instances where habitat to be impacted is marginal or only a very small amount and suitable roost trees are limited to just a few.

In cases where emergence surveys are used in an area of marginal habitat with only a few potential roost trees, negative results usually indicate that the surveyed trees can be cleared the day following completion of the survey (after coordination with the Service). If bats are detected emerging from (a) roost tree(s), the applicant/Federal agency would then need to conduct mist-net surveys (as described above) or assume presence (see “Assuming Presence” below). Please refer to Appendix C for more information on emergence surveys.

Assuming Presence

In lieu of conducting surveys for Indiana bats, the applicant and/or Federal Agency may wish to assume that Indiana bats are present in the proposed action area. When an applicant chooses to assume presence of Indiana bats, the applicant should then work to avoid adverse effects by developing avoidance and minimization measures that will protect the bat and its habitat. Two primary types of impact avoidance measures are:

1. Clearing suitable habitat between September 15 and April 15, (or different dates in areas surrounding potential hibernacula)
2. Preserving suitable habitat into perpetuity.

Applicants and Federal Agencies should be aware that while assuming presence is always an option, it may not always be in their best interest to do so. In some instances, such as when the action area appears to consist of high-quality habitat for a maternity colony, clearing this habitat during the winter may not be enough to avoid adversely affecting Indiana bats. Significant habitat preservation may also be needed. Please see the discussion below for more information regarding when significant habitat preservation may be needed. In instances where the need to preserve habitat is substantial, applicants or Federal Agencies may decide that conducting surveys for bats is a better option (see “Conducting Surveys” section), or they may choose to initiate formal consultation if adverse effects cannot be avoided.

The most common question that arises when deciding which measure(s) to apply when assuming presence is:

“Can I assume presence of Indiana bats, and cut the suitable habitat during the winter to avoid all adverse effects.”

Although clearing during a specific winter time-period will avoid direct impacts to Indiana bats, clearing of suitable habitat during the winter can still result in indirect effects (those occurring later in time) that lead to take of Indiana bats. A primary concern of Service biologists is that the action area may provide important summer habitat for Indiana bats (e.g., it supports a maternity colony). Maternity colonies of Indiana bats exhibit high site-fidelity, meaning that they return to the same area, and often the same trees, to roost, year after year. If the project site provides

important summer habitat for a maternity colony of Indiana bats (see #2 below for a description of high-quality habitat), then clearing this site, even during the winter, may result in indirect adverse impacts to the bat. Because, if Indiana bats return to their former summer roosting area following hibernation and cannot quickly re-establish the colony (because it has been cleared), they must expend extra energy to find suitable alternative roosts, during a time when fat reserves are low, and energy demands are already high due to migration and pregnancy. These extra energy demands may result in delayed parturition, fetal abortion, delayed maturation of young, delayed fall migration, etc.

To determine if indirect adverse effects resulting from habitat removal during the winter may occur, consider the following:

1. Will a large area of wooded habitat be impacted by the project?

If it will impact a large area of suitable habitat, relative to the surrounding landscape, we would evaluate this site more closely. Larger areas of habitat loss, relative to the surrounding landscape, have greater potential for adverse effects than smaller ones. For example, a larger area of habitat loss in a heavily-forested landscape may have less impact on the bat than loss of a smaller area of habitat in a fragmented landscape. If a maternity colony of Indiana bats returns to an area where they had been roosting and/or foraging the previous year, and finds a large area of it gone or fragmented, there will likely be energetic consequences if they must look for alternative suitable habitat.

2. Will the project impact high-quality habitat, regardless of acreage?

Loss of high-quality habitat is more likely than loss of marginal-quality habitat to result in direct or indirect adverse effects. High-quality habitat incorporates many components, but may be summarized by the following:

Open-understory forest, usually mature (the more mature the better), with a predominance of suitable roost trees. Potential primary maternity colony roost trees are especially important in that they allow up to 100 or more bats (females and pups), with specific energetic demands, to roost in them. They are usually larger trees with a predominance of exfoliating bark. They are frequently found in areas that receive solar exposure, such as along the edge of forests, along streams, or in gaps in the forest canopy. Maternity colonies also use multiple alternate roost trees that may be at the edge or interior of the forest, and provide a range of microclimates, which can be used in differing weather conditions. Wetlands and streams with well-developed wooded riparian corridors also contribute to high-quality habitat.

3. What is the amount and quality of Indiana bat habitat in the surrounding area that is protected into perpetuity (e.g., parks, nature preserves).

An abundance of protected suitable habitat in areas adjacent to the project indicates to the Service that the overall character of the landscape will persist.

If it is determined, based on the habitat quality, quantity, and/or amount of surrounding perpetual habitat, that winter clearing will result in adverse effects, the applicant should propose other avoidance and minimization measures, primarily habitat preservation, that will avoid adverse effects. If this is not possible, the applicant/Federal Agency may choose to either 1. survey to demonstrate presence or probable absence, or 2. initiate formal consultation with the Service.

Consulting on Projects within 5 Miles of Known Records

If the project is within 5 miles of a known capture of an Indiana bat (either Summer, Fall, or Winter), there is a greater likelihood that an Indiana bat is present in the action area. Research has shown that in general, the maximum distance female bats fly from their maternity roosts to forage during the summer is approximately 2.5 miles (depending on habitat suitability and structure). Therefore, Indiana bats are more likely to occupy an area within 5 miles of any given capture site (which assumes that the female was 2.5 miles from its primary roost tree when it was captured).

Because it is likely that Indiana bats are present at a site within 5 miles of a known capture, we must closely evaluate the effects of any habitat disturbance at the site. To do this, we typically recommend that the Federal Agency or applicant compile the following information:

- 1) A map of the site with all forested areas indicated, including acreage
- 2) A description of forested habitat, including dominant species composition, age, density of understory, and canopy cover
- 3) The location of suitable roost trees (dead or live trees with peeling bark, cracks, or crevices), and describe species, condition (live or dead), size (diameter breast high), and canopy cover
- 4) Description and size of any forested parcels onsite that will be preserved—preservation of forested habitat is the most significant way to minimize potential impacts to the bat and its habitat.
- 5) The location and size of any other forested properties within the vicinity of the project that are protected in perpetuity (ex. parks, conservation easements, etc.).
- 6) The location of any wetlands, streams, ponds, and cleared paths or trails.
- 7) Describe connectivity of site to other adjacent forested parcels
- 8) Avoidance and minimization measures to protect the bat and its habitat (such as seasonal tree clearing, temporary preservation of suitable habitat, etc.)
- 9) Using the information above as justification, a determination of whether or not the project is likely to adversely affect the Indiana bat

This information will assist the Service in evaluating potential impacts (direct and indirect) to the Indiana bat from the proposed project. For a discussion of possible impacts resulting from habitat loss see the “Assuming Presence” section above. If sufficient information is not provided to document a “not likely to adversely affect” determination, formal consultation under Section 7 of the ESA would be necessary.

Important points to consider

Some important points to keep in mind when addressing section 7 consultation for Indiana bats are:

1. Clearing suitable habitat during the winter may not always avoid adverse effects.
2. A negative mist-net survey (no Indiana bats captured) may not always indicate that adverse effects to Indiana bats would be avoided if trees are removed during the summer.
3. Mist net surveys and seasonal clearing have specific seasonal windows in which they can be conducted. Being conscious of these windows will help avoid unnecessary delays in the consultation process. Some important windows include:

Summer mist-netting season:	May 15 to August 15
Winter clearing of summer habitat:	September 15 to April 15
Winter clearing of habitat within 5 miles of a hibernaculum:	November 15 to March 31

The preceding discussion is not intended to incorporate all conceivable scenarios that may arise during section 7(a)(2) consultation for the Indiana bat. It is presented to offer general technical assistance to Federal Action Agencies, applicants, and their consultants. Some situations may require alternative procedures to fully and adequately evaluate all effects of the Federal Action. In all cases, the Service will use the best available scientific and commercial data to come to its conclusions. In instances where data are not available, the Service will heed its Congressional Mandate to give the benefit-of-the-doubt to listed species. Following the procedures outlined in this document does not constitute consultation under section 7(a)(2) of the ESA. Consultation must occur through direct contact with the Service.

The Service is always willing to answer questions regarding consultation for Indiana bat. Addressing impacts to this species can involve working through complex issues, which requires enhanced communication among the applicant, the Federal Action Agency, and the Service. We encourage anyone who is involved in projects requiring ESA section 7(a)(2) consultation that may affect the Indiana bat to contact us early in project development process to discuss potential effects to this species.

Service Biologists can be reached at:

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APPENDIX A

MIST NETTING GUIDELINES

RATIONALE

A typical mist net survey is an attempt to determine presence or probable absence of the species; it does not provide sufficient data to determine population size or structure. Following these guidelines will standardize procedures for mist netting. It will help maximize the potential for capture of Indiana bats at a minimum acceptable level of effort. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence. Netting effort as extensive as outlined below usually is sufficient to capture Indiana bats. However, there have been instances in which additional effort was necessary to detect the presence of the species.

NETTING SEASON

May 15 - August 15

These dates define acceptable limits for documenting the presence of summer populations of Indiana bats, especially maternity colonies. Several captures, including adult females and young of the year, indicate that a nursery colony is active in the area. Outside these dates, even when Indiana bats are caught, data should be carefully interpreted: If only a single bat is captured, it may be a transient or migratory individual.

EQUIPMENT

Mist nets - Use the finest, lowest visibility mesh commercially available:

1. In the past, this was 1 ply, 40 denier monofilament - denoted 40/1
2. Currently, monofilament is not available and the finest on the market is 2 ply, 50 denier nylon denoted 50/2
3. Mesh of approximately 1 ½ (1 ¼ - 1 ¾) in (~38 mm)

Hardware - No specific hardware is required. There are many suitable systems of ropes and/or poles to hold the nets. See NET PLACEMENT below for minimum net heights, habitats, and other netting requirements that affect the choice of hardware. The system of Gardner et al. (1989) has met the test of time.

NET PLACEMENT

Potential travel corridors such as streams or logging trails typically are the most effective places to net. Place the nets approximately perpendicular across the corridor. Nets should fill the corridor from side to side and from stream (or ground) level up to the overhanging canopy. A typical set is seven meters high consisting of three or more nets "stacked" on top one another and up to 20 meters wide. (Different width nets may be purchased and used as the situation dictates.)

Occasionally it may be desirable to net where there is no good corridor. Take caution to get the nets up into the canopy. The typical equipment described in the section above may be inadequate for these situations, requiring innovation on the part of the observers.

RECOMMENDED NET SITE SPACING

Stream corridors - one net site per km of stream.

Non-corridor land tracts - two net sites per square km of forested habitat.

MINIMUM LEVEL OF EFFORT

Netting at each site should consist of:

- At least four net nights (unless bats are caught sooner) (one net set up for one night = one net night)
- A minimum of two net locations at each site (at least 30 m apart, especially in linear habitat such as a stream corridor)
- A minimum of two nights of netting
- Sample Period: begin at sunset; net for at least 5 hr
- Each net should be checked approximately every 20 min
- No disturbance near the nets, other than to check nets and remove bats

WEATHER CONDITIONS

Severe weather adversely affects capture of bats. If Indiana bats are caught during weather extremes, it is probably because they are at the site and active despite inclement weather. On the other hand, if bats are not caught, it may be that there are bats at the site but they may be inactive due to the weather. Negative results combined with any of the following weather conditions throughout all or most of a sampling period are likely to require additional netting:

- Precipitation
- Temperatures below 10EC
- Strong winds (Use good judgment: moving nets are more likely to be detected by bats.)

MOONLIGHT

There is some evidence that small myotine bats avoid brightly lit areas, perhaps as predator avoidance. It is typically best to set nets under the canopy where they are out of the moonlight, particularly when the moon is ½-full or greater.

Gardner, J.E., J.D. Gamer, and J.E. Hofmann. 1989. A portable mist netting system for capturing bats with emphasis on *Myotis sodalis* (Indiana bat). *Bat Research News* 30(1):1-8.

APPENDIX B

Criteria for Determining if Caves or Abandoned Underground Mines Are Potential Hibernacula for the Indiana Bat

- Mine/cave entrances should not be flooded or prone to flooding (debris on ceiling).
- Mine/cave entrances should be accessible to bats (not collapsed).
 - Foliage and other vegetation in front of mine openings do not stop use by bats. The animals can navigate through foliage.
 - Bats can access mines via old open buildings such as fan houses.
- Openings should be at least 2 years old.
- Openings should be at least one foot in diameter or larger.
- Passage should be evident for some distance into mine workings (never enter a mine opening to verify distance).
- There should be some amount of airflow in or out of entrance.
- Bats will use vertical shafts. Vertical passage should be at least two feet in diameter with some airflow.

Appendix C

Emergence Surveys

- Must be conducted by a qualified biologist. A Federal permit is not required.
- Cannot determine species of bat present.
- Surveyor should contact the Service prior to conducting emergence surveys to determine if this technique is appropriate for the particular situation.
- Must be conducted for a minimum of two consecutive nights for each tree exhibiting characteristics suitable for bat roosting.
- Surveyor(s) should stand/sit by the base of tree for ½ hour before dusk until ½ hour after sunset.
- Tree(s) should be silhouetted against the sky, and surveyor should watch for bats to emerge.
- The survey should not be conducted during inclement weather such as precipitation, strong wind, or temperatures below 10° C.
- If no bats are detected emerging from or entering the tree or nearby trees, the tree may be cut down the day following completion of the survey.
- If any bat activity is detected, a mist-net survey may be needed to determine which bat species are present within the project area.