

# RANGE-WIDE INDIANA BAT & NORTHERN LONG-EARED BAT SURVEY GUIDELINES



**MARCH 2026**



**TABLE OF CONTENTS**

**INTRODUCTION.....1**

**INITIAL PROJECT SCREENING.....4**

**HABITAT ASSESSMENTS.....6**

**SUMMER / YEAR-ROUND SEASON HABITAT .....7**

**POTENTIAL WINTER HIBERNACULA .....11**

**POTENTIAL BRIDGE & CULVERT ROOSTS .....12**

**ESTABLISHING PRESENCE/PROBABLE ABSENCE .....15**

**ACOUSTIC/MIST-NET SURVEYS.....15**

**ACOUSTIC SURVEYS .....20**

**MIST-NETTING SURVEYS .....28**

**POTENTIAL WINTER HIBERNACULA SURVEYS.....35**

**WINTER (INTERNAL) SURVEY .....35**

**FALL OR SPRING EMERGENCE SURVEY .....36**

**POTENTIAL BRIDGE & CULVERT SURVEYS.....39**

**RADIO TRACKING .....46**

**EMERGENCE SURVEYS.....50**

**REFERENCES.....53**

**APPENDIX A. BAT ACTIVITY PERIODS ..... A1**

**APPENDIX B. GLOSSARY..... A6**

**APPENDIX C. EXAMPLE FORMS & DATASHEETS..... A9**

**Recommended Citation for this Document:**

U.S. Fish and Wildlife Service. 2026. Range-wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines. U.S. Fish and Wildlife Service, Region 3, Bloomington, MN. 53 pp + appendices.

## INTRODUCTION

The Range-wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines (Bat Survey Guidelines) provide the U.S. Fish and Wildlife Service's (USFWS) recommendations to project proponents completing habitat assessments and presence/probable absence surveys for the Indiana Bat (IBAT), northern long-eared bat (NLEB), and tricolored bat (TCB). One or more of these three species are considered the “target species” for this guidance. The Bat Survey Guidelines outline preferred and accepted survey methodology and reporting requirements for surveyors. The USFWS does not require surveys for federally listed or proposed species to meet Endangered Species Act (ESA) compliance requirements. Therefore, use of the Bat Survey Guidelines remains voluntary. Also, project proponents may discuss if other methods may be more appropriate with their local USFWS Ecological Services Field Office (FO). For example, natural resource land management agencies and researchers conducting projects that do not result in permanent habitat loss and are interested in landscape-scale surveys of pre-defined areas or conservation properties to inform presence/probable absence may choose to develop surveys at different scales (broad vs. project level) and methodologies, depending on project objectives. These projects may include long-term monitoring projects (e.g., forest-wide acoustic data) and/or targeted survey efforts (e.g., sub-sampling of large project areas), to address target species.

The following guidance is designed to determine whether target species are present<sup>1</sup> or probably absent (P/A)<sup>2</sup> at a given site during the summer/year-round active seasons (see General Process discussion below and [Appendix A](#) for further context), in winter roosting locations (hibernacula), and/or within bridges and culverts, and supersedes all prior survey guidance for these species. Before conducting surveys, please ensure use of the most current version of this document. Future changes to this document may occur and will be posted by March 31st of each year. All USFWS bat survey guidance documents can be found at <https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines>

These protocols may be different from those designed for general bat monitoring as part of the [North American Bat Monitoring Program \(NABat\)](#). NABat acoustic survey protocols are similar to breeding bird surveys in that they are not project-specific surveys in most cases. Information from NABat surveys can be considered as part of “best available” information when assessing whether there is already some existing information on presence of target species in the vicinity of a given project. However, due to different methods and levels of effort, NABat surveys alone are not adequate to confirm probable absence of target species.

---

<sup>1</sup> The guidance is not intended to provide sufficient data to fully determine population size or structure.

<sup>2</sup> Protocols are not 100% likely to detect IBAT, NLEB, and TCB when present and identification errors may occur.

## OBJECTIVES

---

The objectives of the Bat Survey Guidelines are to: (1) provide standardized recommended range-wide survey procedures for the target species; (2) maximize the potential for detection/capture/observation of the target species at a minimum acceptable level of effort (LOE); (3) make accurate presence/probable absence determinations; (4) assist surveyors to remain in compliance with state and federal permit requirements; and (5) aid in conservation efforts for the species' by identifying areas where they are present.

## GENERAL PROCESS

---

The Bat Survey Guidelines described in this document are designed to be implemented during acceptable survey windows. Surveys must be implemented in habitats that consider the needs of each target species and are conducive to the survey techniques described herein. The USFWS recognizes that occasionally there may be suitable target species habitat with site-specific conditions that do not lend themselves to being surveyed using the survey methods (e.g., mist-nets, acoustic detectors, and/or harp traps) provided in the guidance. This is why we strongly encourage coordination with the FO(s) prior to using methods that may not be appropriate for site-specific habitat conditions. An online directory of USFWS FO(s) is available on the USFWS website (<https://www.fws.gov/our-facilities>). The bat activity timeframes (see [Appendix A](#)) are intended to provide consistency regarding seasonal life history periods across the species' ranges and can inform various ESA regulatory processes, avoidance and/or minimization measures, and general conservation actions for the target species. These timeframes are subject to change based on use of the best science available. Recommended survey timeframes within the Bat Survey Guidelines were set to provide project proponents and the USFWS confidence in P/A determinations for the target species and are often shorter than bat activity timeframes.

- 1) **Initial Project Screening** – Project proponents should submit their project through the Information for Planning and Consultation (IPaC) website (<https://ipac.ecosphere.fws.gov/>) to determine if the project area is within the range of the target species. If within one or more target species' ranges, then contact the local USFWS FO(s) to determine if presence has already been established for the project area and whether conservation measures could be implemented to avoid and minimize any potential impacts to these species. If presence is not yet established and/or it is determined that surveys for the target species may be beneficial, proceed to Step 2.
- 2) **Habitat Assessment** – A habitat assessment report should be submitted to the appropriate USFWS FO(s) (and/or to the lead Federal Action Agency). This should include all potential habitat features, including roosting habitat for summer/year-round active occupancy (e.g., trees with exfoliating bark and/or foliage), potential hibernacula (e.g., caves, cave-like features), and anthropogenic structures (e.g., bridges and/or culverts).
- 3) **Develop Survey Study Plan**–Project proponents and surveyors should develop a proposed survey study plan in coordination with the USFWS FO(s) so that all parties fully understand which methods will be deployed, what assumptions will be made, and what the various outcomes would be based on the results of each step. Although optional, we

encourage the use of the fillable [USFWS Study Plan Form for Bat Surveys and Monitoring](#) as it will ensure that all the information necessary is provided to the USFWS FO and expedite review and approval. Surveyors, per Section 10(a)(1)(A) of the ESA, are required to receive prior, site-specific approval from the USFWS FO. Surveyors should submit a study plan to the USFWS FO as soon as the decision to conduct a P/A survey is made. The USFWS FO will in most cases be able to review and approve survey requests quickly (e.g., within 15 working days); however, overall workload, energy projects (e.g., wind, solar), and complex projects that require coordination across multiple USFWS FOs (e.g., transmission) may necessitate as many as 45-60 days to approve. Project proponents are encouraged to coordinate with the USFWS FO(s) regarding when they may cease survey work once an assumption or documentation of their targeted species presence occurs. Field Offices may request changes to a proposed survey if it is determined that the study plan is insufficient for determining P/A of the target species.

4) **Conduct Approved Survey** – Surveys should only be conducted by qualified biologist(s), and qualifications will vary by survey type (e.g., acoustic vs. mist-netting). Surveys that entail the physical capture and handling of federally listed species will require an [ESA Section 10\(a\)\(1\)\(A\) recovery permit](#) (permit). Generally, a permit for the IBAT, NLEB, and/or TCB authorizes the capture of bats for identification, and handling for measurements, photography, banding, and radio transmitter attachment; some (but not all) may also authorize entry into potential hibernacula to conduct internal surveys and other study-specific collection. Following the Bat Survey Guidelines will meet standard USFWS recovery permit requirements; however, surveyors also need to ensure they meet all applicable state permitting and reporting requirements. USFWS may not rely on P/A results that do not follow the Bat Survey Guidelines, as written, and/or a USFWS-approved study plan from the local FO(s), may result in a FO requesting additional survey effort.

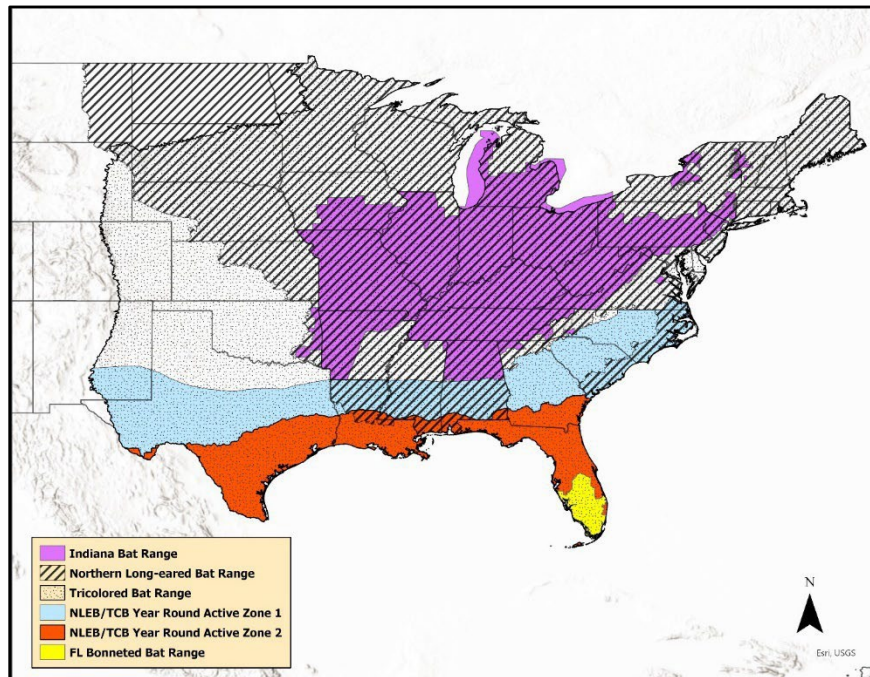
5) **Report Survey Results** – All results (negative or positive) from any survey should be submitted to the coordinating USFWS FO(s). This coordination improves the USFWS' understanding of (1) the level of survey effort underway and (2) the distribution of the species. A single report can be submitted at the end of all surveys conducted for a given project. Results from P/A surveys, including mist-net captures, acoustic data, and associated information (e.g., radio-tracking, banding, etc.) must also be submitted annually to the USFWS using the Section 10 Bat Reporting Spreadsheets (<https://www.fws.gov/media/bat-reporting-spreadsheets>) or as otherwise directed by the USFWS.

Unless otherwise agreed to by the USFWS, negative P/A surveys and habitat assessment results obtained using this guidance are valid for a minimum of five years from their completion (i.e., the year in which the survey is conducted and the four successive years) unless new information (e.g., other nearby surveys, significant habitat modification) suggest otherwise. If negative results are older than 5 years, coordinate with the USFWS FO(s) to discuss if additional surveys are needed. Positive P/A survey results obtained using this guidance cannot be reversed by additional survey efforts following this guidance's recommendations on level of survey effort, coordinate with the USFWS FO(s) if you are interested in more information regarding this topic.



## INITIAL PROJECT SCREENING

1) Determine if your project is within the range of the target species ([Figure 1](#)) through the U.S. Fish and Wildlife Service's Information for Planning and Consultation website (<https://ipac.ecosphere.fws.gov/>). If any of the target species are on the Official Species List generated in IPaC, coordinate with the USFWS FO(s) to determine whether conservation measures could be implemented to avoid and minimize any potential impacts to these species.



**Figure 1:** Hibernating and year-round active ranges of Indiana bat, northern long-eared bat, and tricolored bat. The range for Florida bonneted bat included for reference.

- 2) Coordinate with USFWS FO(s)<sup>3</sup> regarding existing target species' records or occurrence information to determine next steps:
- A. Project is already covered under an existing Endangered Species Act (ESA) incidental take authorization (e.g., Habitat Conservation Plan, Biological Opinion, etc.) – no further summer/year-round active season, potential hibernacula, and/or potential bridge and culvert roost surveys are needed; follow the procedures previously authorized by the USFWS FO(s).
  - B. Project is within 2.5 miles of IBAT or 1.5 miles of NLEB or TCB summer/year-round active occurrences (known as the “inner tier”) – species presence is already

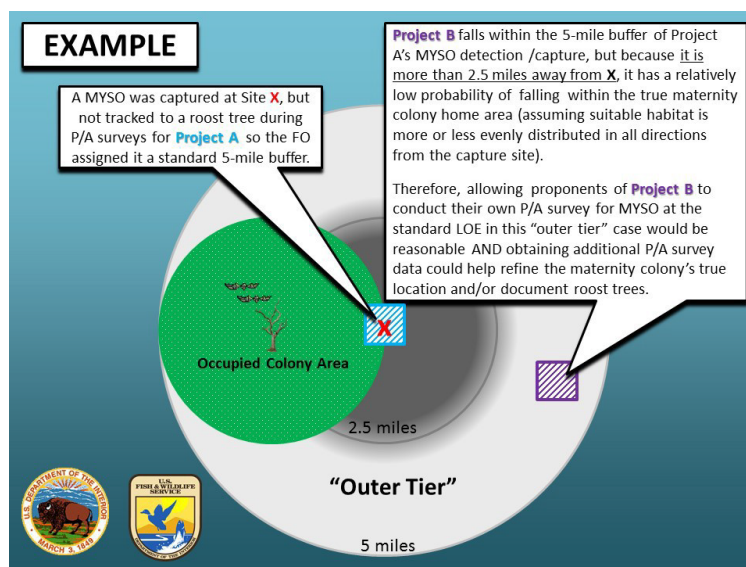
---

<sup>3</sup> Coordinate with the appropriate state natural resource agencies and any involved Federal Action agencies whenever “USFWS” coordination is listed. USFWS FO(s) may direct project sponsors to state agencies for existing target species occurrence information. Coordinate with your local USFWS FO(s) for more information.

established, and the area is therefore generally not eligible for additional surveys to establish P/A for that species. Coordinate with USFWS FO to establish minimization and/or mitigation measures.

- a. To address uncertainties surrounding large-scale declines following white-nose syndrome (WNS), USFWS FO(s) may allow project proponents whose project is either  $\leq 123$  acres in size or affects  $\leq 1\%$  of existing suitable summer/ year-round active habitat within a 5-mile (IBAT) or 3-mile (NLEB/TCB) radius buffer (whichever is greater) the opportunity to proceed with habitat assessments and, if necessary, survey in both the inner-tier and outer-tier of known Hibernating Range NLEB/TCB buffers and IBAT buffers within the Northeast and Appalachian Recovery Units in the [Indiana Bat Draft Recovery Plan](#) (USFWS 2007) when the known occurrence was prior to 2 years after WNS was first confirmed in the state. This decision is left to USFWS FO discretion.
- C. Project(s) within 5 miles (IBAT) or 3 miles (NLEB/TCB) of a known occurrence but  $\geq 2.5$  miles (IBAT) or  $\geq 1.5$  miles (NLEB/TCB) from the occurrence (known as the “outer tier”) and is either  $\leq 123$  acres in size or affecting  $\leq 1\%$  of existing suitable summer/year-round active habitat – may proceed with habitat assessments and, if necessary, conduct a summer/ year-round active P/A survey for the target species using the standard survey LOE. The additional survey data would 1) further refine the home range boundaries of the original colony, 2) confirm presence of additional colonies (if applicable), 3) provide additional radio-tracking opportunities and/or roost tree locations, and 4) provide an option for project proponents to survey instead of assuming presence.
- a. This “outer tier” guidance only applies to summer/year-round active captures/detections (not hibernacula or bridge and culvert roosts).
  - b. USFWS FO(s) may decide not to approve an “outer tier” survey under the following circumstances: (1) If available forest habitat with a 5-mile (IBAT) or 3-mile (NLEB and/or TCB) buffer is not more-or-less evenly distributed, but rather is highly clumped or restricted to a relatively narrow strip(s) (e.g., a riparian corridor); (2)  $< 10\%$  of a 5-mile (IBAT) or 3-mile (NLEB and/or TCB) buffer contains suitable summer/ year-round active habitat; or (3) other site-specific reasons.
  - c. If a project proponent of an “outer tier” project coordinates with the USFWS FO(s) upfront and conducts a valid P/A survey using the appropriate LOE and does not capture/detect an IBAT, NLEB, and/or TCB(s), then no species-specific conservation measures (e.g., avoidance, minimization, etc.) will be required for that specific project area ([Figure 2](#)). However, all assumptions of target species presence outside of a completed “outer tier” project survey area shall remain intact indefinitely within the 5-mile (IBAT) or 3-mile (NLEB and/or TCB) buffer zone or until additional negative survey data or discovery of roost trees indicate adjustments to a buffer are warranted by USFWS. If any target species are captured/detected/radio-tracked during the survey, then the project area will be presumed to be occupied and the USFWS FO(s) will

reassess/adjust the original buffer(s) if warranted using the newly acquired bat location data.



**Figure 2:** Example application of the "outer tier" guidance for an Indiana bat (MYSO) survey scenario.

- D. Project has no known occurrences within 5-miles (IBAT) or 3-miles (NLEB/TCB) of project area – complete necessary habitat assessments (i.e. summer/year-round active season habitat, potential hibernacula, and/or potential bridge and culvert roosts).

## HABITAT ASSESSMENTS

A project proponent is responsible for developing and providing sufficient information as to whether suitable habitat is available within a proposed project area, including potential roost trees for summer or year-round active occupancy, potential hibernacula, and/or suitable bridge and culvert roosts. Habitat assessments should be completed by individuals with a natural resource degree or equivalent work experience demonstrating skills and knowledge in area-specific ecoregions, landscapes, habitats, and ecosystems. If suitable habitat is present, the applicant should calculate the amount and submit this to the USFWS FO(s) either separately or with a P/A survey study plan. Suitable summer/year-round active habitat can be assumed present if the project proponent wishes; however, habitat suitability assessments for potential hibernacula and/or suitable bridge and culvert roosts would require submittal when applicable.

Habitat assessment(s) should be completed for any potential:

- Summer/Year-round Active Season Habitat
- Potential Winter Hibernacula
- Potential Bridge and Culvert Roosts



## SUMMER / YEAR-ROUND ACTIVE SEASON HABITAT

Assessment of suitable summer/year-round active season habitat can be conducted remotely via a desktop analysis (e.g., use of aerial photography and lidar imagery to assess the potential presence of suitable summer habitat and its relative height/stand age); however, on-site field assessment is always preferred. The applicant is responsible for developing and providing sufficient information as to whether suitable summer habitat is present or absent within a proposed project area.

**NOTE:** If target species are present or assumed to be present during any survey, more detailed habitat information may be necessary to adequately assess the potential for impacts (see example [Appendix C2: Bat Summer/Year-Round Habitat Assessment Form](#)). If no suitable habitat is present or it is determined through discussions with USFWS FO(s) that no adverse effects are anticipated from the proposed project, no surveys are recommended to assess risk. Habitat assessments for target species can be completed any time of year, and applicants are encouraged to submit results and proposed study plans well in advance of survey seasons.

---

### INDIANA BAT HABITAT

Suitable summer habitat for IBAT 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<sup>4</sup> such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags  $\geq 5$  inches dbh<sup>5</sup> (12.7 centimeter) that have exfoliating bark, cracks, crevices, and/or hollows), as well as linear features such as wooded fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of another forested/wooded habitat.

Indiana bats have also been observed roosting in human-made structures, such as bridges and bat houses (artificial roost structures). Therefore, these structures should also be considered potential summer habitat; see the Emergence Surveys section and then coordinate with the local USFWS FO(s) regarding how to determine P/A. We recommend that project

---

<sup>4</sup> Non-forested habitats typically should be excluded from acreages used to establish a minimum level of survey effort for surveys.

<sup>5</sup> While trees  $< 5$  inches ( $< 12.7$  cm) dbh that have exfoliating bark, cracks, crevices, and/or hollows may have some potential to be male IBAT summer roosting habitat, the USFWS does not consider early successional, even-aged stands of trees  $< 5$  inches dbh to be suitable roosting habitat for the purposes of this guidance. Suitable roosting habitat is defined as forest patches with trees of 5-inch (12.7 cm) dbh or larger. However, early successional habitat with small diameter trees may be used as foraging habitat by IBATs. Therefore, a project that would remove or otherwise adversely affect  $\geq 20$  acres of early successional habitat containing trees between 3 and 5 inches (7.6-12.7 cm) dbh would require coordination with the USFWS FO. The USFWS may request P/A surveys if  $> 20$  acres of early successional habitat were proposed for removal.

proponents or their representatives coordinate with the appropriate USFWS FO to define suitable habitat more clearly for their region as some differences in state/regional suitability criteria may be warranted (e.g., high-elevation areas may be excluded as suitable habitat in some states).

Examples of unsuitable habitat:

- Individual trees that are  $\geq 1,000$  feet from forested/wooded areas.
- Individual trees and/or small stands located in highly developed urban areas.
- A newly regenerating young forest or woody shrub stand of  $\leq 3$ -inch dbh that does not contain larger residual trees.

## **NORTHERN LONG-EARED BAT HABITAT**

Suitable summer/ year-round active season habitat for the NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel. Although they may also traverse habitat adjacent and interspersed with forest habitat when migrating or foraging, such as emergent wetlands and field edges, they are predominately found in forest/wooded habitat except when/if hibernating. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags  $\geq 3$  inches dbh that have exfoliating bark, cracks, crevices, and/or cavities), 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. NLEBs are nocturnal foragers and use hawking (catching insects in flight) and gleaning (picking insects from surfaces) behaviors in conjunction with passive acoustic cues (Nagorsen and Brigham 1993, p. 88; Ratcliffe and Dawson 2003, p. 851). NLEB often prefer intact mixed-type forests with small gaps (i.e., forest trails, small roads, or forest-covered creeks) in forest with sparse or medium understory vegetation for foraging and commuting rather than fragmented habitat or with large areas that have been clear cut (USFWS 2015, p. 17992). Individual trees may be considered suitable habitat when they exhibit characteristics of suitable roost trees and are within 1,000 feet of another forested/wooded habitat. NLEBs have also been observed roosting (although to a lesser degree than forested habitat) in human-made structures, such as buildings, barns, bridges, and bat houses; therefore, these structures should also be considered potential summer/year-round active season habitat; see the Emergence Surveys section and then coordinate with the local USFWS FO(s) regarding how to determine P/A.

Within the hibernating range, NLEBs occupy their summer habitat for only a portion of year; however, NLEBs in the year-round active part of the range may be active and occupying trees (summer habitat) at any time of year due to milder winters and overall warmer seasonal conditions. NLEBs in these areas (see Figure 1) often have atypical hibernation strategies, going into shorter bouts of torpor in non-traditional roosts (e.g., roadway culverts) compared to the rest of the U.S. Activity dates listed by state can be found in [Appendix A](#).

Examples of unsuitable habitat:

- Individual trees that are  $\geq 1,000$  feet from forested/wooded areas.
- Individual trees and/or small stands found in highly developed urban areas<sup>4</sup>.
- A newly regenerating young forest or woody shrub stand of  $< 3$ -inch dbh that does not contain larger residual trees.

---

## TRICOLORED BAT HABITAT

Suitable TCB summer/year-round active season habitat consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and include some adjacent and interspersed non-forested habitats such as emergent wetlands, shrublands, grasslands, and forested edges of agricultural fields, old fields, and pastures<sup>4</sup>. TCBs may roost and forage in forested areas near anthropogenic structures and buildings as well (e.g., suburban neighborhoods, parks, etc.) (Helms 2010; Shute et al. 2021).

Roosting habitat includes forests, woodlots, and linear features (e.g., fencerows and riparian corridors) containing trees with potential roost substrate (e.g., live and dead leaf clusters of live and recently dead deciduous trees, Spanish moss [*Tillandsia usneoides*], and beard lichen [*Usnea trichodea*])<sup>6</sup>. TCBs will roost in the foliage of a variety of tree species, and their selection of roost sites likely depends upon local availability of trees with suitable roosting substrate. TCBs commonly roost in the mid to upper canopy of trees, although males will occasionally roost in dead leaves at lower heights (e.g., < 16 feet [5 meters] from the ground; Perry and Thill 2007) and females will occasionally roost in Spanish moss of understory trees (Menzel et al. 1999). TCBs also roost in human-made structures, such as bridges and culverts, and occasionally in barns or the underside of open-sided shelters (e.g., porches, pavilions). Therefore, these structures should also be considered potential summer/year-round active season habitat; see the Emergence Surveys section and then coordinate with the local USFWS FO(s) regarding how to determine P/A.

TCBs seem to prefer foraging along forested edges of larger forest openings, along edges of riparian areas, and over water and avoid foraging in dense, unbroken forests, and narrow road cuts through forests (Davis and Mumford 1962; Kurta 1995; Lacki and Hutchinson 1999; Ford et al. 2005; Menzel et al. 2005; White et al. 2006; Thames 2020; Hantulla and Valdez 2021). and Valdez 2021).

TCBs occupy similar forest habitats in the spring, summer, and fall (i.e., non-hibernating seasons) but in the southern portion of the range, where TCBs exhibit shorter torpor bouts and remain active and feed year-round, they may roost in culverts, bridges, cavities in live trees, live and dead leaf clusters, and/or Spanish moss during the winter (Sandel et al. 2001; Newman et al. 2021).

Examples of unsuitable habitat:

- Highly developed urbanized areas devoid of native vegetation
- Isolated trees and/or small stands surrounded by expansive anthropogenic development such as parking lots, industrial buildings, and shopping centers.

---

<sup>6</sup> Occasional summer roosts also include clusters of dead pine needles of large live pines (*Pinus echinata*), live branches of Norway spruce (*Picea abies*), eastern red cedar (*Juniperus virginiana*), abandoned gray squirrel (*Sciurus carolinensis*) nests, and under exfoliating birch (*Betula spp.*) bark (Veilleux et al. 2003; Perry and Thill 2007; WDNR 2016; WDNR 2017a; WDNR 2017b; WDNR 2018; Thames 2020; Hammesfahr et al. 2022).

## **POTENTIAL WINTER HIBERNACULA**

IBAT, NLEB, and TCB have been documented using caves, sinkholes, rock fissures, and other karst features, as well as anthropogenic features such as mines and tunnels as winter hibernation habitat (i.e., hibernacula). TCBs often use a much wider variety of hibernacula and warmer microclimates than would traditionally be considered suitable for IBATs and NLEBs. Coordinate with the local USFWS FO(s) to ensure your assessment of potential winter habitat is acceptable for TCB. Additionally, NLEB and TCBs have the potential to use smaller cave-like features<sup>7</sup> such as rock shelters/outcrops and talus formations. Project proponents need to evaluate whether any potentially suitable hibernacula exist within a proposed project area. This knowledge will be derived from a variety of sources.

## **DESKTOP ANALYSIS AND INITIAL FIELD RECONNAISSANCE**

After coordinating with the FO and appropriate state natural resource agency (when applicable), a desktop analysis and initial field reconnaissance should be completed by individuals with a natural resource degree or equivalent work experience and an in depth understanding of cave and karst topography and/or surface features associated with underground mines. These initial assessments can be completed any time of year.

For all projects, a FO-approved field survey of all land within 0.5 miles of the edge of the project footprint (where access can be obtained) and documentation (e.g., a literature search, maps and information provided by local cave survey groups or grottos, review of aerial photography and topographical maps, previous mining records (if applicable), forest inventories, previous species survey reports, and the work of consultants or other designees) of all known caves and abandoned mines within 3 miles of the outside edge of the project footprint should be conducted. If caves or abandoned mines are found, further detail about the known or estimated underground extent of the cave/mine should be provided to the USFWS FO(s), including minimum and maximum depth of features and where those features are located on a map(s).

In general, underground openings can be deemed unsuitable as a hibernaculum and dismissed from further assessment and surveys if:

- A. There is only one horizontal opening, and it is less than 6 inches (15.2 cm) in diameter.
- B. Vertical shafts are < 1 foot (0.3 m) in diameter.
- C. Passage or opening extends a short distance (e.g., < 50 ft / 15.2 m) with no visible evidence of bats or associated physical features (e.g., visible fissures, crevices, etc.) that bats can access.

---

<sup>7</sup> Currently, The Bat Survey Guidelines does not address how to conduct surveys of these smaller cave-like features. Coordinate with the local USFWS FO(s) regarding how to determine P/A if one of these features will be impacted by a proposed project.

- D. Openings are prone to flooding, collapsed shut and completely sealed, or otherwise are inaccessible to bats; and
- E. Openings that have occurred recently (i.e., within the past 12 months) due to human activity or subsidence. (Include written documentation verifying this determination).

The results of initial field assessments should be submitted to the USFWS FO(s) and State regulatory partners (when applicable) for review and approval prior to proceeding. FO-approved results will remain valid for a minimum of five years.

---

## **HABITAT ASSESSMENT OF POTENTIALLY SUITABLE HIBERNACULA**

Habitat assessments should include all subterranean entrances or openings that will be directly or indirectly impacted by the proposed project. This would include those caves, sinkholes, fissures, other karst features, and cave-like features (e.g., rock shelters/outcrops, talus slopes), as well as anthropogenic features such as mines and tunnels that are within the project site or that are otherwise connected (i.e., by physical passageway, airflow or hydrologically) to any underground feature that will be directly or indirectly impacted by the proposed project (see example [Appendix C3: Potentially Suitable Hibernacula Assessment Form](#)).

The results of a habitat assessment should be submitted to the USFWS FO(s) and State regulatory partners (when applicable) for review and approval prior to proceeding. FO-approved results will remain valid for a minimum of five years.

## **POTENTIAL BRIDGE & CULVERT ROOSTS**

Roadway transportation structures, specifically bridges and culverts, can provide suitable roosting habitat for bats. At least 24 North American bat species, including IBAT, NLEB, and TCB, have been documented using bridges and culverts as day and nighttime roost sites (Keeley and Tuttle 1999). Bridges are typically documented as important roosting locations during the active seasons (staging, maternity, and swarming; Detweiler and Bernard 2023, Keeley and Tuttle 1999) whereas culverts are usually recorded as winter roost sites in areas where suitable cave habitat may be lacking, especially in the southern United States (USFWS 2022). However, there are exceptions to these generalizations and bats may use bridges or culverts at various times throughout their life histories.

A culvert is a round or rectangular-shaped structure hydraulically and structurally designed to convey water, sediment, debris, and, in many cases, aquatic and terrestrial organisms through roadway embankments. Roadway culverts are usually composed of concrete or corrugated metal but can also be constructed of timber or PVC piping. Bridges are vehicular or pedestrian structures that are larger and more structurally open than culverts and may span over waterways, various uplands, or urban areas. Bridges are constructed in numerous designs and are often composed of concrete, metal, wood, or a combination of these materials. Refer to the Glossary ([Appendix B](#)) for more expansive definitions of bridges and culverts.

Bridges and culverts can have many characteristics suitable for bat occupation. Many bat species will take advantage of cracks, crevices, voids, and other openings within structures. These can include cracks and openings caused by structural deterioration (e.g., cracking in concrete, rusted metal, etc.) and typical spaces existing via structural design (e.g., expansion



joints). Bats may also roost in the open on rough surfaces or within drain or weep holes, along guardrails, and within jersey barriers or other voids. Additionally, many bridges and culvert designs create artificial “cave-like” environments where conditions are generally stable and protect bats from adverse weather, thus allowing bats to use them for extended periods of torpor, particularly in areas where natural cave-like habitats may be limited.

**Due to the numerous factors influencing bat use of bridges and culverts, both seasonally and geographically, the appropriate time of year for assessments should be coordinated with your local USFWS FO(s).** The Service may prefer that a bridge or culvert is assessed for use during the timeframe the structure is most likely to be impacted by the project, especially if the timing overlaps with when a target species is most likely to use the structure. However, if the impact is permanent, it may be more important to time the survey when bats are most likely to be active to inform the consultation on how many/how the bat(s) will be affected. Surveys resulting in probable absence for the target species are valid for two years<sup>8</sup> if this guidance is followed and the survey report is approved by the local USFWS FO(s). Validity timeframes for other bat species should be coordinated with your local USFWS FO(s). Those practitioners utilizing the Programmatic Biological Opinion in conjunction with Federal Highway Administration, Federal Railroad Administration, and Federal Transit Administration for Transportation Projects should follow the Bat Survey Guidelines for completing assessments of bridges or culverts.

If IBAT, NLEB, and/or TCB are positively identified during a bridge or culvert assessment or if species identification cannot be verified at a bridge or culvert with evidence of use, coordinate with your local USFWS FO within 48 hours to determine next steps. For other species, coordinate with your appropriate state agency(ies) (e.g., state wildlife and transportation agencies).

---

## **PERSONNEL TRAINING REQUIREMENTS**

Before performing assessments for bats on bridges or culverts, surveyors should coordinate with their local USFWS FO(s) regarding potential field training opportunities that may be required. At a minimum, surveyors should view the USFWS’s virtual bat and transportation structures training (available [here](#).) before conducting field assessments. Additional trainings may be available in specific states (e.g., Georgia, Indiana, New Jersey, and North Carolina).

## **INITIAL ASSESSMENT OF SUITABILITY AND SAFETY**

Prior to conducting any bridge or culvert assessment, a thorough safety assessment of each structure should be conducted to identify any potential health or safety hazards to surveyors and bystanders. Road traffic, unstable surfaces (e.g., riprap, deep sediment, ice, and swift moving water), or enclosed spaces are examples of some potential safety concerns. Surveyors should use appropriate personal protective equipment and take proper precautions to avoid and minimize identified risks according to their own comfort level and following the safety recommendations and guidelines required by their organization and local authorities. Only structures that are deemed safe should be entered at the surveyor’s discretion.

---

<sup>8</sup>The timeframe of two years is to remain consistent with the Programmatic Biological Opinion for Transportation Projects in the Range of the IBAT and NLEB

Upon determining that a site is safe to enter, the bridge or culvert should be evaluated to determine whether it is generally suitable for bat roosting. Because most bridges will contain cracks and crevices that are of suitable size for bat roosting, any bridge that is safe to assess should be considered potential habitat for IBAT and NLEB, as well as TCB. Culvert suitability may vary by species. Table 1 includes the minimum diameter measurements for each species for consideration (adapted from USFWS 2022). The minimum length culvert that the target species have been documented using is 23 feet (N. Anderson, personal communication, Louisiana Department of Wildlife and Fisheries 2014). However, for safety reasons, we do not recommend entry of any site less than 3 feet in diameter at the entrance, regardless of whether the site is greater than 23 feet in length. Practitioners should coordinate with local USFWS FO(s) to determine if local guidance deviates from these minimums when additional species may need to be considered.

**Table 1.** Suggested minimum culvert dimensions for determining IBAT, NLEB, and TCB suitability. If a site meets the minimum entrance height/diameter for a particular species and is 23 feet or greater in length\*, it may be considered suitable.

Species	Minimum Culvert Entrance Height/Diameter (feet)	Source
IBAT	4	L. Pattavina & E. Ferrall, USFWS, personal communication, Georgia (2022)
NLEB	4.5	N. Anderson, personal communication, Louisiana Department of Wildlife and Fisheries (2014)
TCB	3*	USFWS (2022)

\* TCBs have been documented in culverts as small as 2 feet in diameter as reported in USFWS 2022; however, instances of TCB in culverts this small are expected to be rare. We do not recommend entry of sites less than 3 feet in height/diameter, regardless of length.

Additionally, culverts that are fully enclosed or blocked (e.g., under roadway or soil), enclosed with grills or grates, or fully obstructed in any other manner, should not require an assessment. Partially enclosed or obstructed structures may be suitable and should be inspected if of the appropriate size. Uncertainties in suitability should be coordinated with the local USFWS FO(s).

## SUBMITTAL OF HABITAT ASSESSMENTS

Summer/Year-Round Active Season, Potential Winter Hibernacula, and/or Bridge and Culvert Habitat Assessments submitted to USFWS FO(s) should include the following:

- 1) Full names and relevant titles/qualifications of individuals (e.g., John E. Smith, Biologist II, State University, B.S. Wildlife Science 2007) completing the habitat assessment and when the assessment was conducted.
- 2) A map and latitude/longitude or UTM clearly identifying the project location (or approximate center point) and boundaries.
- 3) Detailed project description (if available)
- 4) Documentation of any known/occupied spring staging, summer/ year-round active season, fall swarming, winter habitat, and/or bridge/culvert roosts for the target species

- within or near the project area.
- 5) A description of methods used during the habitat assessment.
  - 6) A summary of the summer/year-round active habitat assessment findings (see example [Appendix C2: Bat Summer/Year-Round Habitat Assessment Form](#))
  - 7) A habitat assessment on all potential winter hibernacula that could be affected by the proposed project (see example [Appendix C3: Potentially Suitable Hibernaculum Assessment Form](#)), if necessary.
  - 8) An assessment of suitability and safety on all bridges and culverts that could be affected by the proposed project (see example [Appendix C5: Bridge and Culvert Bat Assessment Form](#)), if necessary
  - 9) Any other information requested by the local USFWS FO(s) related to the project.

If no suitable summer/year-round active season habitat, winter habitat (i.e., potential hibernaculum), and/or potential bridge/culvert roosts are found within the project/action area, then no further P/A surveys are recommended; however, additional coordination with the USFWS FO(s) is recommended if target species may be present in an action area during other seasons (e.g., spring and fall migration).

## **ESTABLISHING PRESENCE/PROBABLE ABSENCE**

Project proponents wishing to conduct any type of presence/probable absence (P/A) survey should submit a draft study plan for all applicable survey types to the USFWS FO(s) for review and approval. Although optional, we encourage the use of the fillable [USFWS Study Plan Form for Bat Surveys and Monitoring](#) as it will ensure all the information necessary is provided to the USFWS FO and expedite review and approval of your study plan. If you choose not to submit the study plan form, ensure all information requested on the form applicable to your survey is included with your study plan request submittal to your local USFWS FO(s).

## **ACOUSTIC/MIST-NET SURVEYS IN SUMMER/YEAR-ROUND ACTIVE SEASON**

Presence/probable absence (P/A) of target species in suitable summer/year-round active season habitat may be determined by conducting either mist-netting or acoustics as stand-alone methods, or a combination approach (hybrid) of both techniques, as described below. However, surveys within TCB-only range (no range overlap with IBAT and/or NLEB) must use either the acoustic or the combination approach. Project proponents should have knowledge of available habitat for each survey area unit (i.e., ≤123-acre area or 1-km section of linear project) and propose a survey method(s) most suitable for detecting the target species within each unit. The USFWS FO(s) can discuss pros and cons of different approaches depending on project sponsor needs and project-specific habitat conditions. Under no scenario can a project proponent use either mist-netting or acoustic surveys to challenge or refute the other method's results.

The summer survey season within the IBAT, NLEB, and TCB hibernating<sup>9</sup> range is from **15 May through 15 August**. The survey season within the year-round active portion of the NLEB or TCB range is from **1 March through 15 October**. All P/A surveys should be completed by the end of the designated survey season unless otherwise indicated by USFWS FO<sup>10</sup>.

The minimum prescribed survey level of effort for any given survey area unit (i.e., ≤123-acre area or 1- km section of linear project) cannot be completed in a single calendar night regardless of which survey method (netting or acoustic) is used (i.e., minimum survey effort must be spread over at least 2 calendar nights with suitable weather conditions). If netting is chosen as the preferred P/A method and an IBAT and/or NLEB is captured, then surveyors may immediately begin radio-tracking. Radio-tracking of captured IBATs, NLEBs, and/or TCBs will be conducted unless an exemption or agreed-upon deviation has been granted by the respective USFWS FO(s) before any mist-netting occurs. For most situations, survey study plans should be approved by the USFWS FO prior to conducting field work, including receipt of site-specific authorization from the FO when it is required. However, extenuating circumstances may occur; therefore, coordinate with the local USFWS FO(s).

---

## LEVEL OF EFFORT (LOE) AND SURVEY DESIGN

**Level of Effort** – The level of effort (LOE) recommended for a P/A survey will be dependent upon the overall acreage and juxtaposition of suitable habitat that may be impacted by the action (directly or indirectly). To determine the recommended LOE, quantify the amount of suitable summer/year-round active season habitat impacted by the project, divide by 123 acres, round up to the next whole number, and multiply by the highest recommended minimum LOE for the species’ being surveyed (Table 2). There are no recommendations for reducing the minimum LOE to demonstrate probable absence for projects <123 acres in size. Level of effort is based on detection probabilities and occupancy estimates that were derived from past survey efforts using this acreage threshold. However, opportunities to improve survey efficiencies may be available when multiple small projects are proposed, there is habitat connectivity between the project areas, the total habitat impacted is <123 acres in size, and all habitat impacted by the projects falls within a single 2.5-mile IBAT and/or 1.5-mile NLEB/TCB buffer. Level of effort is designed to reach 90% confidence in negative survey results (see [Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper](#); Niver et al. 2014; Armstrong et al. 2023).

---

<sup>9</sup> The hibernating range includes the portion of the range where the species hibernates in the winter, stages and swarms outside of hibernacula in the spring and fall and migrates to summer home ranges.

<sup>10</sup> With prior USFWS FO approval, a survey may be completed after the end of the designated survey season if it was initiated in time to be completed by August 15 or October 15 (year-round active portion of the target species range) and extenuating weather circumstances resulted in delaying completion. Delays as a result of not meeting the acceptable weather requirements are the ONLY valid justification for surveying after August 15 or October 15. In the extenuating, rare instances where a survey is approved to continue beyond the deadline, the USFWS FO is likely to request a larger mist net or acoustic LOE to minimize the potential for a false negative survey.

**Table 2.** Minimum survey level of effort for the Indiana bat (IBAT), northern long-eared bat (NLEB), and/or tricolored bat (TCB). Values indicate the minimum number of net-nights (mist nets) or detector-nights (acoustics) surveyed.

Species	Range	Acoustics Linear (per km)	Acoustics Non-linear (per 123-acre)	Mist-Netting Linear (per km)	Mist-Netting Non-linear (per 123-acre)
IBAT	Range-wide	4	10	2	6
NLEB/TCB	Hibernating Range	4	14	4	10
	Year-Round Active Range	4	14	2	6

**NOTE:** If surveys are specifically targeting more than one of the three bat species, make sure to use the higher minimum LOE for chosen survey methods (e.g., NLEB/TCB range-wide acoustic or mist-netting LOE) to ensure it meets the needs for all species (Table 2).

**Survey Design Requirements** – For all acoustic linear projects, at least 1 detector location within each km must be sampled for at least 2 calendar nights (can sample the same location or move within the km site). For all acoustic non-linear projects, at least 2 detector locations must be sampled per 123-acre "site" over the course of at least 2 calendar nights (may be consecutive) until the appropriate LOE for detector nights has been completed.

For all mist-netting projects, after 2 consecutive nights of netting at the same location without capturing target species, you must change net locations or wait at least 2 calendar nights before resuming netting at the same location. If targeted bat species are captured, then proceed to radio tracking as previously decided in coordination with the FO(s).

**Combined Acoustic and Mist-Netting Survey** – Numerous publications discuss the general advantages of using acoustics and mist-netting in tandem for inventorying bat communities (Kunz and Brock 1975, Kuenzi and Morrison 1998, Murray et al. 1999, O’Farrell and Gannon 1999, Flaquer et al. 2007). Some advantages of a combined approach are that it provides flexibility to address challenging survey conditions (e.g., scenarios where quality mist-net set-ups for the target species are limited and/or inaccessible). These situations are not uncommon, especially for linear projects which can pass through highly variable habitats. A combined approach provides project proponents with the ability to reduce overall survey time and cost while still providing for a suitable LOE. Finally, a combined approach alleviates challenges associated with number of mist-net sites/set-ups and limits on number of survey nights per net-site for projects impacting smaller acreages of suitable habitat.

To calculate the mist-netting and acoustic LOE using the combined approach the surveyor must consider survey LOE as a percent and then balance the netting percent against the acoustic percent, which is what the guidance inherently does in setting the existing sole mist-netting and acoustic LOE standards.

- $X \text{ mist-net nights of effort}/123 \text{ acres} = Y \text{ acoustic nights of effort}/123 \text{ acres}$



First, determine the proportion of effort that will be applied using the mist-netting method. Next, refer to Table 2 and identify the highest mist-netting LOE for the species' being surveyed. Finally, use the information above to calculate the total survey LOE that would be accomplished at high-quality mist-net sets for the proposed P/A survey.

Proportion of Effort (PoE) for combined LOE should be calculated as follows:

- A.  $\text{PoE using mist-netting} \times \text{highest mist-netting LOE for surveyed species} = \text{Total survey LOE in nights accomplished by mist-netting}$

Once the number of nights of the total survey LOE to be conducted by mist-netting is known, then it can be used to determine the minimum required LOE for acoustics. To calculate the necessary acoustic LOE, simply subtract the calculated PoE (see A, above) from 1 and multiply that proportion by the highest overall LOE for the acoustic method for the species' being surveyed from Table 2.

- B.  $(1 - \text{PoE used in A, above}) \times \text{highest overall species acoustic LOE prescribed} = \text{Total number of survey nights necessary to meet the recommended acoustic LOE.}$
- C. Round nights calculated in A up to nearest whole number.

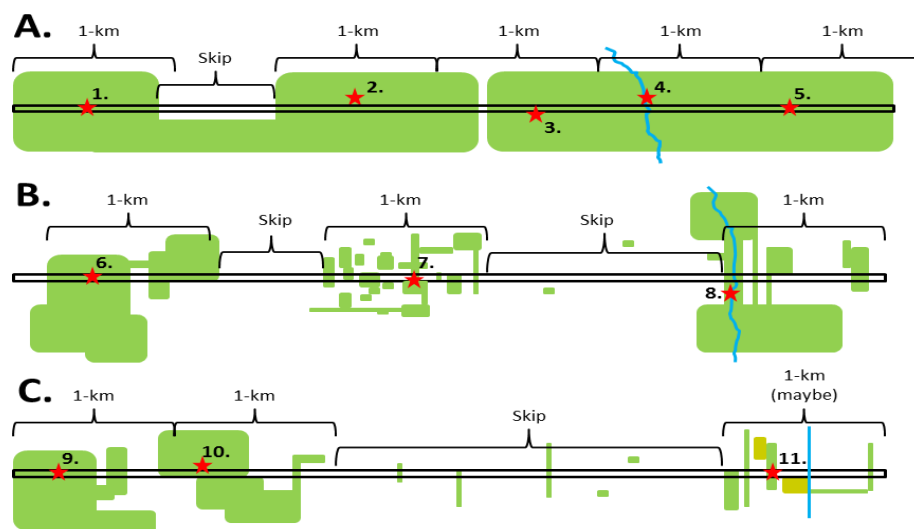
For the USFWS to approve a combined mist-netting and acoustic survey, the survey must be completed as described below:

- 1) There must be a minimum of two mist-net sets and two acoustic locations proposed in the study plan and surveyed.
- 2) Each mist-netting set may only be surveyed two nights (either consecutive or otherwise).
- 3) Surveyors should distribute mist-netting sets and acoustic locations throughout the project area or adjacent habitats. In most cases, net sets and acoustic locations should be at least 656 feet (200 meters) apart. If closer spacing is determined to be necessary or beneficial (e.g., multiple suitable habitats and acoustic sites immediately adjacent to each other), sufficient justification must be provided in the study plan, approved by the USFWS FO(s), and submitted as part of the survey report to USFWS FO(s).
- 4) The combined mist-netting and acoustic survey, including the calculation of LOEs for each method, must be proposed and submitted for approval to the USFWS FO(s) with the study plan. The study plan must also include written justification for the use of the mixed effort including how the proposal will lead to improved survey quality. The mixed LOE may be adjusted before the beginning of the survey with written approval from the USFWS FO(s); however, no modifications are allowed once the survey has started.
- 5) Because the combined approach represents a single LOE for individual project areas, under no scenario can a surveyor use either mist-netting or acoustic surveys to challenge or negate the other method's results. If a target species is documented to be present with one method but not the other, then the USFWS FO(s) will still consider it present in the context of any ESA decision-making processes.

**Linear Projects** – For linear projects (e.g., pipelines and roadways) >1 km in length (shorter

lengths should be considered as a non-linear project), surveyors have the option to use either mist nets or acoustic detectors in any given 1-km segment of suitable habitat. A survey site may also cover other associated linear project facilities (e.g., access roads) that are located within a pre-determined distance of each segment. When possible, surveyors should seek out the best available survey sites located within the footprint of the project alignment, and directly adjacent to, or near, the alignment if no suitable sites are available within the footprint. Because the best survey sites for capturing/detecting bats may fall outside of a project footprint, the surveyor and project proponent should coordinate with the appropriate USFWS FO(s) to establish a project-specific maximum distance from the centerline or project boundary prior to initiating surveys.

Tentative survey site locations along linear projects should be included in a proposed study plan to be reviewed and approved by the USFWS FO(s). Adequate survey effort should be conducted within each approximate 1-km segment that contains suitable forested habitat along the proposed workspace. It is not appropriate to cumulatively add up each habitat block crossed until 1km of habitat has been traversed. Segments of a linear project that do not contain suitable habitat should be skipped until the next patch of suitable habitat is encountered (Figure 3). Establishing exactly how many survey sites are needed for P/A surveys along a linear project often involves some give and take particularly in fragmented habitat areas (Figure 3, rows B and C). The final number of survey sites could be greater than the minimum number of sites prescribed in the protocol to adequately cover the areas of suitable habitat to be impacted. When available, habitat quality and quantity (e.g., size and location of suitable maternity roost trees) from on-the-ground habitat assessments can be used to fine tune and guide the placement of survey sites. In some marginal habitat areas, the quality and quantity of the existing habitat may be low enough to justify skipping some survey segments (e.g., Figure 3, Site 11). Likewise, some isolated woodlots, fence lines or individual trees may be considered too isolated and/or small to independently support bats and may be skipped if the USFWS FO(s) concurs. Habitat suitability in fragmented areas should be assessed on a site-specific basis and consider habitat configuration and connectivity to other suitable habitat patches. In general, we recommend surveying a few more sites for a project than the absolute minimum required.



**Figure 3.** Conceptual linear project (black double lines) through relatively contiguous (A.) and fragmented (B. and C.) forested habitats (green patches) delineated into approximate 1-km survey sections. Numbered red stars represent suitable survey sites (1-11) on or near the project boundaries. Blue lines represent natural streams (A. and B.) and a ditch (C.). Yellow-green patches near Site 11 represent low-quality habitat.

In instances where a mist-netting survey has been proposed, but no suitable mist-net sites can be found or accessed within a particular segment, biologists should contact the USFWS FO(s) for further guidance or ideally agree in advance as to how such situations will be handled when encountered in the field (e.g., a combined survey). Similarly, if an identified area of potentially suitable forested habitat appears to be unsuitable or inaccessible upon field inspection, then you should coordinate with the USFWS FO(s) to determine if an area may be exempted from surveys. To avoid problems, any significant departures from previously agreed to survey plans should be justified and coordinated with the USFWS FO(s) prior to leaving the field.

---

## ACOUSTIC SURVEYS

Detection of target species using acoustic equipment and approved software program(s) confirms summer/year-round presence in the project area. The acoustic sampling period for each site must begin at sunset<sup>11</sup> and ends at sunrise each night of sampling.

- ***Summer Survey Season: May 15 – August 15***
- ***Year-Round Active Survey Season (NLEB & TCB): March 1 – October 15***

---

## PERSONNEL REQUIREMENTS

**Overall** – Acoustic surveyors should have either completed one or more of the available bat acoustic courses/workshops put forth by various entities (e.g., Bat Conservation & Management, Bat Survey Solutions, Titley/AnaBat, Wildlife Acoustics, USFWS, Vesper Bat Detection Services) or be able to show similar on-the-job or academic experience. Trainings should reflect the ability of surveyors to work within the areas where surveys will be completed.

**Detector Deployment** – Acoustic surveyors should have a working knowledge of the acoustic equipment and the target species ecology. Surveyors should be able to identify appropriate detector placement sites and establish those sites in the areas that are most suitable for recording high-quality calls for all target species. Thus, it is highly recommended that all potential acoustic surveyors attend appropriate training and have experience in the proper placement of their field equipment.

**Acoustic Analysis** – Acoustic surveyors should have a working knowledge of the approved acoustic analysis programs, and any candidate acoustic analysis programs used for surveys. Thus, it is highly recommended that all potential acoustic surveyors attend appropriate training and have experience in the analysis of acoustic recordings in regions where surveys are completed.

**Qualitative Analysis** – Individuals qualified to conduct qualitative analysis of acoustic bat calls typically have experience: (1) gathering known calls as this provides a valuable resource in understanding how bat calls change and the variation present in them; (2) identifying bat calls

---

<sup>11</sup> Surveys may need to start a little earlier or later than official sunset times (i.e., at “dusk”) in some settings such as a deep/dark forested valleys or ridge tops to avoid missing early flying bats or capturing late-flying birds, respectively. Sunset tables for the location of survey can be found at: <https://sunrise-sunset.org>

recorded in numerous habitat types; (3) familiarity with the species likely to be encountered within the project area; and (4) individuals must have multiple years of experience and must have stayed current with qualitative ID skills. A resume (or similar documentation) must be submitted along with final acoustic survey reports for anyone making final qualitative identifications.

---

## EQUIPMENT REQUIREMENTS

Full-spectrum (FS) and/or zero-crossing (ZC) detectors are suitable for use in this survey protocol; however, FS is preferred given that FS call files capture more detail and can be converted to ZC for analysis. Detectors used during surveys must be able to retain detailed information that is important for distinguishing between bat species with overlapping echolocation characteristics. Multiple detectors capable of recording high-quality data are available for commercial use. Until further refinements and testing of the AudioMoth detector (Open Acoustic Devices) take place, use of this detector for P/A surveys is not acceptable (Starbuck et al. 2022; Kunberger and Long 2023).

Directional, hemispherical, and omnidirectional microphones are acceptable for acoustic surveys. The use of external microphones on an extension cable is the preferred deployment as it further limits degradation of call quality. Recording without directional horns on hemispherical and omnidirectional microphones is preferred as the addition of these systems may result in some signal degradation and directional microphones are commercially available.

Use recommended manufacturer detector settings for conducting IBAT, NLEB, and/or TCB P/A surveys unless otherwise noted on the Service's Bat Survey Guidelines webpage. For ZC detectors (as well as when converting WAV files to ZC files), the data-division ratio must be set to 8.

---

## ACOUSTIC SAMPLING PROTOCOL

**Detector/Microphone Placement** – IBAT, NLEB, and TCB typically forage in habitats that do not completely overlap ([see Summer / Year-Round Season Habitat](#)); therefore, acoustic sites should reflect these differences when targeting two (or more) species. When sampling for multiple species, surveyors are expected to understand which sites are more likely to detect each species of interest and avoid oversampling habitat used by only one of the target species. Early coordination with the FOs is highly encouraged to ensure the sampling methods are suitable. For instance, NLEB is a clutter-adapted gleaning species ([see Summer / Year-Round Season Habitat](#)), and therefore acoustic sites should target interior forests and forested riparian streams representing a variety of understory cover and canopy closure (Carroll et al. 2002). Conversely, TCBs may opportunistically forage in open areas, such as forest openings with reduced clutter, and are much more likely to be detected along forest edges than NLEB. Ponds and large water-filled road ruts can be productive places to deploy detectors when other water sources are limited.

Detector/Microphone placement is critical to the successful isolation of high-quality bat call sequences for analysis. The following locations are likely to be suitable sites for detectors/microphones to sample for target species, including, but not limited to: (a) forest-canopy openings; (b) near water sources; (c) wooded fence lines that are adjacent to large

openings or connect two larger blocks of suitable habitat; (d) blocks of recently logged forest where some potential roost trees remain; (e) road and/or stream corridors with open tree canopies or canopy height of more than 33 feet (10 meters); and (f) woodland edges (Britzke et al. 2010). Of equal importance to acoustic site selection is the surveyor's working knowledge of the sampling volume and area of highest sensitivity within the zone of detection around a given microphone, which helps to ensure that detector placement as well as microphone selection and orientation are best suited for a particular site to ensure the detection zone is free of clutter. Detection distance, placement (e.g., location, orientation, height of microphone), and specific features (e.g., vegetation, water, and other obstructions) at the sample site should dictate whether a directional, hemispherical, or omnidirectional microphone is used. If detectors/microphones are placed in unsuitable locations, bats may not be recorded, and the results of the sampling effort will be invalid.

Many features (e.g., vegetation, water, wind turbines, high-tensile powerlines, micro-wave towers) can obstruct and reflect call sequences recorded in the field and thereby reduce the surveyor's ability to record high-quality bat call sequences. The following recommendations are provided to aid surveyors in their selection of acoustic sites (also see Cheng and Tyburec 2014). If surveyors choose acoustic sites outside of these recommendations, then adequate justification for doing so should be provided with the acoustic survey report provided to the USFWS FO(s); otherwise, results from these sites will not be accepted. Surveyors should deploy microphones: (a) at least 10 feet (3 meters) in any direction from vegetation or other obstructions (Hayes 2000; Weller and Zabel 2002; Cheng and Tyburec 2014, Fraser et al. 2020); (b) in areas without, or with minimal<sup>13</sup>, vegetation within 100 feet (30 meters) of highly directional microphones or 33 feet (10 meters) from other microphones; (c) parallel to woodland edges; and (d) at least 49 feet (15 meters) from known or suitable roosts<sup>14</sup> (e.g., trees/snags, buildings, bridges, bat houses, cave or mine portal entrances).

Elevating a detector greater than 3 meters above ground level (AGL) vegetation may dramatically improve recording quality. Microphones can be attached horizontally to a pole to listen out into flight space, rather than just listening up from the ground. This will serve to increase the volume of airspace sampled and avoid the distortion effect of recording near the ground. However, the relationship between the zone of detection and the vegetation/clutter, not the placement of the detector is the most important consideration during site selection. Because NLEBs are a clutter-adapted, gleaner species (see NLEB suitable summer / year-round habitat), placement of detectors should be as close to clutter as possible but not in clutter.

---

<sup>13</sup> If necessary, surveyors can remove small amounts of vegetation (e.g., small limbs, saplings) from the estimated detection zone at a site, much like what is done while setting up mist-nets. Deployment of detectors/microphones in closed-canopy locations that typically are good for mist-netting are acceptable as long as the area sampled below the canopy does not restrict the ability of the equipment's detection zone to record high-quality calls (i.e., vegetation is outside of the detection zone).

<sup>14</sup> If the surveyor discovers a potential roost and wishes to document bat use, refer to Emergence Surveys section and contact the USFWS FO(s).



Surveyors should distribute acoustic sites throughout the project area or adjacent habitats. In most cases, acoustic sites should be at least 656 feet (200 meters) apart. If closer spacing is determined to be necessary or beneficial (e.g., multiple suitable habitats and acoustic sites immediately adjacent to each other), sufficient justification must be provided in the acoustic study plan and survey report submitted to USFWS FO(s).

**Verification of Deployment Location** – It is recommended to temporarily attach GPS units to each detector (according to manufacturer’s instructions) to directly record accurate location coordinates for each acoustic site that is paired with the acoustic data files. Regardless of technique used, accurate GPS coordinates must be generated and reported for each acoustic detector location.

**Verification of Proper Functioning** – It is highly recommended that surveyors ensure acoustic detectors are functioning properly through a periodic verification of performance to factory specifications (a service currently offered or in development by several manufacturers). It may be possible that independent service bureaus would be willing to perform this service, providing that a standard test/adjustment procedure can be developed.

It is also recommended to ensure equipment is working during set-up in the field. This can be done simply by producing ultrasound (e.g., finger rubs, calibrator, or follow the equipment manufacturer’s testing recommendations) in front of the microphone at survey start and survey finish. These tests document that the equipment was working when deployed and when picked up (and by assumption throughout the entire period). Detector field settings (e.g., sensitivity, frequency, etc.) should follow the recommendations provided by the manufacturer. Surveyors should also save files produced by detectors (e.g., log files, status files, sensor files) as an excellent way to provide documentation when equipment was functioning within the survey period. Many types of detectors allow for setting timers that initiate and end recording sessions. This saves battery life as well as reducing the number of extraneous noise files recorded. However, if the units are visited when the timer is on (i.e., unit is in standby mode), the surveyor cannot verify that the unit is functioning properly. This is particularly important in areas where no bat activity is recorded for the entire night or during the last portion of the night. In these cases, if the surveyor cannot demonstrate that the detector was indeed functioning properly throughout the survey period, then the site will need to be re-sampled, unless adequate justification can be provided to the USFWS FO(s).

Selection of acoustic sites is similarly important. Suitable set-up of the equipment should result in high-quality call sequences that are adequate for species identification. Nights of sampling at individual sites that produce no bat calls may need to be re-sampled unless adequate justification (e.g., areas with significant bat population declines due to WNS) can be provided to the USFWS FO(s). Modifications of the equipment (e.g., changing the orientation and/or microphone type) at the same location on subsequent nights may improve quantity and quality of call sequences recorded, which can be determined through daily data downloads. If modifications of the equipment do not improve call identification, then the detectors will need to be moved to a new location.

**Orientation** – Detectors deployed with directional microphones should be aimed to sample the

identified flight path/zone to maximize the number of call pulses recorded from individual bats. Omnidirectional microphones deployed on a pole in the center of the flight path/zone should generally be oriented horizontally. In some circumstances, it may be desirable to aim a directional microphone more vertically (facing up) in smaller forest openings. As always, the goal is to sample as large a volume of likely bat flight space as possible while minimizing the interference of clutter. Hemispherical microphones should be aimed vertically, creating a dome-like detection field. Hemispherical microphones are best suited for open areas where deploying at heights > 3 meters AGL is problematic because of the lack of structure to hide the microphone and prevent it from becoming a novel item of interest to bats. Vertical orientation, however, precludes the use of weatherproofing for protection of the microphone. Once acoustic sites are identified, photographs documenting the orientation, detection zone (i.e., “what the detector is sampling”), and relative position of the microphone should be obtained for inclusion in the final survey report (See “Submission of Acoustic Survey Results” for additional description).

**Weather Conditions** – If any of the following weather conditions exist at a survey site during acoustic sampling, note the time and duration of such conditions, and discuss with the USFWS FO whether to repeat the acoustic sampling effort for that night: (a) temperatures fall below 50° F (10°C)<sup>15</sup> during the first 5 hours of survey period; (b) precipitation, including rain and/or fog, that occurs 60 minutes prior to or exceeds 30 minutes or continues intermittently during the first 5 hours of the survey period; and (c) sustained wind speeds greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale) for 30 minutes or more during the first 5 hours of the survey period. At a minimum, nightly weather conditions for survey sites should be checked using the nearest Weather Service Station and summarized in the survey reports.

**Weatherproofing** – Most suppliers of bat detectors and microphones now offer weatherproofing and do not depend on additional tools for keeping gear protected during short term surveys. Recording without after-market weatherproofing is preferred as the addition of these systems may result in some signal degradation and affect the expected zone of sound detection. The decision to weatherproof detectors or not should be determined nightly based on the likelihood of precipitation in the survey area. If necessary, detectors should be placed in after-market weatherproof containers and an external microphone, attached by an extension cable, should be deployed greater than 3 meters AGL. If weatherproofing of equipment is considered necessary, surveyors should discuss how weatherproofing tools affect the zone of detection with the manufacturer ahead of the deployment. Additionally, refer to resources provided on this topic by Britzke et al. (2010) and Corben & Livengood (2014), and coordinate with the local USFWS FO(s) in determining the appropriate measures.

---

## ANALYSIS OF RECORDED ECHOLOCATION CALLS

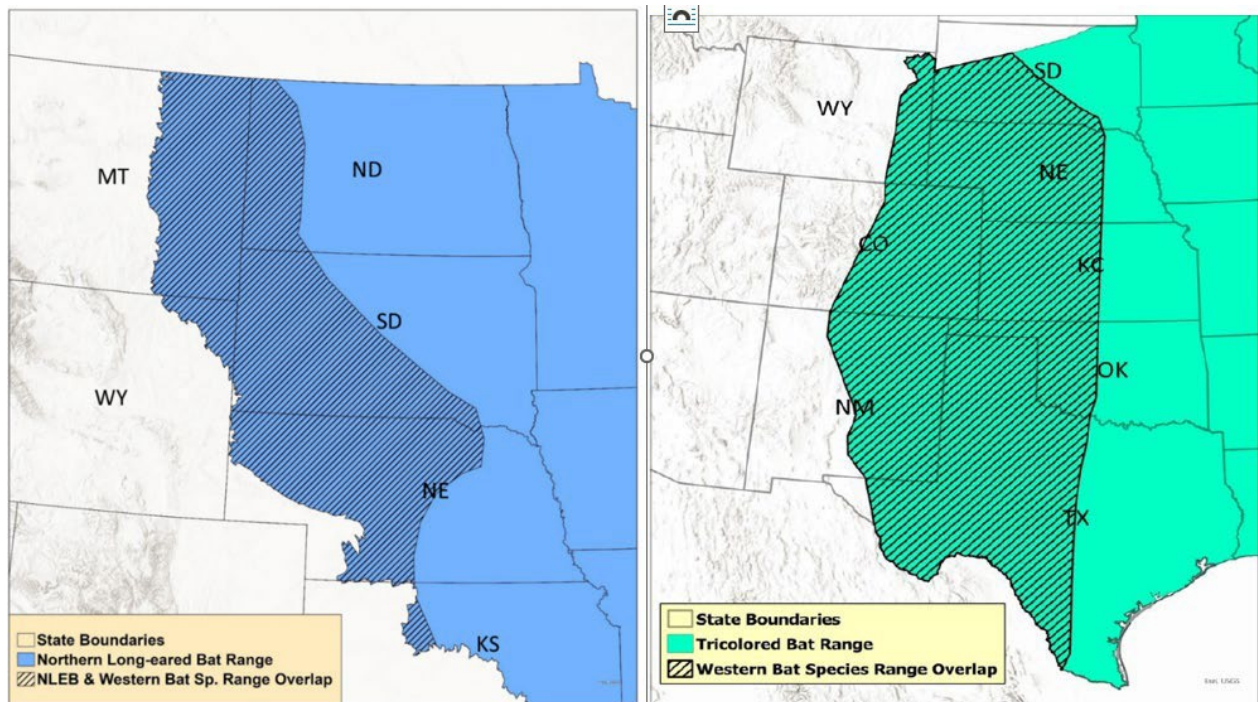
Use one or more of the currently available ‘approved’ acoustic bat ID programs<sup>16</sup> (use most

---

<sup>15</sup> Overnight survey temperatures may be lower in the northern portion of the NLEB range, coordinate with the local USFWS FO in the northern portion of the range for any variation in temperature requirements.

<sup>16</sup> Approved and candidate programs are listed on the USFWS website: <https://www.fws.gov/media/automated-acoustic-bat-id-software-programs>; note all programs are considered ‘candidate’ for areas identified in Figure 4.

current approved software versions available and manufacturer’s recommended settings for target species P/A surveys) as previously identified in your study plan. ‘Candidate’ programs are not yet approved by USFWS for stand-alone use for P/A surveys but may be used in conjunction with one or more of the approved programs. Currently, no programs are ‘approved’ for western states with co-occurring western species (Figure 4). A second ‘candidate’ program should be used to confirm findings if the first program does not detect NLEB and/or TCB for surveys conducted in these locations (always use most recent versions of software programs).



**Figure 4.** Portions of NLEB range (left) and TCB range (right) overlapping with western bat species that may have overlap in their acoustic repertoires (e.g., NLEB and Long-legged Myotis, and TCB and Canyon Bat).

Include your plans for which specific software program(s) you will use in your survey study plan and submit for USFWS FO(s) review prior to conducting surveys. Surveyors will not be allowed to switch programs from what was originally identified in their final study plan.

**Conduct automated acoustic analyses for ALL sites and ALL nights that were approved in the study plan.** For analysis of recordings, set the minimum number of pulses for species identification to the default number provided by the software developer unless otherwise specified on the [approved software website](#). Visual review of either FS of ZC files is acceptable, although a combination is often beneficial. If using Kaleidoscope, Advanced Signal Processing (ASP) - “*When zero crossing for conversion or analysis, enhance with advanced signal processing.*” should be left on (checked) for the analysis under the Signal Parameters tab. If using SonoBat, the ManID field in the Vetting Table must be empty prior to completing automated analysis for MLE calculation. The ManID text will override SppAccp, which impacts calculated MLE values.

- a) Review results by site by night identified by software used. If using SonoBat, for IBAT P/A surveys, any files in the LUSO category should be treated as possible IBAT files. If the approved program identifies no (zero) target species files at any site night, then no further analysis is necessary.
- b) If software identified  $\geq 1$  files to target species and MLE p-value is  $\leq 0.05$ , accept result for site-night (target species is present) OR conduct qualitative analysis to determine if result is false positive.
- c) If software identified  $\geq 1$  files from target species and MLE p-value is  $> 0.05$ , disregard insignificant p-value and assume presence of target species **OR** conduct qualitative analysis to determine if result is false negative for target species.

If presence is established based on target species files identified by an approved software program, surveyors may choose to accept program result and coordinate with the USFWS FO(s) without conducting qualitative analysis.

### ***Conduct Qualitative Analysis of Recordings***

#### **IBAT and NLEB:**

If using Kaleidoscope Pro or BCID: First review all files labeled as IBAT and/or NLEB. If the target species is not confirmed, review all other files in folders containing pulses with characteristic frequency  $\geq 38$  kHz, including those in the NOID folder.

If using SonoBat: Review files labeled as the target species in the “Spp Accp” (Species Accepted) column. If species is not confirmed at this step, next review files in the “~Spp” (Leaning Species) column (e.g., MYSO, MYSO/other species, LUSO). Files in the “LUSO” category could belong to either to Indiana or little brown bat. Any files labeled as LUSO should be treated as possible IBAT files.

#### **TCB:**

If using Kaleidoscope Pro or BCID: First review all files labeled as TCB. If the target species is not confirmed, review all other files in folders containing pulses with characteristic frequency  $\geq 40$  kHz, including those in the NOID folder.

If using SonoBat: Review files labeled as the target species in the “Spp Accp” (Species Accepted) column. If species is not confirmed at this step, next review files identified as potentially belonging to the target species in the “~Spp” (Leaning Species) column (e.g., PESU, LABO/PESU).

**Please Note:** Reviewers may attempt to overturn software species identification results. The decision to overturn results may be straightforward in some instances (e.g. the auto-ID program identifies an EPFU in clutter as a NLEB). However, there may be cases where there is some overlap in the call repertoire between a target and non-target species, as is

the case with IBAT and little brown bat. It is the USFWS preference that reviewers accept a target species auto-ID result unless reviewer provides clear justification for why that sequence could not belong to target species.

Qualitative analysis (i.e., visual vetting) must also include and present within a written report a comparison of the results of each acoustic ID program by site and night (see Submission Requirements below). If there is no visual confirmation of target species, then no further summer/year-round active season surveys recommended. If visual confirmation of target species, presence is established. Coordinate with the USFWS FO(s).

## **A NOTE ON WAV TO ZC CONVERSIONS**

Reviewing recordings in ZC is likely best done by loading the WAV file into a software viewer and toggling ZC on and WAV off. However, **if converting WAV to ZC files in Kaleidoscope, WAV files should be converted with ASP turned OFF in the Batch tab prior to processing. This may be desired for reducing file size, viewing files in software like AnalookW, or so that data can be run through BCID, which only accepts ZC recordings.** FS files are not affected by ASP being turned on, but ZC files are. ASP extracts ZC from data that may be too faint to pick up without using ASP. ASP also cleans up the pulses (removes noise, etc.) to make identification by auto-ID programs more reliable. However, this process can leave large amounts of data missing and can result in many incomplete or entirely missing pulses.

---

## **SUBMISSION OF ACOUSTIC SURVEY RESULTS**

Provide results of acoustic surveys to the appropriate USFWS FO(s) within 30 days of completing the survey unless otherwise agreed upon with the local USFWS FO(s).

### **Acoustic Survey Reports should include the following:**

1. A detailed habitat assessment of the survey area/project boundary footprint (similar to the survey study plan description, but with additional details, if applicable).
2. Explanation of any modifications from original survey plan (e.g., altered site locations)<sup>17</sup>.
3. Full names of all personnel conducting acoustic surveys, including those that selected acoustic sites and deployed detectors.
4. Full name and résumé of individual(s) conducting qualitative acoustic analyses (if applicable). Surveys lacking this information will not be reviewed until the information is provided.
5. Description of acoustic monitoring sites, survey dates, duration of survey, weather conditions, and a summary of findings.
6. Table with information on acoustic monitoring and resulting data, including GPS coordinates for each detector that corresponds with a map (see #7), survey dates, and survey hours.
7. Detailed map with aerial photography and/or clearly defined habitat classifications and

---

<sup>17</sup> If the USFWS previously agreed upon the study plan, any revised approaches to the work must be thoroughly explained and justified.

surrounding features that identifies acoustic detector locations; map figure should align with a table (see #6) and include arrow(s) showing detector microphone(s) directionality, if/when applicable.

8. Photographs documenting the location of each detector, the orientation of the detector and microphone, and the intended sampling area. Include detector and an object for scale (e.g., vehicle, person) in photographs of acoustic sites.
9. Description of acoustic detector and microphone brand(s) and model(s) used, microphone type, use of weatherproofing, acoustic monitoring equipment settings (e.g., sensitivity, audio division ratios), deployment data (i.e., deployment site, habitat, date, time started, time stopped, orientation), and call analysis methods used.
10. A description of how proper functioning of bat detectors was verified.
11. Name of Service-approved and/or Candidate software program(s) used, including version(s) and software settings.
12. Acoustic detector log files renamed by site identifier.
13. Acoustic analysis software program output/summary results by site by night (i.e., number of calls detected, species composition, MLE results, settings files).
14. Discussion for any site-nights with zero bat calls (e.g., any additional nights added, detector functionality, appropriate placement, etc.).
15. If qualitative (visual) vetting was used, discussion of methods, as well as detailed analysis and results of any qualitative acoustic analysis conducted on those projects where a program(s) considered IBAT, NLEB, and/or TCB presence likely, including justification for rejecting any program MLE results (if applicable). We recommend providing a table with each species ID from the program(s), suggested species ID from visual vetting, and rationale for any changes (see introductory paragraph to this section for additional information).
16. Any other information requested by the local USFWS FO(s) related to the project.

**NOTE:** All originally recorded (ZC or FS) data **MUST** be maintained for a period of 5 years and be made available to the USFWS FO(s), if requested. Failure to provide data when requested by USFWS may result in invalidation of survey results.

---

## MIST-NETTING SURVEYS

- ***Summer Survey Season: May 15 – August 15***
- ***Year-Round Active Survey Season (NLEB & TCB): March 1 – October 15***

Mist-netting can be used as a P/A method for the target species, where appropriate. Capture of reproductive adult females (i.e., pregnant, lactating, or post-lactating) and/or young of the year from May 15 – August 15 in the hibernating range confirms the presence of a maternity colony in the area. Capture of reproductive adult females<sup>18</sup> (i.e., pregnant, lactating, or post-lactating) and/or young of the year from March 1 – October 15 in the year-round active range confirms year-round presence of NLEB and/or TCB and the presence of a maternity colony in

---

<sup>18</sup> We recognize that the reproductive condition of captured female NLEBs and/or TCBs in early spring may not be possible; however, available data indicates NLEBs and/or TCBs are not migrating to different areas from summer to winter, so it is likely many of those adult females are indicative of the presence of maternity colonies.

the area. Since adult males and non-reproductive females have commonly been found summering with maternity colonies, radio-tracking results will be relied upon to help determine the presence or probable absence of a maternity colony or large concentrations of bats in the area when only males and/or non-reproductive females are captured.

---

## PERSONNEL REQUIREMENTS

A qualified biologist<sup>19</sup> must (1) select/approve mist-net sets in areas that are most suitable for capturing the target species, (2) be physically present at each mist-net site<sup>20</sup> throughout the survey period, and (3) confirm all bat species identifications. This biologist may oversee other biological technicians and manage mist-net sets near one another if the net-check timing (i.e., every 10 minutes) can be maintained while walking between net-sets<sup>21</sup>. A minimum of two (2) staff must be on-site for every four (4) net-sets being operated, one of which must be a qualified biologist. For example, two qualified biologists and two technicians would be necessary to survey a site with 5 net-sets. Exceptions to on-site minimum staffing levels may be allowed under extenuating circumstances, provided written justification is included in the proposed survey study plan and subsequently approved by the local USFWS FO(s).

---

## EQUIPMENT REQUIREMENTS

Use the finest, lowest visibility mesh mist-nets commercially available, as practicable. Currently, the finest net on the market is 75 denier, 2 ply, denoted 75/2 (Arndt and Schaetz 2009); however, the 50 denier nets are still acceptable for use currently. The finest mesh size available is approximately 1½ inches (38 millimeters). No specific hardware is required. There are many suitable systems of ropes and/or poles to hold nets. The systems of Gardner et al. (1989) and Cheng'er's BCM triple high set-up have been widely used.

To minimize potential for disease transmission, any equipment that comes in contact with bats should be kept clean and disinfected, following approved protocols; this is particularly a concern relative to white-nose syndrome (WNS). Disinfection of equipment to avoid disease transmission (e.g., WNS) is required; protocols are posted at <http://www.whitenosesyndrome.org>. Federal and state permits may also have specific equipment restrictions and disinfection requirements.

---

<sup>19</sup> A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife Permit) for each target species in the state/region in which they are surveying and/or has been authorized by the appropriate state agency to net and handle each target species. Several USFWS offices maintain lists of qualified bat surveyors, and if working in one of those states with authorizations in lieu of a Recovery Permits, the individual will either need to be on that list or submit qualifications to receive USFWS approval prior to conducting any field work.

<sup>20</sup> A Net Site is defined as one or more net sets that can be efficiently walked to and checked by a survey team (typically 2 people) within a 10-minute window from a central bat-processing location. For example, a single net "site" is often composed of 4 individual net sets (separated by at least 30 m apart) that are checked every 10 minutes by a 2-person team (each person checks 2 nets for each net check).

<sup>21</sup> A Net-Set is defined as one mist-net deployment consisting of two poles and typically from 1-3 affixed mist-nets stacked onto one another.



---

## MIST-NET SAMPLING PROTOCOL

**Mist-Net Placement** – Indiana bats, NLEBs and TCBs typically forage in habitats that do not completely overlap (see [Summer/Year-round active Habitat Definitions](#)) therefore, net placement should reflect these differences when targeting multiple species. Net placement along potential travel corridors (e.g., streams, logging trails, roads) as well as other edge habitats (e.g., other water sources, field edges) have traditionally been the most common habitats sampled due to their ease of access. However, non-traditional net placement in interior forest habitats may also be productive, especially for NLEB and TCB (Carroll et al. 2002). Because the best survey sites for capturing bats may fall outside of a project footprint, the surveyor and project proponent should coordinate with the appropriate USFWS FO(s) to establish a project-specific maximum net placement distance from the centerline or project boundary prior to initiating surveys.

When sampling traditional travel corridors with defined edges, place net-sets approximately perpendicular to the edge and, ideally within bends or curves in the corridor that reduces bat reaction time to avoid capture. Net-sets should fill the corridor from side to side, extending beyond the corridor boundaries and into the interior forest to prevent bats from flying along the edges of the corridor and avoiding the nets, and from water (or ground) level up to the overhanging canopy. Surveyed corridors must have overhanging branches, most often within 9 m of the ground, that force bats to fly downward and into the nets. Net-sets of varying widths and heights may be used as the situation dictates. A typical net-set is at least 5 m to 9 m high consisting of two or more nets stacked on top one another (without gaps) and from 6 m to 18 m wide. If netting over water, ensure there is enough space between the net and the water so that captured bats will not get wet. Justification for placing net-sets perpendicular to a forest edge, or any net-set, without overhanging vegetation (i.e., no funneling effect) should be specifically provided in the survey report or ideally discussed with the FO(s) prior to sampling.

Because NLEB is a clutter-adapted and primarily gleaning species (see Summer / Year-Round Active Habitat) or a project area may not have well-defined travel corridors, surveyors should sample more non-traditional habitat types (e.g., small forest openings, ponds, interior forest). The typical equipment and placement described in the section above may be inadequate when netting for IBAT, NLEB, and/or TCB in these non-traditional locations, where a travel corridor is less obvious. This would require innovation on the part of the surveyor (see Humphrey et al. 1968) or use of acoustic surveys instead. For example, net placement in interior forests should be a minimum of 50 m from edge habitats and should represent a variety of understory cover and canopy closure (Carroll et al. 2002). Ponds and large water-filled road ruts can be productive places to net when other water sources are limited. See Kiser and MacGregor (2005) for additional discussion about net placement.

Mist-net sets should be spaced a minimum of 30 meters apart, surveyors should attempt to evenly distribute net-sets throughout suitable habitat and not over-sample individual habitat features (e.g., three or more mist-net sets on a single travel corridor or stream). Surveyors must provide written justification in their report if net-sets were not distributed throughout suitable habitat (i.e., why were they clumped?). Surveys conducted for NLEB should include both traditional and non-traditional (as described above) net placements within suitable habitat when present. Net-sets can be repeatedly sampled throughout the project, but no more than 2 nights at

a single location is recommended. In addition, changing locations within a project area may improve capture success (see Robbins et al. 2008; Winhold and Kurta 2008). Photo-document placement of net-sets.

**Survey Period** – The survey period for each net shall begin at sunset<sup>22</sup> and continue for a minimum of 5 hours (longer survey periods may also improve success).

**Checking Nets** – Each net-set should be checked every 10 minutes (Gannon et al. 2007). If surveyors monitor nets continuously, care should be taken to minimize noise, lights, and movement near the nets. Monitoring the net-sets continuously with a bat detector (ideally using earphones to avoid alerting bats) can be beneficial: (a) bats can be detected immediately when they are captured, (b) prompt removal from the net decreases stress on the bat and potential for the bat to escape (MacCarthy et al. 2006), and (c) monitoring with a bat detector also allows the biologist to assess the effectiveness of each net placement (i.e., if bats are active near the net set but avoiding capture), which may allow for adjustments that will increase netting success on subsequent nights. There should be no other disturbance near the nets, other than to check nets and remove bats. Biologists should be prepared to cut the net if a bat is severely entangled and cannot be safely extracted within 3 or 4 minutes (CCAC 2003; Kunz et al. 2009). Capture and handling are stressful for bats. Emphasis should be on minimizing handling and holding bats to as short a time as possible to achieve field study objectives. Bats targeted for radio-tracking should be released as quickly as possible, but no longer than 30 minutes<sup>23</sup> after capture, or as allowed in federal and state permits. See Kunz and Kurta (1988) for general recommendations for holding bats.

**Weather, Lighting, and Other Environmental Conditions** – Weather can adversely affect the capture of bats. Some individuals may remain active despite inclement weather and may still be captured while others in the same area become inactive. Therefore, negative surveys combined with any of the following weather conditions throughout all or most of a sampling period are likely to require an additional night of mist-netting: (a) temperatures that fall below 50°F (10°C)<sup>24</sup>; (b) precipitation, including rain and/or heavy fog, that occurs 60 minutes prior to or exceeds 30 minutes or continues intermittently during the survey period; and (c) sustained wind speeds greater than 9 miles/hour (4 meters/seconds; 3 on Beaufort scale) for 30 or more minutes.

**NOTE:** Provided that nets are not dripping wet and/or fog moves out of the survey area early enough, surveyors can resume netting to meet the minimum 5-hour requirement after short periods of adverse weather. If nets are under good cover, light rain may not alter bat behavior. However, if no bats are being captured during marginal weather, coordinate with the USFWS FO(s).

---

<sup>22</sup> Surveys may need to start a little earlier or later than official sunset times (i.e., at “dusk”) in some settings such as a deep/dark forested valleys or ridge tops to avoid missing early flying bats or capturing late-flying birds, respectively. Sunset tables for the location of survey can be found at: <https://sunrise-sunset.org>.

<sup>23</sup> Current standard federal Section 10 bat permit conditions require prior written approval from the Field Supervisor in the USFWS FO(s) if capture times may exceed 30 minutes.

<sup>24</sup> Overnight survey temperatures may be lower in northern portions of the NLEB and/or TCB ranges, coordinate with the local USFWS FO in the northern portions of the range for any variation in temperature requirements.

It is typically best to place net sets under the canopy where they are out of moonlight, particularly when the moon is half-full or greater. Net sets illuminated by artificial light sources should also be avoided. The shining of lights, and noise, should be kept to a minimum with no smoking around the survey sites. In addition, the use of radios, campfires, running vehicles, punk sticks, citronella candles, ultraviolet lights and other disturbances will not be permitted within 300 feet of mist nets (or acoustic detectors) during surveys.

**Bat Forearm Banding** – Any bat banding activities (i.e. application of any type of band to the forearm of a bat) should be coordinated with the appropriate USFWS FO and state agency(ies). Bat banding should be limited to efforts that are committed to returning to the capture site or a location where marked bats have a high likelihood of being recovered (e.g., hibernacula), thus enabling meaningful data collection from marked individuals. If approved to band bats, surveyors are required to demonstrate that banding is approved on their USFWS 10(a)1(A) Recovery Permit and adhere to any State permit conditions.

Banding pliers are required for applying bands to bat forearms; securing bands by pinching a band down with fingertips (unless making a very minor adjustment for better fit) is not permitted. Banding pliers should be maintained at the correct calibration to ensure proper function. Surveyors must carry needle nose pliers that can be used to safely remove a band that was either improperly placed or is causing distress to a bat. Bats must be banded with bands that are appropriate in size for the species. TCB should receive 2.4 mm aluminum metal-lipped bands and IBAT and NLEB should receive 2.9 mm bands. Males should be banded on the right forearm and females on their left. Proposals that deviate from these standards must include written justification in the site-specific Study Plan submitted to USFWS FO for approval.

Any recovered bats with bands on their forearms should be assessed for injury and their condition noted on the mist net data form, and as part of the USFWS 10(a)1(A) Permit reporting spreadsheet in the comment section of the Capture Data Worksheet. Surveyor should note (1) type of injury and (2) whether band was left on or removed. Photos and/or videos of the site of injury should be included with the report. If known, duration of the time the band was applied should also be noted. Bands should be cautiously removed when bats show signs of injury, except in situations where band removal may result in additional trauma or fatality.

**Documentation of Indiana Bat, Northern Long-eared Bat and/or Tricolored Bat Captures** – If an IBAT, NLEB, and/or TCB is captured during mist-netting, protocols for radio-tracking and emergence surveys should be followed. In addition, the appropriate USFWS FO(s) must be notified of the capture within 48 hours (or in accordance with permit conditions), and the sex and reproductive condition of the bat and GPS coordinates of the capture site should be provided. Ensure GPS coordinates are recorded for each individual net set on datasheets.

Several species of bats from the genus *Myotis* share common features which can make identification difficult. For example, IBATs and little brown bats (*Myotis lucifugus*) can be particularly difficult to distinguish, as can NLEBs and long-eared myotis (*M. evotis*) where their ranges overlap in the western U.S. Photo documentation of all bats captured and identified as IBAT and/or NLEB and the first 10 little brown bats (if surveying within the IBAT range) or the first 10 captures of each *Myotis spp.* (if surveying in KS, NE, ND, SD, MT, or WY) per project are requested to verify the identifications made in the field.

Photo documentation should include diagnostic characteristics:

- a ¾-view of face showing ear, tragus, and muzzle.
- view of calcar showing presence/absence of keel.
- a transverse view of toes showing extent of toe hairs.

Identification from photos is sometimes tricky because pigment and traits don't show up as well. It is recommended to take short video clips describing the diagnostic characteristics used to make the identification of any questionable *Myotis* bat.

If a bat from the genus *Myotis* is captured during mist-netting that cannot be readily identified to the species level, then species confirmation through DNA analysis may be attempted. The decision of whether DNA collection is necessary is at the discretion of the respective USFWS FO and State agency. DNA species confirmation is unlikely to be necessary for all captured potential NLEB, nor for those species with which they may be mistaken (e.g., *M. evotis*) but rather will be based on expected range overlap as well as previous knowledge of the survey area and species occurrence records. If needed, however, DNA sampling should be included in study plans submitted to the local Service Field Office for review and coordination prior to field work. Please note that collecting DNA samples via wing swabbing, buccal swabbing, and/or wing punching can only be completed by individuals whose Section 10(a)(1)(A) Recovery Permits authorize those activities. Collection of guano opportunistically does not require a Permit unless a bat is either being captured solely to collect guano or is being held longer than the permitted 30-minute processing time to collect the guano.

The USFWS recommends the use of four DNA collection methods: wing swabs, buccal swabs, fecal collection, and 2- or 3-mm wing biopsy punches. When properly collected, efficacy for species identification from wing and buccal swabs as well as fecal samples (particularly if feces are fresh) may reach approximately 95%, while wing biopsy punches provide a slightly higher efficacy of approximately 98%. Given those comparable and favorable percentages, USFWS prioritizes the use of less invasive DNA sampling methods over those that may cause additional stress or harm to bats:

1. Fecal collection (preferred) – it has low risk of injury or additional stress if bats opportunistically defecate while being processed or if feces are collected from below a known roost. However, we recognize that for mist-net or harp-trap surveys, fecal collection from captured bats may not be possible due to the short, allowed holding times and surveyors may need to use alternative methods outlined below.
2. Wing swabbing is the second preferred method – it provides both adequate DNA for analysis and is considered safe for the animals.
3. Buccal swabs are less preferable - this method presents potential for stress or injury as the swab is inserted and moved around within the bat's mouth.
4. Wing biopsy punches may be stressful and leave a hole that requires healing of skin tissue. Wing biopsy holes have the potential for tearing the membrane or becoming infected. Therefore, this method is acceptable but is the least preferred. Further, the risk to bats via this method is increased if biopsies are taken in the early spring, when bats' energy reserves are depleted, or in the fall, when skin membranes may not have time to fully heal prior the bats entering torpor.

Approximate costs, materials, methods, and protocols of the four recommended DNA sampling methods are available at <https://www.fws.gov/media/usfws-recommended-dna-sampling-methods-bat-species-identification>.

---

## SUBMISSION OF MIST-NETTING RESULTS

Provide results of netting surveys to the appropriate USFWS FO(s) in accordance with previously agreed upon timeframes and formats. If any target bat species are captured, this report should also include the results of subsequent radio-tracking and emergence counts.

### **Mist-netting reports should include the following:**

1. Copy of prior survey reports (if not previously provided; See example [Study Plan Form for Bat Surveys and Monitoring](#)).
2. Explanation of any modifications from original survey plan (e.g., altered net locations). If the USFWS previously agreed upon the study plan, it should clearly identify whether the revised work still accomplished the agreed upon methods.
3. Description of net locations (including site diagrams), net sets (including net heights), survey dates, duration of surveys, weather conditions, and a summary of findings.
4. Map identifying netting site locations and information regarding net sets, including lat/long or UTM, individual net placement, net spacing (i.e., include mist-netting equipment in photographs of net locations), and adequate justification if net sets are not evenly distributed across suitable habitat within the project area.
5. Full names of mist-netting personnel attending each mist-net site during an operation, including the federally permitted/qualified biologist present at each mist-net site. Indicate on the field data sheet the full name of person who identified bats each night at each site.
6. Legible copies of all original mist-netting datasheets (see example [Appendix C6: Bat Mist-Netting Datasheet](#)) and a summary table with information on all bats captured during the survey including, but not limited to: capture site, date of capture, time of capture, sex, reproductive condition, age, weight, right forearm measurement, band number and type (if applicable), and Reichard's wing damage index score (Reichard and Kunz. 2009).
7. Photographs of all net sets, as well as all IBAT, NLEB, TCB, and the first 10 little brown bats (*M. lucifugus*) OR of each *Myotis spp.* (if surveying in the states of KS, NE, ND, SD, MT, or WY) captured from each project, so that the placement of netting equipment and identification of species can be verified. Photographs of bats should include all diagnostic characteristics that resulted in the identification of the bat to the species level.
8. Any other information requested by the local USFWS FO(s) related to the project.

## POTENTIAL WINTER HIBERNACULA SURVEYS

If suitable winter habitat is discovered as a result of a Habitat Assessment discussed previously, do not alter, modify, or otherwise disturb entrances or internal passages of caves, mines, or other entrances to underground voids (potential hibernacula) within the action area before completing a P/A survey. The survey protocols for determining occupancy are detailed below. Some surveys may require modification (or clarification); therefore, submittal of a study plan and coordination with the USFWS FO(s) and state natural resource agency is necessary prior to initiating suitable winter habitat/hibernacula surveys. Submit results of completed winter surveys to the appropriate FO(s) prior to clearing or altering of identified summer and winter bat habitat. The USFWS FO(s) will review the results for the purposes of determining whether target species are occupying hibernacula in the project area and whether they may be adversely affected by any proposed actions. Surveys of a potential hibernaculum are in addition to any summer/ year-round active season surveys that may be required for a proposed project.

White-nose syndrome (WNS) is a devastating fungal disease that has killed unprecedented numbers of hibernating bats in eastern North America. WNS and/or *Pseudogymnoascus destructans* (Pd), the fungus causing the disease has been detected throughout the range of the IBAT, as well as most of the range of the NLEB and TCB. Users of this guidance must follow the recommendations provided in the most recent [USFWS Cave Access Advisory](#)<sup>25</sup> as they relate to reducing the potential for humans to disturb hibernating bats or inadvertently transporting Pd to uncontaminated bat habitats. All surveys conducted at caves/mines should be coordinated with the USFWS FO(s) (see example [USFWS Project Study Plan Form](#)).

---

### WINTER (INTERNAL) SURVEY

- ***Acceptable Survey Window: Jan 1 – Feb 28***
- ***Traditional Survey Window of known sites: Jan 15 – Feb 15***

Working near and within abandoned mines and caves can be inherently dangerous due to a variety of potential hazards (e.g., ceiling collapse and presence of toxic gases)<sup>26</sup>. Therefore, surveyors must thoroughly assess their work sites for any known and potential health and safety hazards and must use appropriate personal protective equipment and take proper precautions to avoid and minimize identified risks. If a site is unsafe or too difficult to enter or it is believed that significant portions of the underground system are inaccessible, it should be surveyed using the fall or spring emergence survey guidance to determine presence or probable absence of target species (see example [Appendix C4: Fall/Spring Survey of Potential Bat Hibernaculum Datasheet](#)).

Potential hibernacula that are deemed safe to enter should be entered and all its accessible passages visually surveyed for the presence of IBAT and TCB during hibernation (also see

---

<sup>25</sup><https://www.whitenosesyndrome.org/resources/cfed8596-98af-4508-8ef4-30914aea3f48>

<sup>26</sup> The Service highly recommends that surveyors seek counsel from an occupational health and safety professional(s) prior to working underground or under other potentially hazardous field conditions.

Appendix 4 in the [IBAT Draft Recovery Plan](#) for more guidance on conducting internal surveys. **NOTE:** The use of direct internal surveys is not adequate for NLEB due to the difficulty in visually detecting the species inside hibernacula (i.e., it typically roosts in deep cracks and crevices).

Only properly trained and qualified individuals with the appropriate federal and/or state permits and equipment should attempt internal P/A surveys. If the qualified biologist who completed the Habitat Assessment does not have the necessary experience/permits to complete internal survey work, then this portion of the project should be subcontracted to another individual or group that does.

---

## FALL OR SPRING EMERGENCE SURVEY

- *Acceptable Survey Window:*
  - *Fall: September 15 – October 31*
  - *Spring: April 1 – April 21*

Fall or spring emergence surveys may not be recommended in cases where a project proponent agrees to modify their project to completely avoid adverse impacts to newly documented hibernacula and if abandoned mine openings can be closed with a USFWS FO approved bat friendly gate design.

**Fall surveys of mine/cave entrances** – must be conducted during the fall swarm survey window and prior to any habitat modification (e.g., tree clearing), if applicable, by the project proponent. A minimum of one night of harp trap sampling per week for 6 weeks (i.e., 6 nights of sampling) is required at each suitable entrance as determined by the Habitat Assessment. Each night of sampling should be separated by at least one week of the survey window if weather conditions allow it. However, multiple nights of sampling per week can be accepted in the last two weeks of survey window if forecasted weather conditions require it, at least 3 nights of sampling were completed during the first 3 weeks of the activity period, and the modification is approved by the appropriate USFWS FO(s). Survey effort may be suspended if no bats (of any species) are captured after the first 2 nights of acceptable survey effort in the fall.

**Spring surveys of mine/cave entrances** – must be conducted during the spring staging survey window and prior to any tree clearing by the project proponent. Conducting surveys during the spring emergence is typically more complex than conducting fall surveys due to a greater number of uncontrollable factors (e.g., weather-related factors). Thus, a minimum of three nights of harp trap sampling per week for three weeks (i.e., 9 nights of sampling) is required at each suitable entrance as determined by the Habitat Assessment. Due to the need to monitor weather conditions closely, each proposed spring mine/cave survey must be coordinated with the USFWS FO(s) prior to surveying to ensure that adequate survey results are achieved.

- 1) Unless otherwise approved by the USFWS FO, the capture of an IBAT, NLEB, and/or TCB during a fall or spring mine/cave survey requires that the applicant complete three additional nights of sampling per week for three consecutive weeks (9 additional nights LOE) to determine the relative significance of the mine(s) and/or cave(s) and their associated underground workings. If the mine/cave survey season ends prior to the completion of the required additional sampling, then sampling must be completed the following fall or spring.



- 2) Harp traps are the preferred method for sampling entrances as they are less stressful on captured bats. Mist-nets can also be deployed along corridors immediately adjacent to the entrance to increase survey effectiveness. Mist nets may also be used at the entrance but only when the mine or cave configurations are not suitable for harp trapping. The use of mist nets must be approved by the USFWS FO(s) and appropriate state natural resource agency prior to initiation of survey. Mist nets should be made of the finest, lowest visibility mesh commercially available. Currently, this is 2-ply, 50-denier nylon (denoted 50/2). The mesh should be approximately 1.5-inch in size. No other specific mist netting hardware is required.
- 3) Entrances must be entirely enclosed by the survey gear when harp trapping. If mist nets are used, entrances should not be entirely enclosed by the survey gear.
- 4) All entrances that are potentially inter-connected should be surveyed on the same night. In cases where one team of surveyors cannot feasibly sample all entrances in one night, a modified method could also be used; however, a minimum of 100 feet should separate surveyed vs. un-surveyed entrances in cases where numerous entrances to a potential hibernaculum exist. This method should only be used in situations where entrances are known to be interconnected. In this modified method, half of the interconnected entrances are surveyed on the first night, and the other half of the entrances are completely blocked using bird- exclusion netting, plastic sheets, or other impervious material. On the second night, survey efforts are reversed. Any materials used to block the entrances must be removed each night immediately after conducting the survey. No entrances should be left blocked overnight. Entrances that are not connected (e.g., as determined by existing mine maps) do not have to be surveyed simultaneously.
- 5) The sampling period should begin at sunset and continue for at least 5 hours each night. During this time, harp traps (most preferable method) and/ or mist nets (acceptable method, but less preferable from a bat-handling perspective) should be monitored for captured bats on 30- and 10-minute intervals, respectively, to minimize the number of bats that escape while limiting disruption of the swarm in the fall or emergence in the spring. Surveyors monitoring set-ups must minimize movement near the traps or nets. Monitoring with night vision or thermal cameras can be beneficial: (a) bats can be detected when they are captured, (b) any evidence of bats escaping the trap or net can be documented, and (c) monitoring with night vision or thermal camera also allows the biologist to assess the effectiveness of each trap/net placement (i.e., if bats are active near the set-up but avoiding capture), which may allow for adjustments that will increase capture success on subsequent nights. There should be no other disturbance near the set-up, other than to check traps/nets and remove bats. Biologists should be prepared to cut the net if a bat is severely entangled and cannot be safely extracted within 3 or 4 minutes or reduce harp trap check intervals to less than 30 minutes when capture rates are high. Capture and handling are stressful for bats. Emphasis should be on minimizing handling and holding bats to as short a time as possible to achieve field study objectives. Bats should not be held for more than 30 minutes after capture or as allowed in federal and state permits.

- 6) If captures increase during the survey or if 6 or more bats of any species were captured during the last hour of monitoring, the survey effort must continue until activity declines, or fewer than 6 bats are captured per hour. A total of 30 (fall) or 45 (spring) hours of sampling should take place for a mine/cave survey to be approved.
- 7) Severe weather adversely affects the activity levels of bats. If any of the following weather conditions exist during the fall or spring mine/cave survey, the time and duration of such conditions must be noted on the data sheets and in the survey report, and the survey effort for that night must be repeated: (a) winds sufficiently strong and variable enough to move equipment (i.e., traps or nets) more than 50 percent of the time; and (b) precipitation, including rain and/or fog, that does not stop within 30 minutes or continues intermittently during the survey period; and (c) temperatures that are less than 50° F (10° C) for the first 2 hours, and that drop below 40° F (4.4° C) at any point during the survey.
- 8) All bats captured during fall or spring surveys must be temporarily marked with non-toxic material that will last for the remainder of the survey period to identify any recaptures during subsequent survey nights.
- 9) If IBAT, NLEB, and/or TCB (or any other federally listed species) are captured during fall or spring mine/cave surveys, notification to the local USFWS FO(s) is required within 48 hours (or in accordance with permit conditions), and the sex and reproductive condition of the bat and GPS coordinates of the capture site should be provided.
- 10) A bat detector/roost logger should be deployed at each entrance during sampling to monitor bat activity when trapping or netting. Bat passes should be monitored and tallied hourly. Bat tallies should be reported along with the time sampled. Report the time and number of bat passes in hour blocks. Analysis of recorded bat calls to attempt species identification should not be completed as these calls are not expected to be foraging calls.
- 11) Noise, the use of lights, or other potential disturbances should be kept to, at a minimum, no closer than 300 feet (91.4 m) of the sampling site.
- 12) At least one member of each survey crew must hold, and have in his or her possession, a valid USFWS Section 10(a)(1)(A) recovery (endangered species) permit as well as any applicable state agency permit(s) that allows the qualified biologist to collect bats, including federally listed species. All activities must be carried out with strict adherence to permit conditions and authorizations specified in State and federal permit authorizations. A qualified biologist(s) must (1) select/approve harp trap/mist-net sets, (2) be physically present at each site throughout the survey period, and (3) confirm all bat species identifications. This biologist may oversee other biological technicians and manage set-ups near one another if the traps/nets are monitored as defined in bullet 6 above.
- 13) All survey efforts must follow the most recent USFWS decontamination protocols regarding WNS.

## POTENTIAL BRIDGE & CULVERT SURVEYS

- *Acceptable Survey Window: Coordinate with local FOs.*

After an initial assessment of suitability for bats, surveyors should submit a completed [USFWS Project Study Plan Form](#) or equivalent to the local USFWS FO(s) for approval before they begin inspecting it for evidence of bat occupancy (see example [Appendix C5: Bridge and Culvert Bat Assessment Form](#)). The most ideal vertical crevices for bats are those that are 0.5 – 1.25 inches wide and > 4 inches deep (if sealed at the top) or >12 inches deep if not sealed. Although these characteristics represent the ideal size of cracks and crevices for bat roosting, bats may be found in spaces that are larger and smaller than this range. Assessments should identify and inspect all cracking, crevices, spaces, and voids along the under deck of the bridge and support beams and inner walls, such as below a fillet (a concrete filling between ceiling and vertical beam). Additionally, expansion joints that are unobstructed by debris or other blockages should be identified and inspected. Additional features to inspect include vertical spaces between end walls and bridge deck, areas of spall repair, guardrails and gaps in concrete parapet, plugged drainpipes, and weepholes. During the assessment, individuals should use high-powered flashlights, headlamps, or spotlights to examine all accessible parts of the bridge or culvert. Cave-like areas, recesses, and other similar features inside bridges or culverts (e.g., deck in the case of a bridge; see photos) should be searched in a similar fashion, although these areas may require the use of specialized equipment such as endoscopes. There are numerous indicators that can be used to determine bat use and presence within a bridge/culvert.

### INDICATORS OF BAT PRESENCE

**Roosting Bats** – Upon entry of the bridge/culvert, check for bats roosting out in the open. Open-roosting bats will typically be near the ceiling or on the ceiling itself of a culvert or similarly along the underdeck of a bridge. Bats occasionally roost on or within bird nests, such as those composed of dried mud and created by various species of swallow (CBWG 2022). Bats may also take flight when disturbed and can be quickly accounted for during the assessment. Use binoculars/spotting scopes when attempting to locate bats roosting in higher areas of the bridge/culvert. If bats are present, record species (if determinable), total number, a description of the respective roosting locations, and representative photographs of the individuals (Figure 5). Additionally, provide a sketch map, if possible, showing the locations of where the bat roosts exist on the bridge/culvert (use the bridge/culvert plan sheet as base for sketch). If any dead or injured bats are observed, take photographs and promptly notify the local USFWS FO(s).



**Figure 5.** A TCB roosting on the ceiling of a culvert in Georgia (left; photo provided by Georgia Department of Natural Resources) and IBATS roosting in an expansion joint in Indiana (right; photo provided by USFWS).

**Urine and/or Body Staining** – Urine or body oil stains may appear wet when bats have recently used the structure as a roost and are usually found in dark places. When dry, urine staining may have light-colored mineral deposits, but it can be difficult to differentiate from water staining (the latter often has presence of green algae). Dry urine staining can also be difficult to differentiate from concrete efflorescence (a deposit of soluble salts and bases, usually white in color, that sometimes appears along cracks in concrete or masonry). For body oil staining, look for 4-6 inches-wide dark stains located on concrete support beams and walls immediately below the underdeck of the bridge, and beneath joints (Figure 6). It's important to note that staining on bridges and culverts can be caused by a wide variety of things other than bat presence. Guano deposits almost always accompany bat urine or body staining at structures, so "suspect" staining alone may not be sufficient evidence of bat presence (with the notable exception of structures with roost locations situated over waterways, where guano deposits would be washed away).



**Figure 6.** Open-roosting Indiana bats (*Myotis sodalis*) and associated urine staining on the underside of a bridge in Indiana (photo provided by R. Yaeger).

**Presence of Guano (bat droppings)** – Guano deposition is a relatively quick visual indicator of recent bat use of a structure. Individual bat guano pellets are small, brown/black in color, and unlike



fibrous rodent droppings are more easily crushed and contain notable insect parts<sup>27</sup> (Figure 7). Older droppings may be gray in color. These droppings will accumulate on the ground, floor of a covered bridge, pier caps, or on other horizontal structural components below where bats roost (Figure 8). Droppings may also adhere to vertical surfaces (e.g., support beams and walls) below roosts. Searches for bat droppings should be performed via the use of a high-powered flashlight. Surveyors should wear a dust mask (e.g., N95), and rubber boots are recommended for traversing through large guano deposits. All accessible cracks, cave-like areas, and expansion joints should be checked for the presence of guano. Confirmed and suspected bat droppings should be noted and their location within the bridge/culvert should be documented. Additionally, representative photographs should be taken of guano deposits in-situ, with a ruler or other object for scale, prior to crush-testing or collecting any guano samples (note: if guano samples are intended to be collected, refer to the guano sampling section). It is notable that in many cases, guano accumulation in culverts or at bridges over water will be minimal due to the regular inflow and outflow of water. In these situations, urine and body staining may be a more important indicator of bat use than guano accumulation.



**Figure 7.** Examples of guano accumulations on bridges. (photos provided by Georgia Department of Natural Resources (top) and Indiana Department of Transportation (bottom)).

---

<sup>27</sup> Insect parts may be difficult to see without magnification. Low magnification handheld field microscopes or hand lenses are recommended for those practitioners regularly conducting guano sampling as part of bridge and culvert assessments.

**Sounds and Smells** – Bats occupying bridges/culverts may audibly vocalize when approached, thus high-pitched squeaking or chirping can be a quick indicator of current use. Surveyors that have difficulty hearing high pitch noises may find an acoustic detector with an external speaker or headphone jack helpful for detecting bat chatter, but use of this equipment during visual inspections is not required. Guano deposits, especially large amounts, also have an ammonia odor that can be apparent in some situations.

## INACCESSIBLE AREAS AND ADDITIONAL ASSESSMENT OPTIONS

In some situations, there will be portions of a bridge/culvert that may be inaccessible or unsafe for thorough inspections. In these instances, we recommend coordinating with the USFWS FO and/or local Department of Transportation to determine if any of the following inspection methods or alternate assessment methods included here are recommended.



**Figure 8.** Examples and comparative sizes and characteristics of bat guano from little brown bat (*Myotis lucifugus*) and big brown bat (*Eptesicus fuscus*) (left; photo provided by Vermont Fish and Wildlife Department); Guano deposit from colony of Yuma bats (*M. yumanensis*) on horizontal bridge structure (right; photo provided by P. Crawford/Oklahoma Department of Transportation).

**Acoustic Surveys** – In some circumstances, acoustic surveys can be used to assist in assessing and characterizing bat colony use of a bridge or culvert. However, acoustic surveys should be conducted with caution and only by experienced practitioners. Detectors may also need to be placed further back from the structure to avoid ultrasonic noise associated with vehicle traffic, powerlines, and other nearby infrastructure. Acoustic collections should only be used as a supplement to a larger suite of structural survey/assessment approaches and cannot be used to determine species identification as a stand-alone method. An example scenario where an acoustic survey at a bridge or culvert may be appropriate includes the use of acoustic equipment to assist

in an emergence survey for a structure that has been determined to be unsafe to enter or inspect using traditional methods.

**Emergence Surveys** – Emergence surveys may be used as a supplementary tool to determine use of a structure and can only be used once target species colony presence has been confirmed. If emergence surveys are planned for the structure for TCB, contact the local USFWS FO(s) and respective State Agency(ies) to determine if applicable, or if a modified approach is appropriate for the situation.

**Alternative Techniques** – Assessments from kayak/boat with binoculars to inspect areas over deep water, as well as ladders or construction equipment (cherry pickers, snooper truck, etc.) to access high areas of structures or areas over deep water may be necessary in certain situations.

---

## SPECIES IDENTIFICATION

**Visual Identification** – Visual identification of species may be possible by experienced practitioners, such as those individuals that have Section 10(a)(1)(A) permits to conduct bat surveys. However, voucher photos should be taken with high-quality cameras for inclusion in survey reports regardless of the experience of the surveyor. If species identification cannot be verified visually, in photographs, or by other methods when bats are known to use a structure, it may be appropriate to assume presence of the target species. Please coordinate with the local USFWS FO for guidance about assuming presence.

**Acoustic Identification** – Species identification may not be reliable using acoustic detectors to confirm occupancy at a bridge. Bats just emerging from roosts are often making social calls, which cannot always be reliably identified to species. Detectors may need to be set further back from suspected roost locations to record "search phase" calls that bats make while navigating/foraging. Automatic or qualitative acoustic identifications from bridges or culverts should only be performed following coordination with and approval from the local USFWS FO. Surveyors can use timestamps of acoustic recordings to glean insight into whether the recorded bats may have been made by bats emerging from the roost, but caution should be used in interpreting acoustic data as the detector may have also recorded bats not using the structure.

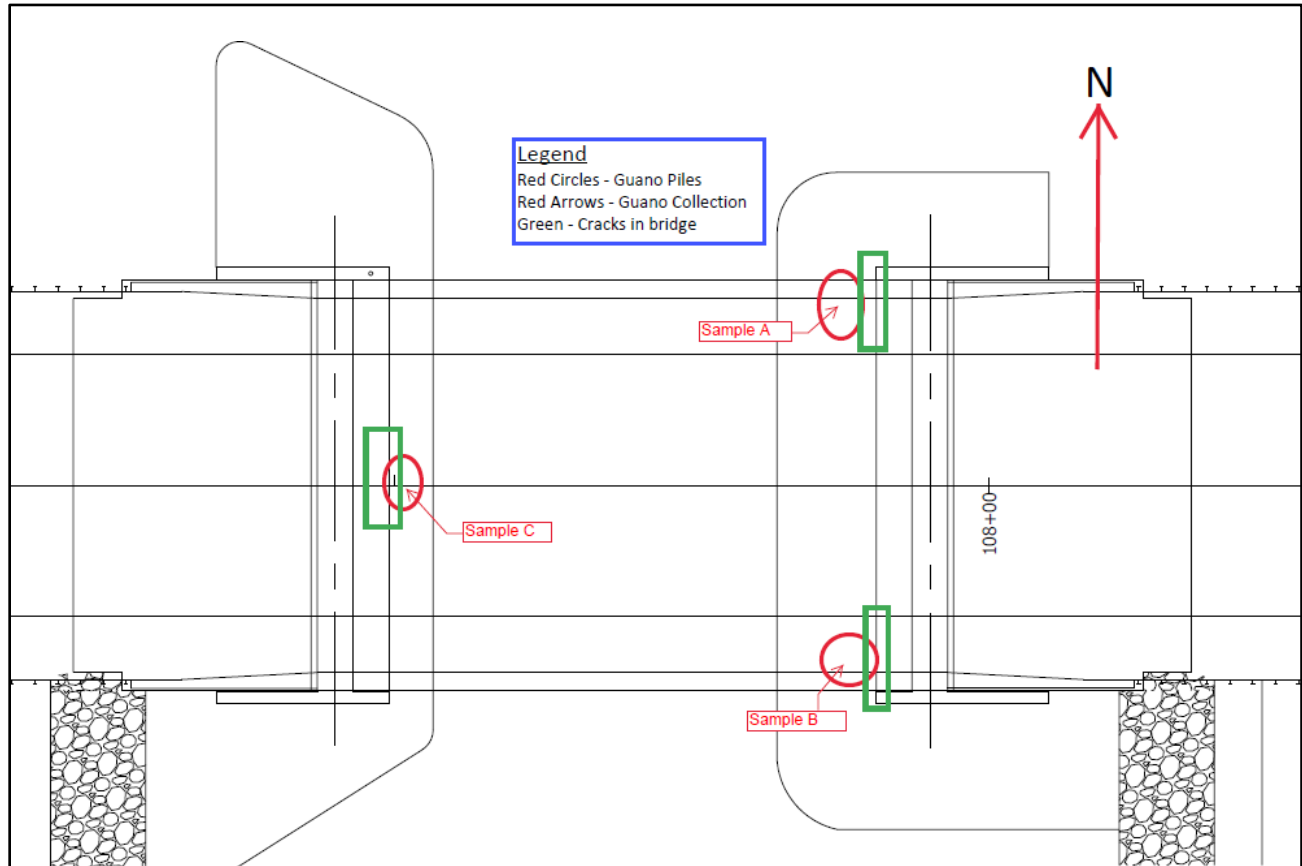
**Guano Collection & Analysis** – Genetic material in bat guano can be analyzed to determine which species deposited the pellet(s). However, samples must be collected in a manner that minimizes contamination and maintains their integrity for lab analysis (Figure 9). If possible, guano should be collected in sufficient amounts to maximize the ability for species to be properly identified. (See [USFWS Recommended DNA Sampling Methods for Bat Species Identification](#))

Guano collections should only be performed after coordinating with the local USFWS FO(s) to develop a collection plan, which may be included in the overall survey Study Plan. The primary goal of a guano collection plan is to obtain samples that provide a full representation of bat use of the structure. Additionally, it should include the following elements:

- 1) number of distinct areas of guano present in the structure.
- 2) guano condition (e.g., old vs. fresh),
- 3) map of guano locations within structure and collection sample points (see Figure 9);



- 4) photographs of structure, guano deposits, on the ground at the time of sample collection.
- 5) time of year<sup>28</sup> that samples will be obtained.
- 6) equipment that will be used to safely collect and curate guano (e.g., sample collection vials, gloves, collection utensils, writing utensils, camera, etc.).



**Figure 9.** Example map for a guano collection plan, showing top-down view of a bridge, showing linear guano piles located along the abutment walls (underneath the structure's expansion joints). Arrows indicate proposed sample collection locations (Photo provided by Indiana Department. of Transportation).

## SUBMISSION OF RESULTS

Findings of bridge or culvert assessments should be submitted to the local USFWS FO(s) and respective State Agency(ies) in a survey report (see example [Appendix C5: Bridge and Culvert Bat Assessment Form](#)). If federally listed bat species are positively identified during a bridge or culvert assessment or if species identification cannot be verified at a bridge or culvert with evidence of use, coordinate with your local USFWS FO within 48 hours to determine next steps. For other species, coordinate with your appropriate state agency(ies) (e.g., state wildlife and transportation agencies).

<sup>28</sup> It is recommended to obtain guano samples during bridge and structure use or as close to movement to hibernacula (if applicable) as possible to avoid sample degradation.

---

### Survey Reporting Checklist:

- 1) Completed survey data form (see example [Appendix C5: Bridge and Culvert Bat Assessment Form](#)).
- 2) Annotated photo log w/representative images of surveyed structure (including areas with no indication of bat presence).
- 3) Detailed information on location(s) where roosting bats and/or signs of bat use (e.g., staining, guano, etc.) was documented.
- 4) Information pertaining to any guano samples collected and locations within the structure where samples were obtained.
- 5) Additional information, photos, results, etc. relevant to any other previously agreed upon survey methods for the structure (e.g., emergence surveys, mist-netting, harp-trapping, acoustics).

**Data Management** – USFWS FOs and respective state wildlife agency(ies) may prefer that bridge and culvert assessment data be submitted electronically<sup>29</sup>, in hard copy survey reports, or both. An example data form that can be printed is available in [Appendix C](#).

## RADIO TRACKING

---

### PERSONNEL REQUIREMENTS

**Transmitter Attachment** – A qualified biologist<sup>30</sup> who is experienced in handling IBAT, NLEB, and/or TCB and attaching radio transmitters must perform transmitter attachments, as further explained in the protocol below.

**Tracking** – Biological technicians and/or a qualified biologist who is experienced in tracking transmitted bats must be present and actively involved in all tracking activities for IBAT, NLEB, and/or TCB as further explained in the protocol below. NOTE: Radio-tracking of TCBs should prioritize identification of the immediate roosting area of the transmitted bat given the difficulty in locating exact roosting location(s).

Biologists should coordinate in advance with USFWS FO(s) regarding radio-tracking recommendations (e.g., number and distribution of transmitters, including prioritization of sex/age and maximum number per site) and whether foraging data would be beneficial to collect. Also, professional judgment should be used to determine whether attachment of transmitters could compromise the health of a bat. Surveyors should be prepared to place transmitters on bats immediately following their capture to minimize holding times at or below 30 minutes, or as allowed in federal and state permits.

---

<sup>29</sup> A template electronic data form that incorporates the minimum fields required for submission to the North American Bat Monitoring (NABAT) Program is included [here](#). Data submission from bridge and culvert assessments to the NABat database is encouraged but not required.

<sup>30</sup> A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife Permit) for federally listed bats in the state/region in which they are surveying and/or has been authorized by the appropriate state agency to mist-net for target species. Several USFWS offices maintain lists of qualified bat surveyors, and if working in one of those states with authorizations in lieu of a Recovery Permits, the individual will either need to be on that list or submit qualifications to receive USFWS approval prior to conducting any field work.

## EQUIPMENT REQUIREMENTS

The radio transmitter, adhesive, and any other markings (e.g., wing bands) should weigh less than 5% of pre-attachment body weight (Aldridge and Brigham 1988, American Society of Mammalogists 1998) and must comply with any USFWS and state permits. In all cases, the lightest transmitters capable of the required task should be used, particularly with pregnant females and volant juveniles. With pregnant bats, biologists should always use the lightest transmitter possible but no more than 5% of their expected non-pregnancy weight. Proper application methods are paramount to the successful retention of an applied transmitter. Qualified biologists should apply commonly accepted methods. Examples of available resources include:

- <https://tccarterlab.files.wordpress.com/2017/10/application-of-transmitters-in-small-insectivorous-bats1.pdf>
- [A Field- and Laboratory-based Comparison of Adhesives for Attaching Radio-transmitters to Small Insectivorous Bats \(Carter et al. 2009\)](#)

Adhesives (or “glues”) used during radio-tracking and telemetry studies<sup>31</sup> to attach transmitters to bats must be included in the approved adhesives for P/A telemetry studies list (Table 3)<sup>32</sup>.

**Table 3:** Approved adhesives for P/A telemetry studies

Type	Active ingredients	Name	Manufacturer
<b>Latex-based Surgical Cement</b> <sup>33</sup>	Liquid latex, N-hexane, zinc oxide	Torbot	Torbot Group, Inc.
	Liquid latex, N-hexane, zinc oxide	Ostobond	Montreal Ostomy Products.
	Liquid latex, N-hexane, zinc oxide	Permatype	Perma-Type Company, Inc.
<b>Silicone-based Surgical Adhesive</b> <sup>34</sup>	Silicone solids, ethyl acetate	Uro-Bond III 5000	Urocare Products, Inc.
<b>Butyl-cyanoacrylate Surgical Adhesives</b> <sup>35</sup>	100% n-butyl cyanoacrylate	Vetbond	3M

<sup>31</sup> The Bat Survey Guidelines do not address recommendations for MOTUS based transmitter applications, wound closure for pit-tag studies, or other applications of adhesives. However, we strongly recommend researchers review SDS information for products prior to use to determine their safety for use on bats. Adhesives that are not recommended for use on human or animal skin should never be used to attach transmitters to bats or to close pit tag wounds. Shut Eye and Locktite Superglues are not intended for application to skin and should be avoided.

<sup>32</sup> To request a specific product addition to the list of adhesives in Table 3, submit a request to [Bat\\_Survey\\_Guidance@fws.gov](mailto:Bat_Survey_Guidance@fws.gov). In the email, provide the product name, product Safety Data Sheet, manufacturer recommendations for product use, active ingredient list, whether the product was developed for human or veterinary purposes, if the product is designed for bonding appliances to skin (preferred) or for closing wounds and any other relevant information.

<sup>33</sup> Liquid, malleable bonding cements that contain latex and take several minutes to cure. Bonds skin to skin.

<sup>34</sup> Liquid, malleable surgical adhesives that contain silicone and take several minutes to cure. Bonds appliances to skin.

<sup>35</sup> Stiff, cyanoacrylate-based products react quickly with water to form a durable, waterproof bond.

The list includes commercially available latex and silicone-based cements that are known to adhere transmitters to bats for approximately 1 to 30 days. Latex-based rubber cements have a long history of use by researchers and to our knowledge have no adverse health effects to bats.

For a list of examples of products that are currently not permitted, see Table 4. This list is not exhaustive and includes products that are likely to adhere transmitters to bats for more than 4 weeks or have been reported to have adverse reactions are not permitted (see Figure 10).

**Table 4.** Examples of **prohibited** adhesives (this list is not exhaustive).

Type	Active ingredients	Name	Manufacturer
<b>Octyl-cyanoacrylate Surgical Adhesives</b>	100% 2-octyl cyanoacrylate	Dermabond	Zoetis Canada Inc
	100% 2-octyl cyanoacrylate	Surgi-Lock 2oc	Meridian Animal Health
	60% 2-octyl cyanoacrylate, 40% n-butyl cyanoacrylate	GluTure	Ethicon, Inc
	60% cyanoacrylate	Loctite 422	Henkel Adhesives



**Figure 10.** A photo of an IBAT with significant fur loss three weeks after transmitter was attached using GluTure. In this example, the transmitter was applied using a small dab of GluTure between the scapulae.

**NOTE:** Surveyors who recapture a bat after using any adhesive should observe the bat's skin for signs of irritation, infection, excessive fur loss, and take photos or a video of the area where transmitter was applied (for example, see Figure 10). Report information to the Bat Survey Guidelines Team ([Bat\\_Survey\\_Guidance@fws.gov](mailto:Bat_Survey_Guidance@fws.gov)).

## RADIO-TRACKING PROTOCOL

- 1) Proposed radio telemetry equipment (e.g., receivers, antennas, and transmitters) and frequencies should be coordinated with the appropriate state natural resource agency and USFWS FO(s). Prior to purchasing transmitters, biologists should inquire with transmitter manufacturers about signal boosting to determine if this option would improve bat detectability in their planned work areas. Transmitters with modified signals must be built to last the duration of the telemetry study approved in the Site Study Plan (e.g., > 7 days).

- 2) Surveyors should thoroughly test transmitter function prior to the Study. Transmitters should be new or no more than one year old at the time they are applied to a bat and should be stored as recommended by manufacturer prior to use. Transmitters more than 1 year old must be tested prior to the study to ensure function and no degradation in anticipated signal strength. To establish function, all transmitters should be temporarily activated for at least 24 hours. To determine signal strength, surveyors should temporarily activate transmitter and test receiver signal strength. Topography, ambient weather conditions, and location of the bat and direction of antenna are all examples of variables that will dictate the distance at which a signal is detectable, but in general, the signal should be consistently detectable from at least one mile away. Transmitters more than 2 years old should be refurbished before using them for P/A surveys.
- 3) The qualified biologist or biological technician(s) should track all radio-tagged bats captured to diurnal roosts in accordance with permit requirements. We generally recommend tracking until the transmitter fails, falls off, or cannot be located for at least 7 days and should conduct a minimum of 2 evening emergence counts at each identified roost (See [Emergence Survey Protocols](#)). However, biologists are encouraged to continue radio-tracking efforts for the life of the transmitter. Biologists should contact the USFWS FO(s) immediately if they plan to cease tracking efforts before the 7-day tracking period ends. If landowner access is denied, approximate roost locations (i.e., coordinates) should be determined using triangulation.
- 4) Daily radio telemetry searches for roosts must be conducted during daylight hours and should be conducted until the bat(s) is located or for a minimum of 4 hours of ground or 1 hour of aerial-searching effort per tagged bat per day for 7 days. However, multiple bats captured at the same net location or nearby may be tracked simultaneously. Once a signal is detected, tracking should continue until the roost is located. At a minimum, biologists should document all ground and aerial-searching effort for all bats not recovered during radio-tracking for submittal with the survey report. For each roost identified during tracking, the biologist should complete a [USFWS Bat Roost Datasheet](#).
- 5) To minimize potential for disease transmission, any equipment that comes in contact with bats should be kept clean and disinfected, following approved protocols; this is particularly a concern relative to WNS. Protocols are posted at <http://www.whitenosesyndrome.org/>. Federal and state permits may also have specific equipment restrictions and disinfection requirements.

---

## **SUBMISSION OF RADIO-TRACKING RESULTS**

Radio-tracking results should be included with the mist-netting report and submitted to the appropriate USFWS FO(s). Each report should include the following information related to radio-tracking efforts:

1. Copy of prior project survey reports (if not previously provided).

2. Explanation of any modifications from original survey plan (e.g., number of transmitters used, frequency of transmitters changed)<sup>36</sup>.
3. Map and narrative detailing all ground and aerial search effort for all bats not recovered during radio-tracking and relative to the negotiated or agreed effort as determined by the appropriate USFWS FO(s).
4. Map summarizing IBAT, NLEB, and/or TCB data collected from summer/ year-round active surveys for the proposed project (e.g., project area boundary and results from the site habitat assessment, acoustic survey, mist-net survey, radio-tracking, and emergence surveys).
5. Full names and permit numbers of personnel who attached transmitters to IBAT, NLEB, and/or TCB and full names of all personnel conducting radio-tracking efforts.
6. Photographs of all roosts identified during radio-tracking.
7. Legible copies of all original USFWS IBAT and/or NLEB Roost Datasheets (see example [Appendix C7: Bat Roost Datasheet](#)).
8. Any other information requested by the local USFWS FO(s) where work was conducted.

## EMERGENCE SURVEYS

### PERSONNEL REQUIREMENTS

Qualified biologists<sup>37</sup>, biological technicians, and any other individuals deemed qualified by a local USFWS FO may conduct emergence surveys for IBAT, NLEB, and/or TCB by following the protocols below.

### EMERGENCE FROM KNOWN ROOST TREE LOCATIONS

Before using the emergence survey protocols for TCBs, the respective USFWS FO(s) should be contacted since typical roosting locations used by the species (e.g., dead leaf clusters in the canopy of live trees) can be highly variable, making emergence surveys logistically challenging. An emergence count may be attempted on the rare occasion that the surveyor is able to discover the exact roosting location of a transmittered TCB and believes he/she can observe the bat(s) emerging (see example [Appendix C8: Bat Emergence Survey Datasheet](#)).

The following protocols should begin as soon as feasible after identification of a diurnal roost (ideally that night):

---

<sup>36</sup> If the USFWS previously agreed upon the study plan, any changes or deviations must be thoroughly justified by the surveyor in accomplishing the work.

<sup>37</sup> A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife Permit) for federally listed bats in the state/region in which they are surveying and/or has been authorized by the appropriate state agency to mist-net for IBAT, NLEB, and/or TCB. Several USFWS offices maintain lists of qualified bat surveyors, and if working in one of those states with authorizations in lieu of a Recovery Permits, the individual will either need to be on that list or submit qualifications to receive USFWS approval prior to conducting any field work.

- 1) Emergence surveys should begin one half hour before sunset<sup>38</sup> and continue until at least one hour after sunset or until it is otherwise too dark to see emerging bats. The surveyor(s) should be positioned so that emerging bats will be silhouetted against the sky as they exit the roost. Tallies of emerging bats should be recorded every few minutes or as natural breaks in bat activity allow. There should be at least one surveyor per roost. Surveyors must be close enough to the roost to observe all exiting bats but not close enough to influence emergence. That is, do not stand directly beneath the roost, do not make noise or carry on a conversation, and minimize use of lights (use a small flashlight to record data, if necessary). Do not shine a light on the roost as this may prevent or delay bats from emerging. Use of an infra-red, night vision, or thermal-imaging video camera or spotting scope is encouraged but not required. Likewise, use of an ultrasonic bat detector may aid in identifying the exact timing of bats emerging and may be used to help differentiate between low- and high-frequency bat species, and therefore, is strongly recommended. If multiple roosts are known within a colony, then simultaneous emergence surveys are encouraged to estimate population size. [NOTE: If a roost cannot be adequately silhouetted, then the local USFWS FO(s) should be contacted to discuss alternative survey methods].
- 2) Bat activity is affected by weather; therefore, emergence surveys should not be conducted when the following conditions exist: (a) temperatures that fall below 50°F (10°C); (b) precipitation, including rain and/or fog, that exceeds 30 minutes or continues intermittently during the survey period; and (c) sustained wind speeds greater than 9 miles/hour (4 meters/second; 3 on Beaufort scale).
- 3) Surveyors should submit all datasheets (see example [Appendix C8: Bat Emergence Survey Datasheet](#)).
- 4) Surveyors should also complete a Bat Roost Datasheet (see example [Appendix C7: Bat Roost Datasheet](#)) for each roost known to be used by one or more target species.
- 5) Completed datasheets should be included in reports prepared for the USFWS.

---

## SUITABLE ROOST TREE EMERGENCE SURVEYS

In some limited cases (e.g., individual hazard tree removal during the active season<sup>39</sup>), surveyors may have the option of conducting tree emergence surveys for individual potential IBAT and/or NLEB roosts to determine use prior to removal. Due to their size and roosting preferences, emergence surveys are not a suitable form of determining presence/probable absence for TCB. Evaluations of whether potential roosts meet the criteria to conduct emergence surveys should be for each individual tree rather than groups of trees.

---

<sup>38</sup> Surveys may need to start a little earlier or later than one half hour before official sunset times (i.e., before “dusk”) in some settings such as deep/dark forested valleys or ridge tops, respectively. Sunset tables for the location of survey can be found at: <https://sunrise-sunset.org>

<sup>39</sup> See Bat Activity Periods, [Appendix A](#)



The following protocol applies to these surveys:

- 1) Consult with the local USFWS FO(s) to determine whether a tree(s) that needs to be felled or otherwise disturbed may be potential roosting habitat for IBAT and/or NLEB and whether conducting an emergence survey is an appropriate means of avoiding take of IBAT and/or NLEB<sup>40</sup>. In general, the USFWS only approves of conducting emergence surveys as a means of avoiding direct take of bats for projects that only affect a very small number of potential roosts (e.g., less than or equal to 10)<sup>41</sup> in relatively small project areas. In addition, emergence surveys are only valid if all parts of the tree (limbs and trunk) can be observed by the surveyor. Therefore, trees within woodlands that are directly adjacent to other trees and whose canopy is blocked are not suitable for emergence surveys.
- 2) If the USFWS FO(s) approves/concurs, then follow the guidance for Emergence Surveys for Known IBAT and/or NLEB Roosts (above) to determine if any bats are roosting in the tree(s).
- 3) At the conclusion of the survey:
  - a. If **no** bats were observed emerging from the potential roost(s), then it may be felled immediately. If safety concerns dictate that a tree cannot be felled immediately (i.e., in the dark), then the tree(s) should be felled as soon as possible after sunrise on the following day. If a tree is not felled during the daytime immediately following an emergence survey, then the survey must be repeated, because bats may switch roosts on a nightly basis. Immediately after the tree is felled, a visual inspection of the downed tree must be completed to ensure that no bats were present, injured, or killed. The USFWS FO should be contacted immediately if bats are discovered during this inspection.
  - b. If **1 or more** bats (regardless of species, because species identification cannot reliably be made during visual emergence counts alone) are observed emerging from the roost, then it should **not** be felled, and the USFWS FO(s) should be contacted the next working day for further guidance.

---

## SUBMISSION OF EMERGENCE SURVEY RESULTS

Emergence survey results should be included with the mist-netting survey report, unless the survey was completed as an evaluation of potential roosts and should be submitted to the appropriate USFWS FO(s) for review.

---

<sup>40</sup> If a potential bat roost tree poses an imminent threat to human safety or property, emergency consultation procedures may be warranted. (50 CFR §402.05); If it does not pose an imminent threat, USFWS requests that it be felled during the bat's inactive season. When possible, felling of potential roost/hazard trees should be avoided during the primary maternity period and pup seasons (see [Appendix A](#)).

<sup>41</sup> Areas containing >10 hazard trees will be assessed by the USFWS on a case-by-case basis with the project proponent.

**Each survey report should include the following information related to tree emergence survey efforts:**

1. Copy of prior reports (if not previously provided).
2. Explanation of any modifications from the tree emergence count study plan (e.g., number of potential roosts surveyed), if applicable.
3. Summary of roost emergence data.
4. Map identifying location of roost(s) identified during radio-tracking and/or tree emergence surveys for the target species, including GPS coordinates.
5. Full names of personnel present during emergence survey efforts and who conducted tree emergence surveys of roosts.
6. Photographs of each identified roost.
7. Surveyors should submit all datasheets (see example [Appendix C8: Bat Emergence Survey Datasheet](#)). Surveyors should also complete an IBAT and/or NLEB Roost Datasheet (see example [Appendix C7: Bat Roost Datasheet](#)) for each roost known to be used by one or more IBAT and/or NLEB.
8. Any other information requested by the local USFWS FO(s) where work was conducted.
9. Copy of the pre-approved site-specific written authorization from USFWS and/or state natural resource agency (if required).

## REFERENCES

- Aldridge, H., and R.M. Brigham. 1988. Load carrying and maneuverability in an insectivorous bat: a test of the 5% “rule.” *Journal of Mammalogy* 69:379-382.
- Amelon, S.K. 2007. Multi-scale factors influencing detection, site occupancy, and resource use by foraging bats in the Ozark Highlands of Missouri. PhD Dissertation. University of Missouri – Columbia.
- American Society of Mammalogists. 1998. Guidelines for the capture, handling and care of mammals. *Journal of Mammalogy* 79:1416-1431.
- Armstrong, M.P., R.A. King, E.D. Thorne, J. De La Cruz, J.S. Utrup, V. Kuczynska, and K. Lott. 2023. Addendum 3 – An Update to Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper [with Northern long-eared Bat Addition]. U.S. Fish and Wildlife Service, Region 3, Bloomington, MN. 4 pp. Available on the USFWS website provided in the introduction.
- Armstrong, M.P., R.A. King, R.A. Niver, J. Utrup, V. Kuczynska, E.D. Thorne, J. De La Cruz, S.M. Deeley, K.M. Gorman, W.M. Ford, and R.E. Russell. 2022. Addendum 2 – An Update to the Indiana Bat Summer Survey Level of Effort Trigger and Inclusion of Minimum Recommended Effort for Northern Long-eared Bats. U.S. Fish and Wildlife Service, Region 3, Bloomington, MN. 17 pp. Available on the USFWS website provided in the introduction.
- Arndt, R.J. and B.A. Schaetz. 2009. A tale of two deniers: nylon versus polyester mist nets. *Bat Research News* 50(3):57.
- Britzke, E.R, B.A. Slack, M.P. Armstrong, and S.C. Loeb. 2010. Effects of orientation and weatherproofing on the detection of bat echolocation calls. *Journal of Fish and Wildlife Management* 1(2):136-141.
- California Bat Working Group (CBWG). 2022. Bats in Swallow Nests (rev. 4 April 2022). Accessed 1 February 2024. Available: <https://www.calbatwg.org/resources/>
- Canadian Council on Animal Care (CCAC). 2003. CCAC species-specific recommendations on bats. 9pp.

- Carroll, S.K., T.C. Carter, and G.A. Feldhamer. 2002. Placement of nets for bats: effects on perceived fauna. *Southeastern Naturalist* 1:193-198.
- Chenger, J.D. and J.D. Tyburec. 2014. Comparing bat detector deployments at different heights, in different orientations, and using different microphone types. Poster presentation at the Southeast Bat Diversity Network Meeting, Nacogdoches, TX. February 2014.
- Corben, C., and K. Livengood. 2014. Weather protection for Anabat detectors. Poster presentation at the Southeastern Bat Diversity Network Meeting, Nacogdoches, TX. February 2014.
- Detweiler, L.W. and Bernard, R.F. 2023. Wildlife Use of Anthropogenic Structures: A Comprehensive Review of Bridge Use by Bats, *Acta Chiropterologica* 25(1), 135-157.
- Duchamp, J.E., M. Yates, R. Muzika, and R.K. Swihart. 2006. Estimating probabilities of detection for bat echolocation calls: an application of the double-observer method. *Wildlife Society Bulletin* 34(2):408-412.
- Ellison, Laura E. "Summary and Analysis of the U.S. Government Bat Banding Program." U.S. Geological Survey, 2008. [http://pubs.usgs.gov/of/2008/1363/pdf/OF08-1363\\_508.pdf](http://pubs.usgs.gov/of/2008/1363/pdf/OF08-1363_508.pdf).
- Flaquer, C., I. Torre, and A. Arrizabalaga. 2007. Comparison of sampling methods for inventory of bat communities. *Journal of Mammalogy* 88:526-563.
- Fraser, E.E., A. Silvis, R.M. Brigham, and Z.J. Czenze, editors. 2020. Bat Echolocation Research: A handbook for planning and conducting acoustic studies. Second Edition. Bat Conservation International, Austin, Texas, USA. <[https://www.batcon.org/wp-content/uploads/2020/09/2Bat\\_Echolocation\\_Research\\_2nd\\_Ed\\_20200925.pdf](https://www.batcon.org/wp-content/uploads/2020/09/2Bat_Echolocation_Research_2nd_Ed_20200925.pdf)>.
- Gannon, W.L., R.S. Sikes, and the Animal Care and Use Committee of the American Society of Mammalogists. 2007. Guidelines of the American Society of Mammalogists for the use of wild mammals in research. *Journal of Mammalogy* 88:809-823.
- Gardner, J. E., J.D. Garner, and J.E. Hofmann. 1989. A portable mist-netting system for capturing bats with emphasis on *Myotis sodalis* (Indiana bat). *Bat Research News* 30:1-8.
- Georgia Department of Natural Resources (GADNR). 2023. Unpublished data. Referenced in email exchange with E Ferrall and M Hunt, dated 18 March 2024.
- Hayes, J.P. 2000. Assumption and practical considerations in the design and interpretation of echolocation-monitoring studies. *Acta Chiropterologica* 2:225-236.
- Humphrey, P.S., D. Bridge, and T.E. Lovejoy. 1968. A technique for mist-netting in the forest canopy. *Bird-Banding* 39(1): 43-50.
- Indiana Department of Transportation (INDOT). 2021. INDOT Protected Species Guidance. Environmental Policy Office, Environmental Services Division, INDOT. Indianapolis, IN. 37 pp.
- Keeley, B. W. and M. D. Tuttle. 1999. Bats in American Bridges. Bat Conservation International, Inc. Austin, TX. Resource Publication No. 4. 41 pp.
- Kiser, J.D. and J.R. MacGregor. 2005. Indiana bat (*Myotis sodalis*) mist net surveys for coal mining activities. Pp. 169-172 in K.C. Vories and A. Harrington (eds.), *The Proceedings of the Indiana bat and coal mining: a technical interactive forum* Office of Surface Mining, U.S. Department of the Interior, Alton, IL.
- Kuenzi, A.J., and M.L. Morrison. 1998. Detection of bats by mist-nets and ultrasonic sensors. *Wildlife Society Bulletin* 26(2):307-311.
- Kunberger, J.M. and A.M. Long. 2023. A comparison of bat calls recorded by two acoustic monitors. *Journal of Fish and Wildlife Management* 14(1):171-178.
- Kunz, T.H. and A. Kurta. 1988. Capture methods and holding devices. Pp. 1-29 in T.H. Kunz (ed.), *Ecological and behavioral methods for the study of bats*. Smithsonian Institution Press, Washington, D.C.
- Kunz, T.H., and C.E. Brock. 1975. A comparison of mist nets and ultrasonic detectors for monitoring flight activity of bats. *Journal of Mammalogy* 56:907-911.
- Kunz, T.H., R. Hodgkison, and C.D. Weise. 2009. Methods of capturing and handling bats. Pp. 3-35 in T.H. Kunz and S. Parsons (eds.), *Ecological and behavioral methods for the study of bats*, second edition. The Johns Hopkins University Press, Baltimore, Maryland.

- Loeb, S.C., T.J. Rodhouse, L.E. Ellison, C.L. Lausen, J.D. Reichard, K.M. Irvine, T.E. Ingersoll, J.T.H. Coleman, W.E. Thogmartin, J.R. Sauer, C.M. Francis, M.L. Bayless, T.R. Stanley, and D.H. Johnson. 2015. A plan for the North American Bat Monitoring Program (NABat). General Technical Report SRS-208. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 112 p.
- MacCarthy, K.A., T.C. Carter, B.J. Steffen, and G.A. Feldhamer. 2006. Efficacy of the mist-net protocol for Indiana bats: A video analysis. *Northeastern Naturalist* 13:25-28.
- MacKenzie, D.I., and J.A. Royle. 2005. Designing occupancy studies: general advice and allocating survey effort. *Journal of Applied Ecology* 42:1105-1114.
- Murray, K.L., E.R. Britzke, B. Hadley, and L.W. Robbins. 1999. Surveying bat communities: a comparison between mist nets and the Anabat II bat detector system. *Acta Chiropterologica* 1(1):105-111.
- Niver, R.A., R.A. King, M.P. Armstrong, and W.M. Ford. 2014. Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper. Accessed 13 January 2014 and available on the USFWS website provided in the introduction.
- Niver, R.A., R.A. King, M.P. Armstrong, and W.M. Ford. 2018. Addendum 1 - Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper. Accessed 2 February 2022 and available on the USFWS website provided in the introduction.
- O'Farrell, M.J., and W.L. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. *Journal of Mammalogy* 80(1):24-30.
- Reichard, J.D., and T.H. Kunz. 2009. White-nose syndrome inflicts lasting injuries to the wings of little brown myotis (*Myotis lucifugus*). *Acta Chiropterologica* 11: 457-464.
- Robbins, L.W., K.L. Murray, and P.M. McKenzie. 2008. Evaluating the effectiveness of the standard mist-netting protocol for the endangered Indiana bat (*Myotis sodalis*). *Northeastern Naturalist* 15:275-282.
- Romeling, S., C.R. Allen, and L. Robbins. 2012. Acoustically detecting Indiana bats: how long does it take? *Bat Research News* 53(4):51-58.
- Starbuck, C.A., L.M. SeSchepper, M.L. Hoggatt, and J.M. O'Keefe. 2023. Bioacoustics, DOI: <https://www.tandfonline.com/doi/full/10.1080/09524622.2023.2290715>
- U.S. Fish and Wildlife Service (USFWS). 2007. Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 91 pp.
- U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Northern Long-Eared Bat With 4(d) Rule; Final Rule and Interim Rule. *Federal Register* 80(63): 17974–18033.
- U.S. Fish and Wildlife Service (USFWS). 2018. Programmatic Biological Opinion for Transportation Projects in the Range of the Indiana Bat and Northern Long-Eared Bat. Midwest Regional Office, Bloomington, Minnesota. February.
- U.S. Fish and Wildlife Service (USFWS). 2019. New Jersey Guidance on Surveying Transportation Structures for Bat Occupancy. September 2019. 3 pp.
- U.S. Fish and Wildlife Service (USFWS). 2022. WHITE PAPER: Recommended Minimum Culvert Dimensions for Bat Roost Surveys in Western North Carolina. USFWS, Asheville Field Office, Asheville, NC. 11 pp.
- Walker, F. and D. Sanchez. 2021. Standard Operating Procedure – Fecal Collection for Genetics. Northern Arizona University, College of Engineering, Forestry, and Natural Resources.
- Weller, T.J., and C.J. Zabel. 2002. Variation in bat detections due to detector orientation in a forest. *Wildlife Society Bulletin* 30:922-930.
- Winhold, L. and A. Kurta. 2008. Netting surveys for bats in the Northeast: differences associated with habitat, duration of netting, and use of consecutive nights. *Northeastern Naturalist* 15:263-274.
- Yates, M.D. and R.M. Muzika. 2006. Effect of forest structure and fragmentation on site occupancy of bat species in Missouri Ozark forests. *Journal of Wildlife Management* 70(5):1238-1248

## APPENDIX A. BAT ACTIVITY PERIODS

State	Hibernation	Winter Torpor <sup>1</sup>	Spring Staging <sup>2</sup>	Summer Occupancy	Pup Season	Fall Swarming <sup>3</sup>
	Timeframe when most bats are hibernating (i.e., inactive <sup>4</sup> season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor <sup>5</sup>	Timeframe when most bats are emerging from hibernation, roosting near hibernacula, and preparing for migration to summer home range	Timeframe when bats are present on their summer home range and/or roosting in colonies <sup>6</sup>	Timeframe during late pregnancy and when most young are born until they can fly and forage independently	Period of increased activity near hibernacula (including foraging, roosting in trees, and mating) prior to hibernation
Alabama: Hibernating Range	Nov 16 – Mar 14	N/A	Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
Alabama: Year-round Active Range (Zone 1) <sup>7</sup>	N/A	Dec 15 – Feb 15	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Alabama: Year-round Active Range (Zone 2)	N/A	N/A	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Arkansas	Nov 16 – Mar 14	N/A	Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Colorado	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Connecticut	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Delaware	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15

<sup>1</sup> Only applies in Zone 1 of the year-round active range (see [Figure 1](#)).

<sup>2</sup> We currently have no information to inform spring staging timeframe near winter roosts within the year-round active portion of the NLEB or TCB range; consequently, the Service will consider new information in the future that may inform spring staging timeframe.

<sup>3</sup> We currently have no information to inform fall swarming timeframe near winter roosts within the year-round active portion of the NLEB or TCB range; consequently, the Service will consider new information in the future that may inform fall swarming timeframe.

<sup>4</sup> The “active season” is the inverse of the hibernation period. If no hibernation period is listed, bats in this area are active year-round.

<sup>5</sup> State of lowered body temperature and metabolic activity.

<sup>6</sup> IBAT (range-wide) and NLEB (hibernating range) often remain in colonies until the end of Summer Occupancy. TCB (range-wide) and NLEB (year-round active range) roost singly once juveniles can fly and forage independently (i.e., the end of the pup season).

<sup>7</sup> If your project falls within suitable summer IBAT habitat and IBATs are assumed or confirmed present, then default to using the more protective activity periods (AL: hibernating range).

State	Hibernation	Winter Torpor <sup>1</sup>	Spring Staging <sup>2</sup>	Summer Occupancy	Pup Season	Fall Swarming <sup>3</sup>
	Timeframe when most bats are hibernating (i.e., inactive <sup>4</sup> season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor <sup>5</sup>	Timeframe when most bats are emerging from hibernation, roosting near hibernacula, and preparing for migration to summer home range	Timeframe when bats are present on their summer home range and/or roosting in colonies <sup>6</sup>	Timeframe during late pregnancy and when most young are born until they can fly and forage independently	Period of increased activity near hibernacula (including foraging, roosting in trees, and mating) prior to hibernation
District of Columbia	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Florida	N/A	N/A	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Georgia: Hibernating Range	Nov 16 – Mar 14	N/A	Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
Georgia: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Mar 15 – July 15	My 1 – July 15	N/A
Georgia: Year-round Active Range (Zone 2)	N/A	N/A	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Illinois	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Indiana	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Iowa	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Kansas	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Kentucky	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Oct 15	May 15 – July 31	Aug 16 – Nov 15
Louisiana: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Louisiana: Year-round Active Range (Zone 2)	N/A	N/A	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Maine	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Maryland	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Massachusetts (Inland)	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31

State	Hibernation	Winter Torpor <sup>1</sup>	Spring Staging <sup>2</sup>	Summer Occupancy	Pup Season	Fall Swarming <sup>3</sup>
	Timeframe when most bats are hibernating (i.e., inactive <sup>4</sup> season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor <sup>5</sup>	Timeframe when most bats are emerging from hibernation, roosting near hibernacula, and preparing for migration to summer home range	Timeframe when bats are present on their summer home range and/or roosting in colonies <sup>6</sup>	Timeframe during late pregnancy and when most young are born until they can fly and forage independently	Period of increased activity near hibernacula (including foraging, roosting in trees, and mating) prior to hibernation
Massachusetts (Coastal) <sup>8</sup>	Dec 1 – Mar 14	<b>N/A</b>	Mar 15 – May 14	Mar 15 – Sept 30	June 1 – Aug 15	Aug 16 – Nov 30
Michigan (Outside Indiana Bat Range)	Nov 1 – Apr 14		Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Michigan (Within Indiana Bat Range)	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Minnesota	Nov 1 – Apr 14		Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Mississippi: Hibernating Range	Nov 16 – Mar 14		Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
Mississippi: Year-round Active Range (Zone 1)	<b>N/A</b>	Dec 15 – Feb 15	<b>N/A</b>	Mar 15 – July 15	May 1 – July 15	<b>N/A</b>
Mississippi: Year-round Active Range (Zone 2)	<b>N/A</b>	<b>N/A</b>		Mar 15 – July 15	May 1 – July 15	<b>N/A</b>
Missouri	Nov 16 – Mar 31	<b>N/A</b>	Apr 1 – May 14	Apr 1 – Oct 15	May 15 – July 31	Aug 16 – Nov 15
Montana	Nov 1 – Apr 14		Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Nebraska	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
New Hampshire	Nov 1 – Apr 14		Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
New Jersey	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
New Mexico: Hibernating Range	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
New Mexico: Year-round Active Range (Zone 1)	<b>N/A</b>	Dec 15 – Feb 15	<b>N/A</b>	Apr 1 – July 15	May 1 – July 15	<b>N/A</b>

<sup>8</sup> Coastal Massachusetts includes Martha’s Vineyard, Nantucket, and Cape Cod.



State	Hibernation	Winter Torpor <sup>1</sup>	Spring Staging <sup>2</sup>	Summer Occupancy	Pup Season	Fall Swarming <sup>3</sup>
	Timeframe when most bats are hibernating (i.e., inactive <sup>4</sup> season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor <sup>5</sup>	Timeframe when most bats are emerging from hibernation, roosting near hibernacula, and preparing for migration to summer home range	Timeframe when bats are present on their summer home range and/or roosting in colonies <sup>6</sup>	Timeframe during late pregnancy and when most young are born until they can fly and forage independently	Period of increased activity near hibernacula (including foraging, roosting in trees, and mating) prior to hibernation
New Mexico: Year-round Active Range (Zone 2)	N/A	N/A	N/A	Apr 1 – July 15	May 1 – July 15	N/A
New York (Inland)	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
New York (Long Island)	Dec 1 – Feb 28		Mar 1 – May 14	Mar 1 – Sept 30	June 1 – Aug 15	Aug 16 – Nov 30
North Carolina: Hibernating Range	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
North Carolina: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Apr 1 – July 15	May 1 – July 15	N/A
North Dakota	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Ohio	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Oklahoma	Nov 16 – Mar 14		Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Pennsylvania	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Rhode Island	Nov 1 – Apr 14		Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
South Carolina: Hibernating Range	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
South Carolina: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Apr 1 – July 15	May 1 – July 15	N/A
South Dakota (Plains)	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
South Dakota (Black Hills)	Oct 1 – April 30		May 1 – June 1	May 1 – Aug 31	June 15 – Aug 31	Aug 16 – Sept 30
Tennessee	Nov 16 – Mar 31		Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Texas: Hibernating Range	Nov 16 – Mar 14		Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Sept 1 – Nov 15

State	Hibernation	Winter Torpor <sup>1</sup>	Spring Staging <sup>2</sup>	Summer Occupancy	Pup Season	Fall Swarming <sup>3</sup>
	Timeframe when most bats are hibernating (i.e., inactive <sup>4</sup> season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor <sup>5</sup>	Timeframe when most bats are emerging from hibernation, roosting near hibernacula, and preparing for migration to summer home range	Timeframe when bats are present on their summer home range and/or roosting in colonies <sup>6</sup>	Timeframe during late pregnancy and when most young are born until they can fly and forage independently	Period of increased activity near hibernacula (including foraging, roosting in trees, and mating) prior to hibernation
Texas: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Texas: Year-round Active Range (Zone 2)	N/A	N/A	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Vermont	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Virginia: Hibernating Range	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Virginia: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Apr 1 – July 15	May 1 – July 15	N/A
West Virginia	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Wisconsin	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Wyoming (Plains)	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Wyoming (Black Hills)	Oct 1 – April 30	N/A	May 1 – June 1	May 1 – Aug 31	June 15 – Aug 31	Aug 16 – Sept 30

## APPENDIX B. GLOSSARY

- **Above ground level (AGL)** – height at which an acoustic detector microphone is elevated above the top of ground-level vegetation present at the detector deployment location.
- **Action Area** – may refer to all areas to be affected directly or indirectly by a project or action and not merely the immediate area involved in the action. May also be referred to as the project area.
- **Acoustic bat survey** – bat sampling conducted through recording and analyzing echolocation calls.
- **Acoustic location** – actual site where an acoustic detector and microphone is deployed; multiple acoustic locations may be used for a full acoustic bat survey.
- **Approved software program** – bat acoustic program (see also *automated bat call ID software*) approved through the USFWS software testing procedures for stand-alone use in presence/probable absence surveys for Indiana bat and/or northern long-eared bat.
- **Automated bat call ID software** – a form of echolocation identification in which recorded files are filtered and identified within a software program; the program compares the statistical properties of a recorded call to a library of known calls to classify to species.
- **Bat detector** – equipment capable of detecting ultrasonic echolocation calls of bats that are above the range of human hearing.
- **Bridge** – FHWA defines a bridge as a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads. A bridge typically uses structural components and elements in the deck, superstructure and substructure (abutments and piers) to support dead and live loads. Bridges typically have an opening of more than 20 feet (measured along the centerline of the roadway) between under copings of abutments, spring lines of arches, or extreme ends of openings for multiple boxes.
- **Call quality** – how closely the sequence matches typical search-phase behavior for the species.
- **Call sequence** – a series of bat echolocation call pulses.
- **Candidate software program** – bat acoustic program (see also *automated bat call ID software*) submitted to USFWS for software testing but not yet approved for stand-alone use in presence/probable absence surveys for Indiana bat and/or northern long-eared bat.
- **Clutter** – obstacles present in an area that can affect recording of bat echolocation calls; may be caused by either scattering echolocation calls from sound bouncing off obstacles (thereby reducing call quality) or by bats adjusting their normal search phase calls in response to additional obstacles resulting in changed bat echolocation call parameters.
- **Culvert** – The Federal Highway Administration (FHWA) defines a culvert as a structure comprised of one or more barrels or cells, beneath an embankment and designed structurally to account for soil-structure interaction. These structures are hydraulically and structurally designed to convey water, sediment, debris, and, in many cases, aquatic and terrestrial organisms through roadway embankments. Culvert barrels have many sizes and shapes and have inverts that are either integral or open, i.e., supported by spread or pile-supported footings. A culvert typically has soil materials (i.e., backfill) between the travel way (e.g., road or rail or trail) and actual culvert structure (i.e., barrels, cells). To support dead loads and live loads (e.g., cars, trucks, trains, pedestrians, etc.), the culvert consists of those barrels or cells (typically concrete, metal, or plastic material), backfill, and soil bedding underneath the culvert.
- **Detection probability** – the likelihood of detecting the presence of a species when that species is present.
- **Detector sensitivity** – measures the ability of a bat detector to detect an echolocation call.
- **Detector** – see *bat detector*.
- **Directional microphone** – a microphone that is more sensitive to sound arriving from certain directions; compared to omni-directional, may detect sounds from a further distance away, but within a narrower cone of detection.
- **Echolocation** – use of ultrasound and the returning echoes to orient and navigate in the environment.
- **Emergence survey** – a survey method that involves visually counting bats that emerge from a known or suspected roost; usually conducted in early evening (e.g., 30 minutes before sunset) when bats exit to forage.
- **False negative** – the failure to detect a bat species when it is present in the area; statistically a type II error in hypothesis testing.
- **Forest canopy openings** – gaps in the continuous forest cover formed by tree crowns, where sunlight reaches the forest floor.
- **Forest corridor** – Three-dimensional corridors that bats use to travel within forests (also known as flyways).

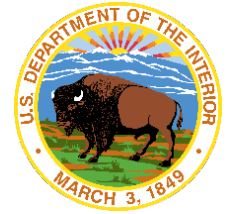
- **Forest interior** – forest areas surrounded by forest edge, typically 50-300 feet inside from an outer edge.
- **Forest strip** – narrow area with trees. Examples include visual buffers or forest fragments dominated by edge effects.
- **Forest/woodland edge** – transition area between forest and open spaces. Edges create edge effects by impacting the species communities and growth of vegetation extending into the forest from the edge. Edge can occur whenever there is a 30-foot break in canopy cover.
- **Forest/woodland gap** – area between intact forest areas that form small open areas. These areas are partially shaded by forest areas and natural regeneration will likely fill the gap.
- **Frequency filter** – pre-programmed range of sound frequencies (in kHz) set for acoustic bat detectors to record.
- **Full-spectrum detector** – bat detectors in which all desirable information about the recorded sound is preserved, including time, frequency, and amplitude.
- **Harp-trapping** – capture method by which a device (harp-trap) composed of a metal frame, multiple strands of equally-spaced nylon strings, and a catch bag at the bottom, is deployed near the entrances of caves, cave-like openings, and mines. Bats are captured as they exit a restricted opening to forage.
- **Hemispherical microphone** – see *omni-directional microphone*.
- **Hibernaculum (pl. “hibernacula”)** – a thermally-stable roost used by bats for extended periods of torpor during winter. Typically, a cave, natural cave-like feature (e.g., sinkhole, fissure, talus opening, etc.), or anthropogenic structure (e.g., mine, tunnel, bridge, etc.).
- **High-frequency calls** – a general classification of calls that refers to those with minimum frequencies >35 - 40 kilohertz.
- **Kilohertz (kHz)** – a unit of measure of the frequency of sound; one thousand hertz.
- **Level-of-effort (LOE)** – Minimum number of survey nights required (using a particular survey methodology) to determine probable absence of a target bat species; statistically set at a particular confidence level (e.g., 90%, 95%, etc. – depending upon species and region) by USFWS.
- **Linear project** – a project with a footprint greater in length than width (e.g., pipeline, roadway, or right-of-way) with  $\geq 1$  km (0.6 mi) of suitable habitat; may contain contiguous and fragmented patches of suitable habitat, but only segments at least  $\geq 1$  km in length can be considered for presence/probable absence survey sites.
- **Manual-vetting** – Also referred to as visual vetting. See *qualitative call identification*.
- **Maximum-Likelihood Estimate (MLE)** – a statistical method of estimating the parameters of a statistical model. For our purposes, the MLE is a statistical method that can be used to determine species presence or probable absence at a particular site on a particular night by means of a classification matrix.
- **Microphone sensitivity** – the minimal amplitude required at a given frequency for a microphone to detect a sound.
- **Microphone orientation** – the direction in which the microphone is pointing’ thereby affecting the cone of detection.
- **Mist-netting** – survey technique that uses low-visibility, mesh nets affixed between two poles to capture foraging bats in areas of increased activity (e.g., travel corridors, ponds, etc.)
- **Net set** – one mist-net deployment consisting of two poles and typically from 1-3 affixed mist-nets stacked onto one another. A typical net set is at least 5 m to 9 m high consisting of two or more nets stacked on top of one another (without gaps) and from 6 m to 18 m wide.
- **Net site** – see *site*.
- **Noise** – unwanted or extraneous environmental sound or electronic interference detected by a bat detector.
- **Non-linear project** – any project generally not linear in nature or linear and  $< 1$  km in length; may contain contiguous and fragmented patches of suitable habitat, but only blocks  $\leq 123$  acres can be considered for presence/probable absence survey sites.
- **North American Bat Monitoring Program (NABat)** – A multi-national, multi-agency coordinated bat monitoring program across North America that was created to monitor bats at local to range-wide scales. It incorporates winter hibernaculum counts, maternity colony counts, mobile acoustic surveys, and stationary acoustic surveys (<https://www.nabatmonitoring.org>).
- **Omni-directional microphone** – a microphone that can detect equally in all directions (e.g., has a spherical cone of detection). Hemispherical microphones are a type of omni-directional microphone.
- **Out-tier project guidance** – a USFWS discretionary survey guidance scenario that can be applied when an Indiana and/or northern long-eared bat has been captured or acoustically-detected, but no known roosting

areas have been identified. Under “out-tier” guidance, 2.5 and 5-mile or 1.5 and 3.0- mile buffers are placed around the Indiana bat or northern long-eared bat capture or detection location. Surveyors are allowed to perform a standard P/A survey to help refine a maternity colony’s true location and/or document roost trees if the project area is more than 2.5 or 1.5 (for NLEB) miles away from the Indiana bat capture/detection site, but within the 5- or 3-mile (for NLEB) buffer.

- **Pass** – a single crossing of a bat through a bat detector’s cone of detection; see *call sequence*.
- **Probable absence** – using the appropriate Level of Effort (LOE), a determination that survey protocols are not 100% likely to detect IBAT or NLEB when present and that identification errors may occur.
- **Pulse** – a brief, continuous emission of sound; see *call sequence*.
- **Qualified biologist** – For activities involving the handling of bats, an individual who holds a USFWS Section 10(a)(1)(A) Recovery Permit (Federal Fish and Wildlife Permit) for federally-listed bats in the state/region in which they are surveying. For qualitative analysis of acoustics, an individual that has completed one or more available bat acoustics trainings/workshops and/or able to show similar on-the-job or academic experience; furthermore, have demonstrated multiple years of experience in 1) gathering known calls of the target species, 2) have identified bat calls recorded in numerous habitat types, 3) are familiar with species likely to be encountered within the project area, and 4) must have stayed current with qualitative identification of bat calls.
- **Qualitative call identification (Visual vetting)** – identification of call sequences through visual comparison with a known call library. Qualitative analysis must also include and present within a written report a comparison of the results of each acoustic ID program by site and night. Qualitative analysis of each acoustic site and night with probable detections of IBAT and/or NLEB should include the entire night’s high frequency call data, including “no ID” files, and not just those files making it through the acoustic analysis tools as probable IBAT and/or NLEB; accuracy can be highly variable based on researcher experience; also referred to by some as visual vetting (see *qualified biologist*).
- **Roost tree** – A live or dead standing tree (snag) occupied by one or more bats. Throughout most of the IBAT and NLEB range, trees are typically occupied by bats outside of the hibernation period (spring, summer, fall),
- **Roost** – see *roost tree*.
- **Site** – an area containing one or more individual net sets or harp traps in relatively close proximity that can be efficiently walked to and checked by a survey team (typically two people) within a 10- minute window from a central bat-processing location.
- **Site-night** – The standard unit of time for operating an acoustic detector at one site for one calendar night during an acoustic P/A survey. The MLE should be assessed for a target species on a site-night basis.
- **Ultrasonic/ultrasound** – sounds made of frequencies that are beyond the range of human hearing (often arbitrarily set at 20 kilohertz, although most adults have trouble hearing sounds above 15 kHz.)
- **Weather proofing** – various methods/materials used to protect a bat detector/microphone from the elements (primarily rain).
- **Winter habitat** – see *hibernaculum*.
- **Zero-crossing detector** – a detector type that calculates frequencies by measuring the time between moments of zero sound pressure, which corresponds to the period of the wave.

- 1. Study Plan Form for Bat Surveys and Monitoring**
- 2. Bat Summer / Year-Round Habitat Assessment Form**
- 3. Potentially Suitable Hibernacula Assessment Form**
- 4. Fall/Spring Survey of Potential Bat Hibernaculum Datasheet**
- 5. Bridge and Culvert Bat Assessment Form**
- 6. Bat Mist-Netting Datasheet**
- 7. Bat Roost Datasheet**
- 8. Bat Emergence Survey Datasheet**

Data submission to the NA Bat Database is encouraged. Bulk Upload templates for NA Bat are located [here](#).



## A Note on Bat Survey and Monitoring Activities Requiring Site-Specific Authorization

All survey, monitoring, and/or other similar research activities for federally listed bats that may result in take (as defined in the Endangered Species Act (ESA) as listed below) are regulated under the U.S. Fish and Wildlife Service's 10(a)(1)(A) Recovery Permit program. The Section 10(a)(1)(A) Recovery Permit (Permit) authorizes certain activities for scientific purposes or to enhance the propagation or survival of listed species ([50 CFR §17.22](#)).

One of the conditions within the Permit states that permittees are required to coordinate with the appropriate USFWS Field Office and obtain written concurrence before conducting permitted activities. Compliance is typically achieved through the submission of a **Site-Specific Authorization (SSA)** request which provides the local Field Office with detailed information on proposed survey methods, timing, and locations.

The requirement for Field Office authorization ensures that:

1. Proposed activities are consistent with the conditions of the Permit.
2. USFWS biologists can determine whether the activity may result in take, if alternative actions can be used to avoid or minimize take, and whether additional conservation measures are warranted.
3. Potential impacts to listed bat species are reviewed in the context of range-wide and local population status, seasonality, magnitude, and permanence of activity.

The following bat survey, monitoring, and/or research activities that may result in take must be completed by [a qualified biologist](#) holding a valid Federal Recovery Permit and require a SSA:

- Handling/capturing bats with mist nets or harp traps, or other methods
- Entering hibernacula, maternity caves, or other roosts known to be occupied by bats
- Emergence surveys from trees or other roosts that may disturb bat activity
- Collecting biological samples (e.g. hair, blood, DNA)
- Temporary or permanent marking of bats (e.g. banding, pit tagging, radio-tagging)

Activities that are not likely to result in take of bats (e.g., acoustic surveys) do not require an SSA. However, regardless of whether authorization is required, project proponents are encouraged to use the fillable [Site Study Plan Form for Bat Survey and Monitoring](#) when coordinating with Field Offices and following the recommendations in the Bat Survey Guidelines. The form streamlines survey reviews by ensuring all necessary information is provided and gives Field Offices an opportunity to provide feedback on proposed surveys. Additionally, the SSA Service-approval page (p. 6) of the fillable form facilitates the required authorization (when necessary) of your request as part of the USFWS Field Office Study Plan review.

If you are uncertain if an SSA is required for a proposed project or survey, review the conditions specified in your Permit, or contact your local Field Office or Regional Recovery Permit Coordinator.





## Study Plan Form for Bat Surveys and Monitoring (v. 2.6)

### PROJECT & SURVEY INFORMATION

Project Name: \_\_\_\_\_ Proposed Survey Start Date: \_\_\_\_\_

Project Proponent's Name (e.g., client/company/institution): \_\_\_\_\_

Project Location: State(s): \_\_\_\_\_ County(s): \_\_\_\_\_

Latitude: \_\_\_\_\_ Longitude: \_\_\_\_\_

REQUIRED: Attach shapefiles and/or Google Earth® KMZ files  
(mapping must show project boundaries, impacted forest habitat (if known) and all proposed survey sites)

Files are attached: Yes ☐ No ☐

File link/URL (if applicable): \_\_\_\_\_

Project Summary. In the space provided below, please provide a description of the proposed action, including any activities that will permanently or temporarily alter the current environment and existing habitat features.

### CONTACT INFORMATION

Project Manager/Primary Point of Contact (POC): \_\_\_\_\_ Phone: \_\_\_\_\_

Field Survey Crew Leader (if different from POC): \_\_\_\_\_ Cell Phone: \_\_\_\_\_

Institution/Company Name: \_\_\_\_\_

Mailing Address: \_\_\_\_\_ Resumes included for all personnel: Yes ☐

POC Email Address: \_\_\_\_\_

USFWS Sec. 10(a)(1)(A) Permit No.(s) (if applicable): \_\_\_\_\_

State Permit No.(s) (if applicable): \_\_\_\_\_

Have project proponents been informed that abiding by protective time-of-year restrictions (where available) may be sufficient to avoid take of federally listed bats and (in some cases) may negate the need for a bat survey? Yes ☐ No ☐

Have project proponents been informed that the Service does not require presence/probable absence surveys for federally listed species and that presence can be assumed in a project area containing suitable habitat? Yes ☐ No ☐

Will this survey be conducted on private or public lands? (Check both if applicable): Private ☐ Public ☐

Has permission of all necessary landowners/managing agencies been obtained? Yes ☐ No ☐

If no, explain: \_\_\_\_\_

Does this project have a federal nexus<sup>1</sup>? Yes ☐ No ☐ Unsure ☐

If yes, explain: \_\_\_\_\_

IPaC<sup>2</sup> Consultation Code (if applicable): \_\_\_\_\_

Purpose of Survey: Official P/A Survey ☐ Research ☐ Monitoring ☐  
Educational Outreach/Training ☐ Other: \_\_\_\_\_

Survey Target Species: Indiana bat (IBAT) ☐ Northern long-eared bat (NLEB) ☐  
Tricolored bat (TCB) ☐ Other: \_\_\_\_\_

Has a Habitat Assessment\* of the project area been conducted? Yes ☐ No ☐  
If yes, how was the habitat assessment conducted? Field ☐ Desktop ☐ Combo ☐  
(\*if available, attach a written report)

Is suitable habitat<sup>3</sup> present (or assumed present) for all “target” species? Yes ☐ No ☐

If no, explain: \_\_\_\_\_

Does this project fall within the outer tier<sup>4</sup> of any “target” species known home range? Yes ☐ No ☐ Unsure ☐

If yes, which species: \_\_\_\_\_

#### Project Configuration

Is this project **linear** (≥1 km in total length)? Yes ☐ No ☐ Combo ☐ Unsure ☐

If yes, how many 1-km sections containing suitable IBAT/NLEB habitat will be impacted? \_\_\_\_\_

#### **PROPOSED METHODS & SURVEY LEVEL OF EFFORT**

Is this project **non-linear**? Yes ☐ No ☐ Combo ☐ Unsure ☐

If yes, how many acres of suitable IBAT/NLEB habitat is in the overall project area? \_\_\_\_\_

If yes, how many acres of suitable IBAT/NLEB habitat will be directly impacted/cleared? \_\_\_\_\_

Identify which method (acoustics, mist-netting, combination) proposed to be used: \_\_\_\_\_

Has availability of high-quality sites for target species been assessed via ground-truthing to meet the required LOE?

Yes ☐ No ☐ (If No, justify method selection):

<sup>1</sup> A project or action that is authorized, funded, and/or permitted by a federal agency.

<sup>2</sup> <https://ipac.ecosphere.fws.gov/>

<sup>3</sup> See the Bat Survey Guidelines regarding suitable habitat definitions.

<sup>4</sup> See the Bat Survey Guidelines regarding what constitutes “out-tier” of a known bat colony's range.

## ACOUSTICS

Total number of detector sites proposed to be surveyed: \_\_\_\_\_ Total number of detector nights for entire survey: \_\_\_\_  
Number of detector nights/site: \_\_\_\_\_

Total proposed number of calendar nights to complete the entire survey: \_\_\_\_\_

Detector(s) (Brand, Model): \_\_\_\_\_ Microphone(s): directional ☐ omnidirectional ☐

Recording Format: Full Spectrum ☐ Zero-Crossings ☐

FWS-Approved<sup>5</sup> Acoustic Bat ID Software: **KaPro**: vers. \_\_\_\_ Classifier, NA vers. \_\_\_\_ **BCID** vers. \_\_\_\_  
**SonoBat**: vers. \_\_\_\_ Classifier \_\_\_\_ Other: \_\_\_\_\_

### Species to be included for automatic software ID classification analysis:

EPFU ☐ CORA ☐ COTO ☐ LABO ☐ LACI ☐ LANO ☐ LASE ☐ TABR ☐ MYCI ☐ MYEV ☐ MYGR ☐ MYLU ☐  
MYLE ☐ MYSE ☐ MYSO ☐ MYTH ☐ MYVO ☐ NYHU ☐ PESU ☐ Others: \_\_\_\_\_

Will qualitative analysis (i.e., visual vetting) be used? Yes ☐ No ☐ Unsure ☐

Name(s) of qualified biologist(s) conducting qualitative/visual identifications (attach resume or link with qualifications):  
\_\_\_\_\_

## MIST-NETTING

Total number of net sites to be surveyed: \_\_\_\_\_ Total number of net nights/site: \_\_\_\_\_

Total number of net nights for entire survey (No. of sites X No. of net nights/site): \_\_\_\_\_

Total proposed number of calendar nights to complete the entire survey: \_\_\_\_\_

- A) Maximum number of net set-ups that will be operated/checked (10-min interval) on a given calendar night at a given survey site: \_\_\_\_\_  
B) Minimum Number of personnel present to operate/check X (see A) net set-ups on a given site: \_\_\_\_\_  
C) Proposed Staffing Rate (A divided by B): \_\_\_\_\_

### Staffing Rate

Number of Section 10-permitted biologists per net site (or state-permitted in USFWS R5): \_\_\_\_\_

Do you propose to band bats? Yes ☐ No ☐

If yes, please answer the following:

What species will be banded? COTO ☐ MYGR ☐ MYLU ☐ MYSE ☐ MYSO ☐ PESU ☐  
Others: \_\_\_\_\_

If banding *Myotis* sp. or PESU, specify band size: \_\_\_\_\_

Describe your proposed bands (color and letter-numbers) and banding scheme: \_\_\_\_\_

Will banding pliers be used? Yes ☐ No ☐

Will any biological samples be collected from captured bats (e.g., guano, hair, swab, wing punch)? Yes ☐ No ☐

If yes, explain: \_\_\_\_\_

Name of institution or facility to conduct DNA analysis: \_\_\_\_\_

<sup>5</sup> <https://www.fws.gov/media/automated-acoustic-bat-id-software-programs>

## **RADIO-TRACKING**

Will any bats be radio-tagged and tracked? Yes ☐ No ☐

If yes, please answer following:

Which species will be radio-tagged? \_\_\_\_\_

Name of USFWS Section 10 permitted biologist(s) who will apply transmitter(s): \_\_\_\_\_

Make/model and approximate weight of transmitter(s) to be used: \_\_\_\_\_

Manufacturer date and estimated lifespan of transmitters to be used: \_\_\_\_\_

Frequency range (MHz) of transmitters (e.g., 150.xxx or 172.xxx): \_\_\_\_\_

If radio-tracking multiple targeted bats/species, what criteria\* will be used in selecting individuals?

Will all radio-tagged bats be tracked (min. of 4-hrs. search effort/day) to their diurnal roosts for the minimum recommended period of 7 days? Yes ☐ No ☐

If no, explain:

Will night-time foraging data/telemetry be collected? Yes ☐ No ☐

Glue used for attaching transmitters: Type: \_\_\_\_\_ Name: \_\_\_\_\_

(\*for additional space, use p.5)

Manufacturer:

3M

Other: \_\_\_\_\_

## **EMERGENCE SURVEYS**

After diurnal roost sites of radio-tagged bats are identified, will emergence surveys be conducted at each identified roost (assuming landowner permission is obtained)? Yes ☐ No ☐

If yes, how many emergence surveys/roost? \_\_\_\_\_

Have you identified a small number (e.g.,  $\leq 10$ ) of potentially suitable roost trees\* that you propose to conduct emergence surveys for? Yes ☐ No ☐

(\*If yes, provide photographs of each tree documenting that all of the tree can be observed by the surveyor along with coordinates (lat/long and/or KML/shapefile) of all trees to be surveyed.)

## **POTENTIAL HIBERNACULA SURVEYS**

Are any known hibernacula used by the target species located within or adjacent to the project area?

Yes ☐ No ☐ Unknown ☐

If yes or unknown, list sites or explain: \_\_\_\_\_

Has your desktop analysis identified any natural or man-made features that could be used as a hibernaculum by any of the target bat species? Yes ☐ No ☐

If yes, underground features (e.g., caves, mines, tunnels, bunkers, cisterns) present: Yes ☐ No ☐

If yes, above-ground features\* (e.g., crawl spaces) present: Yes ☐ No ☐

If unknown, explain: \_\_\_\_\_

Are you requesting approval of a field survey for potential hibernacula at this time? Yes\* ☐ No ☐

(\*If yes, attach a separate narrative explaining how the project area(s) will be surveyed for potential hibernacula.)

Are you submitting the results of a Habitat Assessment of potentially suitable hibernacula identified from field surveys? Yes\* ☐ No ☐

(\*If yes, provide a Habitat Assessment Data Sheet for each potential hibernaculum/portal(s)<sup>6</sup> identified to be surveyed.)

<sup>6</sup> If there are multiple cave entrances/portals, please list all locations.

## BRIDGE & CULVERT ASSESSMENTS

Do any bridges or culverts exist within the project area that have the potential to be used by the target species?

Yes ☐ No ☐

If 'yes', complete the following fields:

Structure type(s) (check all that apply): Bridge ☐ Culvert ☐ Other ☐

If "other", explain: \_\_\_\_\_

Survey methodology for structure(s) (check all that apply):

Visual inspection ☐ Guano collection ☐ Emergence survey ☐ Acoustics\* ☐  
Mist-net\* ☐ Harp-trap\* ☐ Other \_\_\_\_\_

(\*Due to site-specific conditions of structures, coordination with the local USFWS Field Office and appropriate state agency(ies) is necessary before proceeding with these survey methodologies)

Will guano be collected and analyzed to confirm species ID? Yes ☐ No ☐

If "yes", name of institution/entity performing analysis: \_\_\_\_\_

Acknowledgment that USFWS bats & transportation structures virtual training materials<sup>10</sup> have been viewed: Yes ☐

### ADDITIONAL SURVEY INFORMATION

Will the proposed bat survey deviate from the current version of the USFWS Survey Guidelines?<sup>7</sup> Yes ☐ No ☐

If 'yes', provide justification for any departures or modifications to the guidelines, as well as any additional pertinent information, below:

I hereby acknowledge that the information being provided to the Service is accurate and complete as of today's date.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

<sup>7</sup> Proposed surveys deviating from the current Range-wide Bat Survey Guidelines will only be accepted with a thoroughly described justification; coordinate with your local USFWS Field Office (<https://www.fws.gov/our-facilities>) for acceptable modifications.



United States Department of the Interior  
Fish and Wildlife Service  
Ecological Services Program



**SITE-SPECIFIC AUTHORIZATION FOR ESA SECTION 10(a)(1)(A) ACTIVITIES**

Our Field Office has reviewed your study plan and found it to contain sufficient information. When signed, this statement serves as your site-specific authorization to conduct the proposed activities authorized by your section 10(a)(1)(A) federal permit (permit) at the specified locations included in the attached Study Plan Form and must be carried with your permit when conducting work for this project. All activities must be carried out with strict adherence to conditions and authorizations specified in your permit as well as your state permit(s) (if needed). The permit issued by our agency authorizing the activities (if applicable) must always remain with the surveyor. For proposed activities on private lands, this authorization is not valid without explicit private landowner permission.

In addition to the final survey report, surveyors must maintain supporting data and files and use the appropriate U.S. Fish and Wildlife Service (USFWS) bat survey data spreadsheet, available on the Range-wide Bat Survey Guidelines website, for reporting Section 10(a)(1)(A) permit-authorized results. If the work expands beyond the scope of your original study plan or if there are adverse effects to bats that were not anticipated, cease all survey and/or research activities, and contact this office prior to continuing. Additionally, if a federally listed bat is captured or detected, this USFWS Field Office must be notified within 48 hours.

Approving Official: \_\_\_\_\_ Field Office: \_\_\_\_\_

Email: \_\_\_\_\_ Phone: \_\_\_\_\_

**Authorized as Proposed:** ☐

**Authorized with Conditions:** ☐

Phone: \_\_\_\_\_

**Not Authorized** ☐ (see comments)

**Not authorized** ☐ (see comments)

**Additional Comments**

Signature: \_\_\_\_\_

Date: \_\_\_\_\_





## Bat Summer / Year-Round Habitat Assessment

### PROJECT & SURVEY INFORMATION

Project Name: \_\_\_\_\_ IPaC Consultation Code (if applicable): \_\_\_\_\_

Project Proponent's Name (e.g., client/company/institution): \_\_\_\_\_

Project Location: State(s): \_\_\_\_\_ County(s): \_\_\_\_\_

Latitude: \_\_\_\_\_ Longitude: \_\_\_\_\_

REQUIRED: Attach or provide links to Google Earth® KMZ files (preferred) and/or shapefiles (mapping must show project boundaries, impacted forest habitat (if known), and sampling sites if assessing discrete habitats at multiple sites in a project area)

Files are attached: Yes ☐ No ☐

File Links: \_\_\_\_\_

Is suitable habitat present (or assumed present) for any of the following bat species?

☐ Indiana Bat (MYSO) ☐ Northern Long-eared Bat (MYSE) ☐ Tricolored Bat (PESU)

### PROJECT AREA

Project	Total Acres	Forest Acres		Open Acres
Proposed Tree Removal (Acres)	Completely Cleared	Partially Cleared	Preserved Acres (No Clearing)	

### VEGETATION COVER TYPES

Pre-Project	Post-Project

### LANDSCAPE WITHIN 5-MILE RADIUS

Flight corridors to other forested areas?
Describe Adjacent Properties (e.g., forested, grassland, commercial or residential development, water sources)

**SAMPLE SITE DESCRIPTION(S)** (attach additional sheets if necessary. A single sheet can be used for multiple sites if same habitat)

Sample Site No.(s)

**WATER RESOURCES AT SAMPLE SITE**

Stream Type (# and length)	Ephemeral	Intermittent	Perennial
Pools/Ponds (# and size)		Open and accessible to bats?	
Wetlands (approx. acres)	Permanent	Seasonal	
Describe existing condition of water sources:			

**FOREST RESOURCES AT SAMPLE SITE**

Closure or Density	Canopy (>50')	Midstory (20-50')	Understory (<20')
% Trees w/ Exfoliating Bark			
Dominant Species of Mature Trees			
Size Composition of Live Trees %	Small (3-8 in DBH)	Med (9-15 in DBH)	Large (>15in DBH)
No. of suitable snags			
<i>Standing dead trees with exfoliating bark, cracks, crevices, or hollows. Snags without these characteristics are not considered suitable</i>			

**ADDITIONAL COMMENTS**

<b>Photographic Documentation:</b> Habitat shots at edge and interior from multiple locations, understory/midstory/canopy; examples of potential suitable snags and live trees, water sources et.



## Potentially Suitable Hibernacula Assessment Form

Project Name: \_\_\_\_\_ IPaC Consultation Code (if applicable): \_\_\_\_\_

Project Proponent's Name (e.g., client/company/institution): \_\_\_\_\_

Project Location: State(s): \_\_\_\_\_ County(s): \_\_\_\_\_

Latitude: \_\_\_\_\_ Longitude: \_\_\_\_\_

**REQUIRED:** Attach or provide links to Google Earth® KMZ files (preferred) and/or shapefiles (mapping must show project boundaries, and potential suitable hibernacula)

Files are attached: Yes ☐ No ☐

File Links: \_\_\_\_\_

Descriptors	Opening #1	Opening #2	Opening #3
Opening Type (e.g., cave, portal, shaft)			
Opening vertical or horizontal			
Opening Size: Height x Width (or Diameter)			
Internal Dimensions: Height x Width			
Slope (up or down from entrance)			
Entrance Stable?			
Direction of Airflow (In or out?)			
Amount of Airflow (e.g., none, slight, heavy)			
Internal air warmer or cooler than outside temp.?			
Evidence of collapse?			
Ceiling Condition			
Amount of water in opening			
Evidence of past flooding?			
Observed length of internal passage			
Distance to nearest water source			
% Canopy Cover at entrance			

Openings suspected or known to be connected: \_\_\_\_\_

Are there any observable side passages? \_\_\_\_\_

Additional Comments:

# U.S. Fish and Wildlife Service



## Fall / Spring Survey of Potential Hibernaculum

Site ID				Project Proponent (e.g., client/company institution)						Date			
State:				County:				Y (Lat/N)				X (Lon/E)	
UTM Zone:													
Surveyors (include Permit No.):													

#	Time	Species	Age	Sex	Repro Cond.*	RFA (mm)	Mass (g)	Flight Direction (In/out)	Notes	START TIME:	END TIME:
1											
2										Moon Phase:	%
3										Rise	Set
4										Moon:	
5										Sun:	
6										Time	Temp
7										Wind	
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											

\*Measure hourly









**Beauford Wind Code**

0	Calm (0 mph)
1	Light wind (1-3 mph)
2	Light Breeze (4-7 mph)
3	Gentle Breeze (8-12 mph)
4	Moderate Breeze (13-18 mph)

**\* Reproductive Condition**

(P)	Pregnant
(L)	Lactating
(PL)	Post-Lactating
(NR)	Non-Reproductive
(TD)	Testes Descended

# Bridge/Structure Bat Assessment Form

<u>Date &amp; Time of Assessment</u>	<u>DOT Project Number</u>	<u>Route/Facility Carried</u>	<u>County</u>
<u>Federal Structure ID</u>	<u>Structure Coordinates</u> (latitude and longitude)	<u>Structure Height</u> (approximate)	<u>Structure Length</u>
<b>Structure Type</b> (check one)		<b>Structure Material</b> (check all that apply)	
<i>Bridge Construction Style</i>		<i>Deck Material</i>	<i>Beam Material</i> <i>End/Back Wall Material</i>
<input type="radio"/> Cast-in-place 	<input type="radio"/> Pre-stressed Girder 	<input type="checkbox"/> Metal	<input type="checkbox"/> None <input type="checkbox"/> Concrete
<input type="radio"/> Flat Slab/Box 	<input type="radio"/> Steel I-beam 	<input type="checkbox"/> Concrete	<input type="checkbox"/> Concrete
<input type="radio"/> Truss 	<input type="radio"/> Covered 	<input type="checkbox"/> Timber	<input type="checkbox"/> Steel
<input type="radio"/> Parallel Box Beam 	<input type="radio"/> Other: _____	<input type="checkbox"/> Open grid	<input type="checkbox"/> Timber
		<input type="checkbox"/> Other: _____	<input type="checkbox"/> Other: _____
<i>Culvert Type</i>		<i>Culvert Material</i>	<i>Creosote Evidence</i>
<input type="radio"/> Box	<input type="radio"/> Other Structure	<input type="checkbox"/> Metal	<input type="radio"/> Yes <input type="radio"/> No
<input type="radio"/> Pipe/Round		<input type="checkbox"/> Concrete	<input type="radio"/> Unknown
<input type="radio"/> Other: _____		<input type="checkbox"/> Plastic	<i>Notes:</i>
		<input type="checkbox"/> Stone/Masonry	
		<input type="checkbox"/> Other: _____	
<b>Crossings Traversed</b> (check all that apply)		<b>Surrounding Habitat</b> (check all that apply)	
<input type="checkbox"/> Bare ground	<input type="checkbox"/> Open vegetation	<input type="checkbox"/> Agricultural	<input type="checkbox"/> Grassland
<input type="checkbox"/> Rip-rap	<input type="checkbox"/> Closed vegetation	<input type="checkbox"/> Commercial	<input type="checkbox"/> Ranching
<input type="checkbox"/> Flowing water	<input type="checkbox"/> Railroad	<input type="checkbox"/> Residential-urban	<input type="checkbox"/> Riparian/wetland
<input type="checkbox"/> Standing water	<input type="checkbox"/> Road/trail - Type: _____	<input type="checkbox"/> Residential-rural	<input type="checkbox"/> Mixed use
<input type="checkbox"/> Seasonal water	<input type="checkbox"/> Other: _____	<input type="checkbox"/> Woodland/forested	<input type="checkbox"/> Other: _____
<b>Areas Assessed</b> (check all that apply)			
Check all areas that apply. If an area is not present in the structure, check the "not present" box. Document all bat indicators observed during the assessment. Include the species present, if known, and provide photo documentation as indicated.			
<b>Area</b> (check if assessed)	<b>Assessment Notes</b>	<b>Evidence of Bats</b> (include photos if present)	
<input type="checkbox"/> All crevices and cracks: <b>Bridges/culverts:</b> rough surfaces or imperfections in concrete <b>Other structures:</b> soffits, rafters, attic areas	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> Concrete surfaces (open roosting on concrete)	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> Spaces between concrete end walls and the bridge deck	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> Crack between concrete railings on top of the bridge deck <div style="text-align: center;">Gap Railing </div>	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> Vertical surfaces on concrete I-beams	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> Spaces between walls, ceiling joists	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> Weep holes, scupper drains, and inlets/pipes	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> All guiderails	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
<input type="checkbox"/> All expansion joints	<input type="checkbox"/> Not present	<input type="checkbox"/> Visual - live #    dead #	<input type="checkbox"/> Audible <input type="checkbox"/> Species
		<input type="checkbox"/> Guano	<input type="checkbox"/> Odor
		<input type="checkbox"/> Staining	<input type="checkbox"/> Photos
Name: _____		Signature: _____	

# U.S. Fish and Wildlife Service



## Bat Mist-Netting Data Sheet

Site No.		Project Proponent (e.g., client/company institution)										Date	
State:		County:		Y (Lat/N)		X (Lon/E)		UTM Zone:					
Surveyors (include Permit No.):													

#	Time	Species	Age	Sex	Repro Cond.*	RFA (mm)	Mass (g)	Net/Ht	Guano/Hair	Wing Score	Band #	Moon Phase:		%		
												Rise	Set			
1												Moon:				
2													Sun:			
3												Time		Temp	Sky	Wind
4																
5																
6																
7																
8																
9																
10																
11												Avg.				
12												Sky Code				
13												0	Clear			
14												1	Few Clouds			
15												2	Partly Cloudy			
16												3	Cl			
17												4	Smoke or Fog			
18												5	Drizzle or L			
19												6	Thunderstorm			
20												Beaupo				
21												0	Calm (0 mph)			
22												1	Light wind (1-3 mph)			
23												2	Light Breeze (4-7 mph)			
												3	Gentle Breeze (8-12 mph)			
												4	Moderate Breeze (13-18 mph)			
												* Reproductive Condition				
												(P)	Pregnant			
												(L)	Lactating			
												(PL)	Post-Lactating			
												(NR)	Non-Reproductive			
												(TD)	Testes Descended			



# U.S. Fish and Wildlife Service



## Bat Mist-Netting Data Sheet

### Net Site Diagram

#### Dominant Vegetation

1	
2	
3	
4	
5	

#### Net Site(s) by Habitat

Habitat	A	B	C	
River				
Stream				
Pond				
Road Rut				
Corridor				
Cave/Mine				
<b>TOTAL</b>				

#### No. of Poles X Net Length

A	=		X	
B	=		X	
C	=		X	
D	=		X	

Other Species:

### Comments



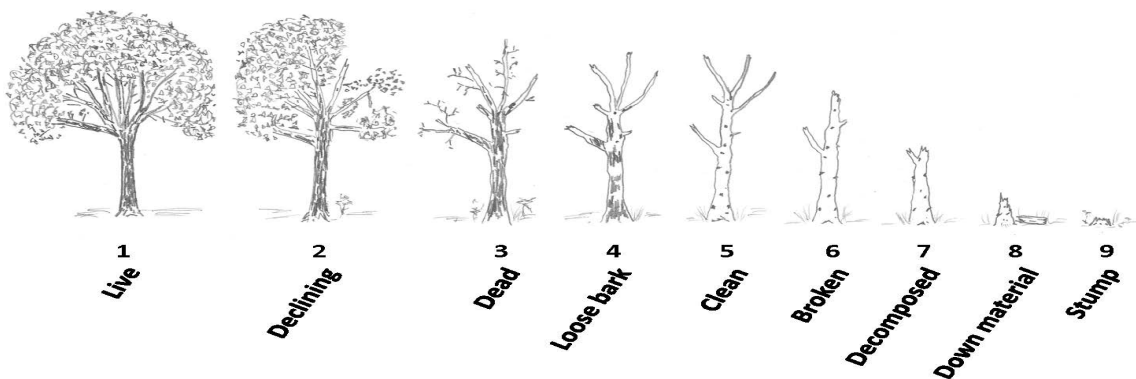
## Bat Roost Datasheet

### PROJECT & SURVEY INFORMATION

Surveyor(s): \_\_\_\_\_ Date: \_\_\_\_\_  
 Property Owner \_\_\_\_\_ Phone #: \_\_\_\_\_  
 State: \_\_\_\_\_ County: \_\_\_\_\_ Site #: \_\_\_\_\_ Roost #: \_\_\_\_\_  
 Y (Lat/N): \_\_\_\_\_ X (Lon/E): \_\_\_\_\_ UTM Zone: \_\_\_\_\_

### ROOST TREE INFORMATION

Tree Species	<input type="checkbox"/> LIVE <input type="checkbox"/> SNAG		
DBH (in or cm)		Roost Position Aspect (deg)	
Total Tree Height (ft or m)		Height of Roost Area (if known)	
Exfoliating Bark %	<input type="checkbox"/> TIGHT <input type="checkbox"/> PLATY <input type="checkbox"/> SLOUGHING		
Cavities Present	<input type="checkbox"/> NO <input type="checkbox"/> YES, DESCRIBE:		
Canopy Position	<input type="checkbox"/> DOMINANT <input type="checkbox"/> CO-DOMINANT <input type="checkbox"/> SUPPRESSED		
Roost Decay State (see below)			



### SURROUNDING HABITAT CONDITION

Canopy Closure at Roost (%)		Approx. woodlot size	
Dist. From Capture Site (ft or m)		Dist. To non-forest (ft or m)	
Describe forest/woodlot current condition (mature, partially cut over, burned, insect damage, etc.)			

## PROJECT & SURVEY INFORMATION

**Bat Species Known to be using this Roost/Feature (if not known, leave blank):**

**Survey Start Time:** \_\_\_\_\_ **Time of Sunset:** \_\_\_\_\_ **Survey End Time:** \_\_\_\_\_

**NOTE:** Emergence surveys should begin ½ hour before sunset and continue until at least one hour after sunset or until it is otherwise too dark to see emerging bats. The surveyor(s) should position him or herself so that emerging bats will be silhouetted against the sky as they exit the roost. Tallies of emerging bats should be recorded every few minutes or as natural breaks in bat activity allow. Ensure that surveyor(s) are close enough to the roost to observe all exiting/returning bats, but not close enough to influence emergence (i.e., do not stand directly beneath the roost and do not make unnecessary noise and/or conversation, and minimize use of lights other than a small flashlight to record data, if necessary). Do not shine a light on the roost tree crevice/cave/mine entrance itself as this may prevent or delay bats from emerging. If available, use of an infrared, night vision, or thermal-imaging video camera or spotting scope and an ultrasonic bat detector are strongly recommended but not required.

[illegible]

**Bat Tree Emergence Datasheet (Continued)**

Site # \_\_\_\_\_

Roost # \_\_\_\_\_

Time	No. of Bats Leaving Roost *	Comments/Notes
Total Number of Bats Observed Emerging from the Roost/Feature during the Survey:		

**Describe Emergence:** Did bats emerge simultaneously, fly off in the same direction, loiter, circle, disperse, etc. If radio-tagged bat was roosting in feature, at what time did it emerge?