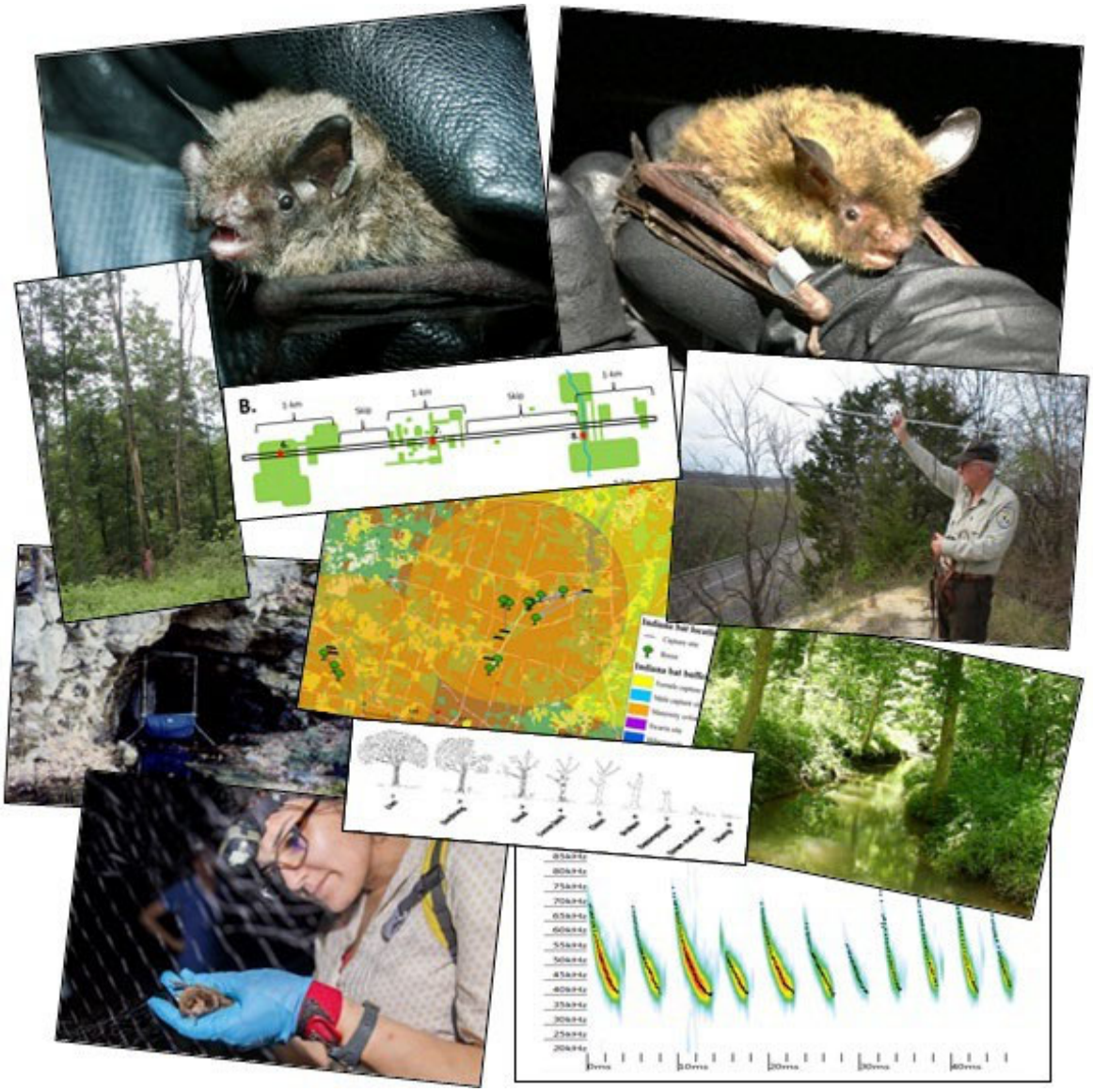
U.S. Fish and Wildlife Service

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



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

(modifications from the previous guidelines are in **blue**)

INTRODUCTION

The Indiana bat (IBAT) (*Myotis sodalis*) was originally listed as being in danger of extinction under the Endangered Species Preservation Act of 1966 (32 FR 4001, March 11, 1967), and is currently listed as endangered under the Endangered Species Act (ESA) of 1973, as amended. The northern long-eared bat (NLEB) (*Myotis septentrionalis*) was listed as threatened under the ESA on April 2, 2015, and reclassified to endangered on March 31, 2023. This survey protocol provides the U.S. Fish and Wildlife Service's (USFWS) recommended guidance on survey methods and outlines additional reporting requirements for surveyors. These guidelines provide recommendations to project proponents completing habitat assessments and presence/probable absence surveys for IBAT and NLEB. Following these recommendations streamlines project coordination with USFWS[1]. The USFWS does not require surveys for federally listed species to meet ESA compliance within Section 7 or 10 contexts. Therefore, use of these guidelines remains optional, and project proponents may discuss other options with the local USFWS Field Office (FO).

The following guidance is designed to determine whether IBAT or NLEB are present[2] or probably absent (P/A)[3] at a given site during the summer/active season (see Appendices B, C, I, or J), within bridges and culverts (see Appendix K), or during the winter (see Appendix H) (also refer to Table 1). The phased-approach includes coordination with the USFWS, habitat assessments, acoustic, mist-net, and an assortment of survey guidance appendices, and supersedes all prior survey guidance for these two species. Future changes to this document may occur and will be posted on the USFWS IBAT and NLEB survey guidance website by March 31st of each year. Before conducting surveys, please check this website to ensure use of the most current version of this document. All USFWS survey guidance documents can be found at https://www.fws.gov/library/collections/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)[4]. NABat surveys may be thought of as similar to breeding bird surveys and 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 IBAT or NLEB in the vicinity of a given project.

NOTE: These protocols may also be used for tricolored bat (*Perimyotis subflavus*; TCB) presence/probable absence surveys using the NLEB level of effort (LOE) for the 2024 field season. We collected preliminary data from these datasets to complete an initial evaluation of LOE for TCB to ensure that deferring to the NLEB LOE for 2024 was acceptable. The unique factors and differences from NLEB protocols include:

- The definition of suitable summer habitat for tricolored bats (Appendix A);

[1] Coordinate with the appropriate state natural resource agencies and any involved federal agency(ies) whenever "USFWS" coordination is listed. USFWS FO(s) may direct project sponsors to state agencies for existing occurrence information. Coordinate with your local USFWS FO(s) to understand the process for their area of jurisdiction.
[2] The guidance is not intended to be rigorous enough to provide sufficient data to fully determine population size or structure.
[3] Recognizing protocols are not 100% likely to detect IBAT and NLEB when present and identification errors may occur.
[4] Loeb et al. 2015 available at https://www.nabatmonitoring.org

- Acoustic or combination acoustic and mist-netting surveys are required for TCB when it is the only species (IPaC species list includes TCB but not IBAT or NLEB) being surveyed for P/A (Appendix C or I);

- Manual vetting is necessary for linear projects when using an approved version of Kaleidoscope Pro if the MLE is > 0.05 for all site-nights and 10 or more passes are auto-classified as potentially belonging to TCB at any site-night. If you choose not to manually vet calls meeting these criteria, then you should assume presence of TCB for the project (Appendix C or I);

- Radio-tracking of TCB should prioritize identification of the immediate roosting area (if the exact roosting locations cannot be determined) of the transmittered bat given the frequent difficulty in locating the bats' exact roosting location (Appendix D);

- Emergence surveys of potentially suitable (versus known) roost trees for TCB is not always a viable option given the variability in roosting locations (Appendix E); and

- Internal surveys of potentially suitable hibernacula may be completed for TCB (Appendix H).

OBJECTIVES

The objectives of IBAT and NLEB survey guidelines are to: (1) standardize range-wide survey procedures; (2) maximize the potential for detection/capture of IBAT and NLEB at a minimum acceptable level of effort (LOE); (3) make accurate presence/probable absence determinations; and (4) aid in conservation efforts for the species' by identifying areas where they are present.

BACKGROUND

In 2011, the USFWS developed a multi-agency team to determine whether improvements could be made to the 2007 IBAT Mist-Net Protocols (USFWS 2007). The USFWS implemented the revised guidance in 2014. Since then, a USFWS team with support from USGS has made any necessary revisions to the guidelines each year (e.g., formally incorporated NLEB in 2022). The USGS conducted initial independent testing of automated acoustic software programs during the winter of 2014-15 and continues to provide support to USFWS testing new versions of available software using software- testing procedures updated in January 2019[5].

We considered the best available information for all aspects of the guidance. For example, see our white paper[6] and 2018 addendum outlining the methods used to determine the minimum IBAT LOE. Our 2022 addendum provided the rationale for the NLEB minimum LOE for acoustic and mist-net surveys (previously we deferred to LOE used for IBAT) as well as updating the IBAT acoustic LOE. The 2023 addendum utilized new data to provide updated mist-netting LOE recommendations for IBAT and NLEB and year-round active LOE recommendations for NLEB. As we receive additional information, we may incorporate additional survey recommendations for the IBAT, NLEB, and/or other bat species. The USFWS continues to partner with local, State, and Federal biologists; scientific and academic institutions; commercial organizations; and other interested parties to collect additional data on the distribution, ecology, and biology of the IBAT and NLEB, as well as other at- risk bat species, and looks forward to receiving any additional pertinent information from partners.

[5] Revised USFWS Software Testing Procedures are available on the USFWS website provided in the intro.
[6] The white paper, 2018, 2022 and 2023 addenda are available on the USFWS website provided in the intro.

GENERAL PROCESS

IBAT and NLEB surveys for some proposed projects will require modification (or clarification) of this guidance through coordination with the USFWS Ecological Services Field Office(s) (FOs) responsible for the state(s) in which the project occurs[7]. Before coordinating with the USFWS FO(s) on survey plan development, project proponents should submit their project through the Information for Planning and Consultation (IPaC) website (https://ipac.ecosphere.fws.gov/). If not already required by federal permit, federal action agencies 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 all the information necessary is provided to the USFWS FO and expedite review and approval. 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. Pre-survey coordination typically will preclude the need for subsequent reviews of intermediate steps by USFWS FO(s) during the busy field season. An online directory of USFWS FO(s) is available on the USFWS website (https://www.fws.gov/our-facilities). Unless otherwise agreed to by the USFWS, negative P/A survey results obtained using this guidance are valid for a minimum of five years[8] from their completion unless new information (e.g., other nearby surveys) suggest otherwise. If negative survey results are older than 5 years, coordinate with the USFWS FO(s) to discuss if additional surveys are needed. If not already required by federal permit, submit all results (negative or positive) from any phase to the USFWS FO(s) you have been in coordination with. We strongly encourage this coordination as it 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 phases conducted for a given project. Results of acoustic survey data collected as part of P/A surveys must also be submitted annually in Section 10 reporting spreadsheets to the USFWS.

USFWS FO-level coordination is also important during the survey planning process. USFWS Section 10 permits require FO approval for each individual survey study plan in order to be in compliance. Field Offices have the authority to deny a proposed survey if it is determined that the study plan is insufficient for Section 7 consultation requirements of the ESA. For example, radio-tracking of captured IBAT and/or NLEB may be required by individual FOs and should be discussed as part of the study plan and pre-survey coordination. The guidelines that are described in this document are designed to be implemented during acceptable survey windows (see Table 1) and in typical habitats that are conducive to the standard survey techniques described herein. However, the USFWS recognizes that occasionally there may be some site-specific conditions in summer habitats or at potential hibernacula sites that do not lend themselves to being surveyed using the standard survey options (e.g., mist nets, acoustic detectors, or harp traps) even though a site may otherwise meet the definition of suitable IBAT and/or NLEB habitat. Therefore, we strongly encourage coordination with the FO(s) prior to using methods that may not be appropriate for site-specific habitat conditions. The bat activity timeframes (see Appendix L) are intended to provide consistency across the species' ranges and aid conversations between project proponents and USFWS FOs regarding Section 7 consultations (e.g., avoidance and minimization). Similarly to other components of the guidelines, these timeframes are subject to change based on use of the best science available.

[7] For example, project sponsors for large acreage and/or landscape-scale projects that do not result in permanent habitat loss and would not pose an ongoing threat of lethal take, especially those proposed by land management agencies, may work with local USFWS FOs to apply different scales of surveys (broad vs. project-level) or different types of surveys, such as long-term monitoring results (e.g., forest-wide acoustic data) and/or targeted survey efforts (e.g., sub- sampling of large project areas), to address P/A concerns.

[8] The timeframe may be reduced if significant habitat changes have occurred in the area or increased based on local information.

Because surveys that result in the capture of IBAT and/or NLEB result in take, such surveys should only be conducted by a qualified biologist[9]. Generally, a recovery permit for the IBAT and NLEB authorizes the capture of bats for identification, and handling of bats 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 this survey guidance will meet standard USFWS Section 10 recovery permit requirements; however, surveyors also need to ensure they meet all applicable state permitting and reporting requirements. Failure to follow the survey guidance, as written, and/or failure to follow a study plan which has received concurrence from the local USFWS FO(s), may result in a USFWS FO requesting additional survey effort.

The following provides a step-by-step outline of how IBAT and/or NLEB summer surveys and/or potential hibernacula surveys should be conducted. Some of these steps can occur concurrently.

NOTE: If surveys are specifically targeting both the IBAT and NLEB, **make sure to use the higher minimum LOE for chosen survey methods (e.g., NLEB range-wide acoustic or mist-netting LOE, also see 2022 and 2023 Addendum)** to ensure it meets the needs for both species.

PHASE 1 – INITIAL PROJECT SCREENING

Step 1. Determine if your project is within the range of IBAT and/or NLEB through the U.S. Fish and Wildlife Service's Information for Planning and Consultation website (https://ipac.ecosphere.fws.gov/). Once completed, coordinate with the U.S. Fish and Wildlife Service Field Office(s)[10] regarding existing IBAT and/or NLEB summer and/or winter occurrence information. [*Projects located within known IBAT and/or NLEB summer habitat and/or known hibernacula/spring-staging/fall swarming zones will not proceed to Phase 2 of this process unless the project meets the definition of an "outer-tier project" outlined in Appendix G. "Outer-tier" guidance only applies to summer captures/detections (not hibernacula)*].

a) If a project (located within or outside of a known maternity colony home range or spring-staging/fall-swarming zone of a known hibernaculum) is already covered under an existing Endangered Species Act (ESA) incidental take authorization (e.g., HCP, BO), then no further summer and/or potential hibernacula surveys are needed, follow the procedures previously authorized by the USFWS FO(s).

b) If there are known IBAT or NLEB occurrences (e.g., known roost trees, capture locations, foraging locations or hibernacula) within the project action area[11];

OR

if there are no known IBAT or NLEB summer or spring/fall/winter occurrences within the proposed project area itself, but the project area is located within a known maternity colony

[9] A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife Permit) for IBAT and/or NLEB in the state/region in which they are surveying and/or has been authorized by the appropriate state agency to net and handle IBAT and/or NLEB. 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.

[10] 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 occurrence information. Coordinate with your local USFWS FO(s) to understand the process for their area of jurisdiction.

[11] The "action area" is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. [50 CFR Section 402.02]

home range and/or the spring-staging and fall-swarming zone of a known hibernaculum[12];

OR

if the project is located outside a known maternity colony home range and/or spring- staging and fall-swarming zone of a hibernaculum but is within the range of the IBAT and/or NLEB (note this can change over time), then proceed to Step 2.

Step 2. Conduct Habitat Assessment (Desktop or Field-based; see Appendix A, H, and K).

a) If suitable summer habitat, a potential hibernaculum(a), and/or a potential bridge/culvert roost is present within the action area, then proceed to Step 3.

b) If suitable summer and winter habitat (i.e., potential hibernaculum) and potential bridge/culvert roosts are absent within the action area, then no further P/A surveys are recommended; however, additional coordination with the USFWS FO(s) may be recommended if IBAT and/or NLEB may be present in an action area during other seasons (e.g., spring and fall migration) and may be affected by the proposed project.

Step 3. Assess potential for adverse effects to IBAT and/or NLEBs

a) If the project is not anticipated to result in adverse effects to IBAT and/or NLEB (as proposed), then no further summer, bridge/culvert roost, and/or potential hibernacula surveys are recommended, coordinate with the USFWS FO(s).

b) If the project may result in adverse effects to IBAT and/or NLEB, but impacts can be adequately assessed and conservation measures can be designed to minimize those effects without additional P/A information (this includes **all** proposed projects within known summer maternity colony home ranges and /or at known hibernacula and their surrounding spring-staging and fall-swarming zones, but may include other areas as well), then no further surveys are recommended. Coordinate with the USFWS FO(s) regarding an assessment of the project's potential effects, development of conservation measures, determination of the need for any ESA incidental take authorization, and discussion of value of additional surveys.

c) If the project does not meet the conditions of 3a or 3b, then proceed to **Phase 2, 5, and/or 6**.

PHASE 2 – SUMMER/ACTIVE SEASON P/A SURVEYS (NETTING AND/OR ACOUSTIC)[13]

Presence/probable absence (P/A) of IBAT and/or NLEB may be determined by conducting either Step 4 (mist-netting; see Appendix B or Appendix J) or Step 5 (acoustics; see Appendix C or Appendix J) as outlined below. If the project area contains habitat that is appropriate to conduct either survey method, it is the project proponent's choice as to which option to use, for each survey area unit (i.e., ≤123-acre area or 1-km section of linear project). A combined mist-netting and acoustic approach is also acceptable (see "pilot" Appendix I). Under no scenario can a project proponent use either mist-netting or acoustic Phase 2 surveys to challenge the other methods results. The USFWS accepts the results of either option and has no preference for methods. The USFWS FO(s) can discuss pros and cons of different approaches depending on project sponsor needs and project- specific habitat conditions. For example, a project area may not have suitable conditions for a mist- net survey and an acoustic survey may be the only

[12] See USFWS IBAT Section 7 and Section 10 Guidance for Wind Energy Projects (Questions 4 & 5) on the USFWS website provided in the introduction.

[13] NOTE: acoustic and/or mist-net surveys should be conducted in the best suitable habitat possible for each survey type to increase the likelihood of detecting/capturing IBAT and/or NLEB. In some cases, the most suitable habitat for effectively conducting surveys may occur outside a project site boundary and may be sampled if landowner permission is granted.

appropriate method for establishing P/A. It is up to the surveyor's professional judgment to determine whether the habitat on-site has the appropriate structure for the survey method chosen prior to the survey and to coordinate with the FO(s) if issues arise with the method chosen and need to be reconsidered.

Acoustics at the Phase 2 level of effort (LOE) (or otherwise agreed to with the USFWS FO) may be used as a coarse screening tool for conducting subsequent mist-netting at the Phase 2 LOE. For example, if NO high frequency (HF) calls (≥35 kHz) are detected, then no netting is required within that 123-acre (non-linear) or 1-km (linear) survey area due to IBAT and/or NLEB probable absence. If ANY HF calls are detected, then mist-net at the Phase 2 LOE. Any project study plan that includes use of both acoustics and netting needs to be written clearly to avoid potential misunderstandings between the project proponent and the USFWS FO.

Also, Phase 2 acoustic results should be used to inform whether, when, and where to conduct any optional Phase 3 mist-netting. In this case, acoustics is the P/A method and if presence is detected (HF screen, automated/MLE and/or manual vetting), then IBAT and/or NLEB presence is established. Negative results from follow-up mist-netting (at any LOE) does not refute a previously established positive acoustic result. The goal of Phase 3 netting is simply to verify where IBAT and/or NLEB(s) are active and to capture and track individuals to document roost trees and population size to further inform consultation or coordination under the ESA.

The summer survey season for IBAT and the hibernating[14] NLEB range is from 15 May through 15 August, unless the survey is being conducted within the year-round active portion of the NLEB range where the survey season is from 1 March through 15 October (see Appendix J). All P/A surveys should be completed by the end of the designated survey season unless otherwise indicated by USFWS FO[15]. 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 Phase 4/radio- tracking. Project proponents must decide whether they will proceed to Phase 4 in coordination with the USFWS FO before any mist-netting occurs. Submit Phase 2 study plans to USFWS FO prior to conducting surveys for their review and site-specific authorization.

Step 4. Conduct Mist-Netting Surveys following IBAT and/or NLEB Protocols[16] (See Figure 1, Table 2, and Appendix B, I, or J)

OR

Step 5. Conduct Acoustic Surveys[17] (see Figure 1, Table 2, and Appendix C, I, or J)

[14] The hibernating NLEB 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.
[15] 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 NLEB 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. If tracking is proposed, surveys should be scheduled so that tracking is concluded prior to August 15 or October 15.
[16] We have no recommendations for reducing the mist-netting minimum level of effort 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 that used the same acreage threshold. Level of effort for mist-netting is designed to reach 90% confidence in negative survey results (see Niver et al. 2014; Armstrong et al. 2023).
[17] Acoustic surveys are available as a P/A option throughout the ranges of both species. We have no recommendations for reducing the minimum level of effort required to demonstrate probable absence for projects <123 acres in size. Level

PHASE 3. CONDUCT MIST-NETTING SURVEYS TO CAPTURE INDIANA and/or NORTHERN LONG-EARED BATS.

If mist-netting was not conducted as the P/A method, then mist-netting may be conducted in Phase 3 to capture and characterize (e.g., sex, age, reproductive condition) the IBAT and/or NLEB that are present in an area and to facilitate Phase 4 efforts. We encourage working with the FOs to develop Phase 3 netting plans based on best available information (e.g., positive acoustic locations). There are no minimum requirements for this phase as this is not a P/A phase.

a) If no IBAT and/or NLEB are captured, then coordinate with the USFWS FO.

b) If IBAT and/or NLEB are captured, then proceed to **Phase 4**.

PHASE 4. CONDUCT RADIO-TRACKING AND EMERGENCE SURVEYS (See Appendices D and E)

PHASE 5. CONDUCT POTENTIAL HIBERNACULA SURVEYS (See Appendix H)

PHASE 6. CONDUCT BRIDGE AND CULVERT ROOST SURVEYS (See Appendix K)

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of effort is based on detection probabilities and occupancy estimates that were derived from past survey efforts that used the same acreage threshold. Level of effort for acoustics is designed to reach 90% confidence in negative survey results (see Niver et al. 2014; Armstrong et al. 2022).

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TABLE 1. Standard survey seasons for conducting P/A surveys for IBAT and/or NLEB.

IBAT & NLEB SURVEY SEASONS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
IBat Internal Winter Hibernacula Surveys[1,2]												
Acceptable survey window (1 Jan. - 28 Feb.)												
Traditional survey window of known sites (15 Jan. - 15 Feb.)												
IBat & NLEB Spring & Fall Surveys at Entrances of Potential Hibernacula [3,4]												
Acceptable survey window (1 - 21 Apr. & 15 Sep. - 31 Oct.)												
IBat & NLEB Summer Surveys of Suitable Summer Habitat [5]												
Acceptable survey window (15 May - 15 Aug.)												
Optimal survey window (1 Jun. - 31 Jul.) [6]												
NLEB Surveys of Suitable Habitat in Year-round Active Range												
Acceptable survey window - (1 Mar. - 15 Oct.)												
Optimal survey window (1 May - 30 Sep.) [6]												
IBat & NLEB Bridge and Culvert Surveys [7]												
Acceptable survey window (Year-round)												

[1] visual and photographic surveys conducted within known and/or potential hibernacula (if deemed safe to enter).

[2] internal winter hibernacula surveys are seldom appropriate for NLEB as they typically fail to reliably detect and accurately enumerate the species when present.

[3] conducted using harp traps or mist nets at cave/mine entrances.

[4] if State/USFWS FO approve, spring and fall survey windows can "drift" a bit earliler or later to better accommodate prevailing weather patterns and/or climate conditions in the location of the proposed survey. For example, the fall survey window in nothern portions of the IBAT or NLEB range may begin on or after 1 Sep. and end prior to 31 Oct. pending local State and FO approval. Likewise, if agencies approve, spring surveys of potential hibernacula may be pushed back/extended a few days or longer due to an extended period of unseasonably cold spring weather.

[5] conducted using mist nets or acoustic detectors deployed within suitable flight corridors and foraging areas.

[6] the middle of the maternity season is considered by many to the best or "optimal" time to capture resident bats.

[7] coordinate with your local USFWS FO to determine best time to conduct bridge or culvert surveys for your project.

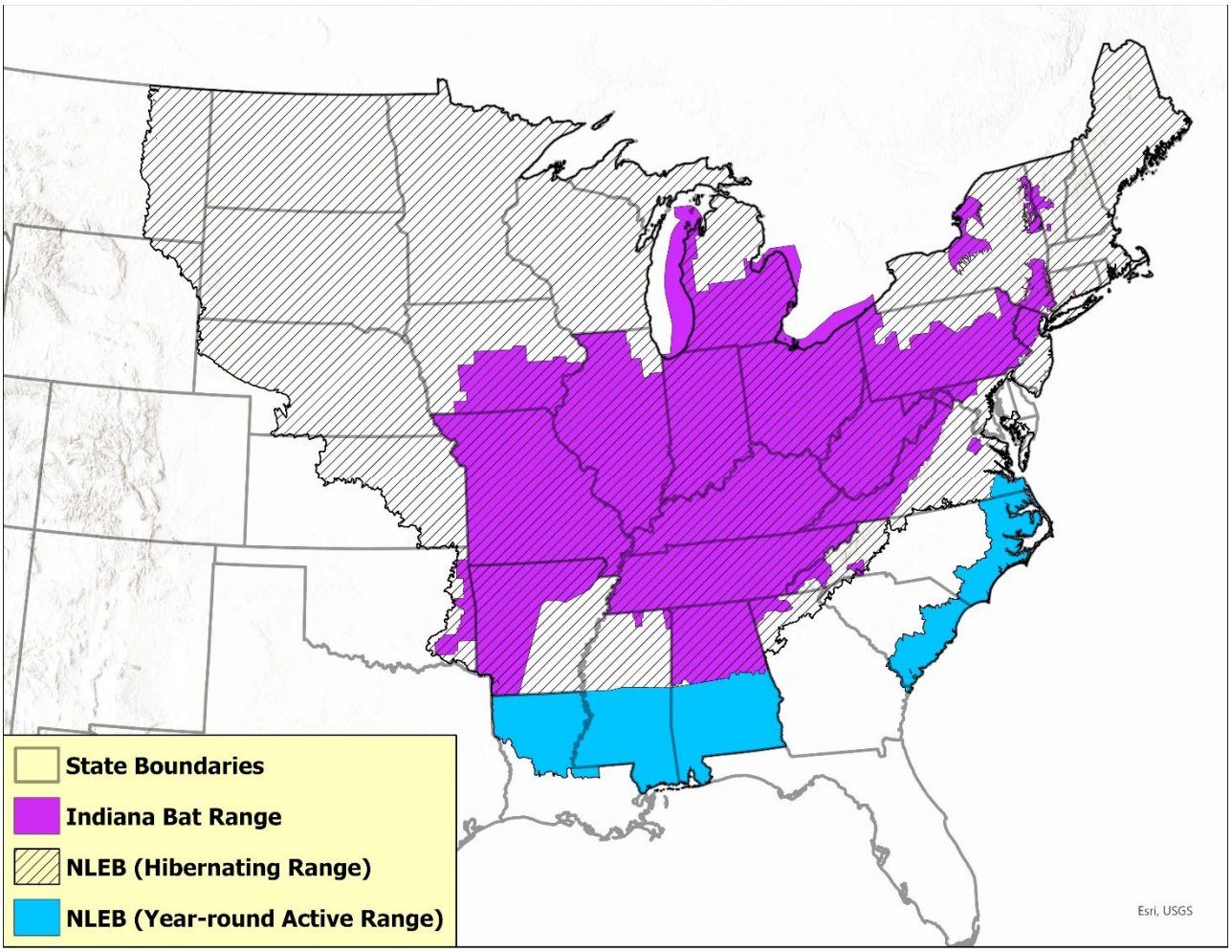

FIGURE 1. IBAT and NLEB ranges as defined for use in presence/ probable absence surveys (also see Table 2).

TABLE 2. Summary of current survey LOEs for IBAT and NLEB.

		MIST-NETTING (net nights)		ACOUSTICS (detector nights)	
Species	Region	Linear (per km)	Non-Linear (per 123 ac.)	Linear (per km)	Non-Linear (per 123 ac.)
IBAT	Range-wide	2	6	4	10
NLEB	Hibernating Range (non-coastal areas)	4	10	4	14
	Year-round Active Range (coastal areas)	2	6		

APPENDIX A: PHASE 1 HABITAT ASSESSMENTS

Summer habitat and potential hibernacula assessments are Step 2 of Phase 1- Initial Project Screening. The information below is provided to assist applicants, consultants, and/or project proponents (hereinafter termed the "applicant") in establishing whether surveys for IBAT and/or NLEB should be conducted. As a reminder, the first steps for determining presence of IBAT and/or NLEB at a given site is to 1) use the USFWS's Information for Planning and Consultation (IPaC) website (https://ipac.ecosphere.fws.gov/), and 2) determine whether there is any existing occurrence data available for the vicinity of the project from the local USFWS FO. This step can be conducted remotely via a desktop analysis (e.g., use of aerial photography to assess the potential presence of suitable summer habitat); however, on-site field assessment is always preferred. The applicant is responsible for developing and providing sufficient information as to whether suitable summer habitat and/or potential hibernacula exist within a proposed project area. If suitable habitat is present, the applicant should calculate the amount and submit this to the USFWS FO(s) and determine the need for any P/A surveys (Phase 2).

NOTE: If IBAT and/or NLEB are present or assumed to be present during any phase, more detailed habitat information may be necessary to adequately assess the potential for impacts (see attached example Bat Habitat Assessment Datasheet). 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 IBAT and/or NLEB can be completed any time of year and applicants are encouraged to submit results and proposed Phase 2 study plans well in advance of survey seasons.

PERSONNEL

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.

DEFINITION FOR SUITABLE INDIANA BAT SUMMER 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[18] 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 ≥5 inches dbh[19] (12.7 centimeter) that have exfoliating bark, cracks, crevices, and/or hollows), 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. Individual trees may be considered suitable

[18] Non-forested habitats typically should be excluded from acreages used to establish a minimum level of survey effort for Phase 2 surveys.

[19] 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 ≥20 acres of early successional habitat containing trees between 3 and 5 inches (7.6-12.7 cm) dbh would require coordination/consultation with the USFWS FO to ensure that associated impacts would not rise to the level of take. The USFWS may request P/A surveys if >20 acres of early successional habitat were proposed for removal.

habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of other 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[20]. We recommend that project proponents or their representatives coordinate with the appropriate USFWS Field Office (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 greater than 1,000 feet from forested/wooded areas;
- Trees found in highly developed urban areas (e.g., street trees, downtown areas); and
- A pure stand of less than 3-inch dbh[21] trees that are not mixed with larger trees.

DEFINITION FOR SUITABLE NORTHERN LONG-EARED BAT SUMMER HABITAT

Suitable summer 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, such as emergent wetlands and field edges, they are predominately found in forest/wooded habitat. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥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 vegetation for foraging and commuting rather than fragmented habitat or 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 other forested/wooded habitat[22]. The NLEB has 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 habitat[23].

NLEBs typically occupy their summer habitat from mid-May through mid-August each year[24] and the

[20] If human-made structures are present within your project area and are proposed to be removed or modified, see Appendix E (Emergence Surveys) and then coordinate with the local USFWS FO(s) regarding how to determine P/A.
[21] 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 IBAT. Therefore, a project that would remove or otherwise adversely affect ≥20 acres of early successional habitat containing trees between 3 and 5 inches (7.6- 12.7 cm) dbh would require coordination/consultation with the USFWS FO to ensure that associated impacts would not rise to the level of take. The USFWS may request P/A surveys if >20 acres of early successional habitat were proposed for removal.
[22] This number is based on observations of bat behavior indicating that such an isolated tree (i.e., ≥1000 feet) would be extremely unlikely to be used as a roost. This distance has also been evaluated and vetted for use for the NLEB. See the "Indiana bat Section 7 and Section 10 Guidance for wind Energy Projects," question 33, found on the USFWS website provided in the intro.
[23] Trees found in highly-developed urban areas (e.g., street trees, downtown areas) are extremely unlikely to be suitable habitat.
[24] Exact dates vary by location., with NLEBs typically being found earlier in spring at lower latitudes. Also, NLEBs in

species may arrive or leave some time before or after this period. In most areas, roosting habitat is considered suitable summer habitat because NLEBs are only present in forested habitat during the summer active months. In some areas of the southern U.S., NLEBs are present in potential roosting habitat year-round. In these areas (see Figure 1 and Figure 3 in Appendix J), habits and habitat use differ significantly from the rest of the species' range.

Examples of unsuitable habitat:

- Individual trees that are greater than 1,000 feet from forested/wooded areas;
- Trees found in highly developed urban areas (e.g., street trees, downtown areas); and
- A pure stand of less than 3-inch dbh trees that are not mixed with larger trees.

DEFINITION FOR SUITABLE TRICOLORED BAT SUMMER HABITAT

Suitable TCB summer 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. 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*]).[25] TCBs will roost in a variety of tree species, especially oaks (*Quercus spp.*), and often select roosts in tall, large-diameter trees, but will roost in smaller diameter trees when potential roost substrate is present (e.g., 4-inch [10-centimeter]; Leput 2004). 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 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).

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 habitat. 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). TCBs may roost and forage in forested areas near anthropogenic structures and buildings (e.g., suburban neighborhoods, parks, etc.) (Helms 2010; Shute et al. 2021). However, highly developed urbanized areas generally devoid of native vegetation (including isolated trees surrounded by expansive anthropogenic development) are considered unsuitable habitat (e.g., parking lots, industrial buildings, shopping centers).

SUBMISSION OF PHASE 1 HABITAT ASSESSMENT & PHASE 2, PHASE 5, AND/OR PHASE 6 STUDY PLAN (IF NEEDED)

the year-round active portion of the range are an exception as they utilize the same habitat in summer as they do in winter.

[25] 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).

If a proposed project may affect (positively or negatively) IBAT and/or NLEB and the conditions outlined in Step 3 a or b are not met, a habitat assessment report should be submitted to the appropriate USFWS FO(s) (and/or to the lead Federal Action Agency as appropriate) along with a draft study plan for the Phase 2 (acoustic or netting), Phase 5 (potential hibernaculum), and/or Phase 6 (bridge/culvert potential roost) survey(s) (if suitable habitat(s) is present). Although optional, we encourage the use of the new 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 are included with your study plan request submittal to your local USFWS FO(s). Complete Phase 1 reports will 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. A detailed project description (if available)
4. Documentation of any known/occupied spring staging, summer, fall swarming, winter habitat, and/or bridge/culvert roosts for IBAT and/or NLEB within or near the project area
5. A description of methods used during the habitat assessment
6. A summary of the assessment findings and a completed Bat Summer Habitat Assessment Datasheet (see example below; use of this datasheet is optional)
7. Other information that may have a bearing on use of the project area (e.g., presence of fall or winter habitat [caves, crevices, fissures, or sinkholes, or abandoned mines of any kind], bridges/culverts and other non-tree potential summer roosts.)
8. A Phase 1 Habitat Assessment on all potential hibernacula that could be affected by the proposed project (see Appendix H for additional instructions for completing this assessment and sample datasheet), if necessary
9. A Step 1 Initial Assessment of Suitability and Safety on all bridges and culverts that could be affected by the proposed project (see Appendix K for additional instructions for completing this assessment and sample datasheet), if necessary
10. Any other information requested by the local USFWS FO(s) related to the project

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BAT HABITAT ASSESSMENT DATASHEET

Project Name:_____ Date:_____

Township/Range/Section:_____

Lat Long/UTM/ Zone:_____ Surveyor:_____

Brief Project Description

Project Area

	Total Acres	Forest Acres	Open Acres
Project			

	Completely cleared	Partially cleared (will leave trees)	Preserve acres- no clearing
Proposed Tree Removal (ac)			

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 residencial development, water sources)

Proximity to Public Land

What is the distance (mi.) from the project area to forested public lands (e.g., national or state forests, national or state parks, conservation areas, wildlife management areas)?

Use additional sheets to assess discrete habitat types at multiple sites in a project area

Include a map depicting locations of sample sites if assessing discrete habitats at multiple sites in a project area

A single sheet can be used for multiple sample sites if habitat is the same

Sample Site Description
Sample Site No.(s): _____

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

Forest Resources at Sample Site				
Closure/Density	Canopy (> 50')	Midstory (20-50')	Understory (<20')	1=1-10%, 2=11-20%, 3=21-40%, 4=41-60%, 5=61-80%, 6=81=100%
Dominant Species of Mature Trees				
% Trees w/ Exfoliating Bark				
Size Composition of Live Trees (%)	Small (3-8 in)	Med (9-15 in)	Large (>15 in)	
No. of Suitable Snags				

Standing dead trees with exfoliating bark, cracks, crevices, or hollows. Snags without these characteristics are not considered suitable.

IS THE HABITAT SUITABLE FOR INDIANA BATS? _____

IS THE HABITAT SUITABLE FOR NORTHERN LONG-EARED BATS? _____

Additional Comments:

Attach aerial photo of project site with all forested areas labeled and a general description of the habitat

Photographic Documentation: habitat shots at edge and interior from multiple locations; understory/midstory/canopy; examples of potential suitable snags and live trees; water sources

APPENDIX B: PHASE 2 OR PHASE 3 MIST–NETTING

Mist-netting can be used as a P/A method (Phase 2 surveys) or it can be conducted for the purpose of attempting to capture IBAT and/or NLEB after detection during acoustic P/A surveys (Phase 3 surveys). The same recommendations (e.g., season, personnel, equipment, net placement, checking nets) apply for either use of mist-netting surveys. NOTE: Appendix B is intended for use within the IBAT range and/or NLEB hibernating range (see Figure 1); also refer to Appendix J for additional guidance on conducting mist-netting in the year-round active range of the NLEB.

SUMMER MIST-NETTING SEASON: May 15 – August 15[26]

Capture of reproductive adult females (i.e., pregnant, lactating, or post-lactating) and/or young of the year during May 15 – August 15 confirms the presence of a maternity colony in 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

A qualified biologist(s)[27] must (1) select/approve mist-net sets in areas that are most suitable for capturing IBAT and/or NLEB, (2) be physically present at each mist-net site[28] throughout the survey period, and (3) confirm all bat species identifications. This biologist may oversee other biological technicians and manage mist-net sets in close proximity to one another if the net-check timing (i.e., every 10 minutes) can be maintained while **walking** between net-sets[29]. A minimum of two (2) biologists (e.g., one qualified and one technician) must be on-site for every four (4) net-sets being operated. 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).

NOTE: The mist-netting survey protocol may also be used for determining P/A of TCBs using the NLEB LOE for the 2024 field season when the survey is also being conducted for IBAT and/or NLEB; however, an acoustic or combined acoustic/mist-net survey must be completed in portions of the range where TCBs are the only species identified by IPaC and the project proponent chooses to conduct a P/A survey.

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[26] With prior USFWS FO approval, a survey may be completed after August 15 if it was initiated in time to be completed by August 15 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. If tracking is proposed, surveys should be scheduled so that tracking is concluded prior to August 15.

[27] A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife Permit) for IBAT and NLEB in the state/region in which they are surveying and/or has been authorized by the appropriate state agency to net and handle IBAT and/or NLEB. 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.

[28] 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).

[29] 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. 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.

COORDINATION WITH USFWS FIELD OFFICES (FOs)

If not already required by federal permit, we recommend that applicants submit a draft study plan for all survey phases to the USFWS FO(s) for review and approval (See Appendix A for guidance on submitting a draft study plan).

EQUIPMENT

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 Chenger's BCM triple high has been widely used. See NET PLACEMENT discussion below for minimum net heights, habitats, and other netting requirements that affect the choice of hardware.

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.

MINIMUM P/A MIST-NETTING LEVEL OF EFFORT (PHASE 2)

The level of netting survey effort required for a non-linear project will be dependent upon the overall acreage of suitable habitat that may be impacted by the action (directly or indirectly). To determine the survey effort, quantify the amount of suitable summer habitat within the project area.

NOTE: for projects where other impacts than tree removal are likely (e.g., collision), ensure that P/A surveys are designed to cover all suitable habitat within the entire project area (where exposure to any kind of impacts may be anticipated) and NOT just the locations where tree removal is planned. Additional guidance for linear projects is in Appendix F.

Conduct Mist-Netting Surveys following IBAT and/or Hibernating NLEB Range Level-of-Effort Recommendations (See Figure 1 and Table 2)

Range-wide IBAT Mist-netting LOE:

Linear projects: a minimum of 2 net nights per km (0.6 miles) of suitable summer habitat (see Appendix F).

Non-linear projects: a minimum of 6 net nights per 123 acres[30] (0.5 km^2) of suitable summer habitat.

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.

[30] We have no recommendations for reducing the minimum level of effort required to demonstrate probable absence for projects <123 acres in size. Detection probabilities and occupancy estimates were derived from past survey efforts that used the same acreage threshold (see Niver et al. 2014).

a) If no capture of IBAT(s), then no further summer surveys are recommended[31].

b) If capture of IBAT(s), then stop or proceed to **Phase 4** as previously decided in coordination with the FO(s).

Hibernating NLEB Range Mist-netting LOE:

Linear projects: a minimum of 4 net nights per km (0.6 miles) of suitable summer habitat (see Appendix F).

Non-linear projects: a minimum of 10 net nights per 123 acres (0.5 km^2) of suitable summer habitat.

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.

a) If no capture of NLEB(s), then no further summer surveys are recommended.

b) If capture of NLEB(s), then stop or proceed to **Phase 4** as previously decided in coordination with the FO.

MIST-NETTING SURVEYS TO CAPTURE INDIANA AND/OR NORTHERN LONG- EARED BATS AFTER ACOUSTICS WERE USED AS P/A METHOD (PHASE 3)

If netting was not conducted as the P/A method, then netting may be conducted to capture and characterize (e.g., sex, age, reproductive condition) the IBAT and/or NLEB (documented through the Phase 2 acoustic P/A survey) present in an area and to facilitate radio-tracking (Phase 4) efforts. We encourage working with the FO(s) to develop Phase 3 netting plans based on best available information (e.g., positive acoustic locations). There are no minimum requirements for this phase as this is not a P/A phase.

a) If no IBAT and/or NLEB are captured, then coordinate with the USFWS FO.
b) If IBAT or NLEB are captured, then proceed to **Phase 4** as previously decided in coordination with the FO(s).

NET PLACEMENT

Indiana and Northern long-eared bats typically forage in habitats that do not completely overlap (see species-specific habitat definitions in Appendix A) therefore, net placement should reflect these differences when targeting both 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 IBAT (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

[31] NOTE: For Phase 2 P/A Surveys, wherever the phrase "no further summer surveys are recommended" occurs within this document, the USFWS FO(s) is in affect assuming probable absence of IBAT and/or NLEB during the summer.

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 a) NLEB is a clutter-adapted gleaning species (see definition of suitable summer habitat in Appendix A) or b) a project area may not have well-defined travel corridors, surveyors may 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 and NLEB 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). 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 m 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 northern long-eared bat 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[32] and continue for at least 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, take care 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

[32] 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.

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. Indiana and/or northern long-eared bats should not be held for more than 30 minutes after capture, unless the individual is targeted for radio-tracking. Bats targeted for radio-tracking should be released as quickly as possible, but no longer than 30 minutes[33] 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

Severe weather adversely affects capture of bats. Some IBAT and NLEBs 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[34]: (a) temperatures that fall below 50°F (10°C)[35]; (b) precipitation, including rain and/or heavy fog, that 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, 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).

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 and other disturbances will not be permitted within 300 feet of mist nets (or acoustic detectors) during surveys.

DOCUMENTATION OF INDIANA AND/OR NORTHERN LONG-EARED BAT CAPTURES

If an IBAT and/or NLEB is captured during mist-netting, protocols for radio-tracking and emergence survey requirements, as provided in Appendix D and E, respectively, 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; IBATs and little brown bats (*Myotis lucifugus)* can be particularly difficult to distinguish. Photo documentation of all bats captured and identified as IBAT and/or NLEB and the first 10 little brown bats

[33] 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.

[34] With prior USFWS FO approval, a survey may be completed after August 15 if it was initiated in time to be completed by August 15 and extenuating weather circumstances resulted in delaying completion. Delays because of not meeting the acceptable weather requirements are the ONLY valid justification for surveying after August 15. If tracking is proposed, surveys should be scheduled so that tracking is concluded prior to August 15.

[35] Overnight survey temperatures may be lower in northern portions of the NLEB range, coordinate with the local USFWS FO in the northern portions of the range for any variation in temperature requirements.

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

Consider taking short video clips of the bat and its diagnostic features, as videos may also be helpful to later confirm bat identification. If a bat from the genus *Myotis* is captured during mist-netting that cannot be readily identified to the species level, then species verification may be attempted through fecal DNA analysis. Collect one or more fecal pellets (i.e., guano) from the bat in question by placing it temporarily in a holding bag (15 minutes is usually sufficient, no more than 30 minutes is recommended). The pellet (or pellets) collected should be placed in a small vial (e.g., 1.5 ml) with silica gel desiccant; pellets from each individual bat should be stored in separate vials and out of direct light. Fees charged by independent laboratories for sequencing fecal DNA samples is generally inexpensive (approx. $50 per guano sample).

BAT BANDING

Bat banding (i.e. application of any type of band to the forearm of a bat) should be limited to well-designed projects with clear objectives addressing a research question of significant importance to the species' conservation and coordinated with the appropriate USFWS FO and state agency. 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 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 the USFWS FO for approval. All band information needs to be included in the mist net survey report and as part of the annual Section 10 reporting spreadsheet.

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 from 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.

SUBMISSION OF MIST-NETTING RESULTS

Provide results of netting surveys to the appropriate USFWS FO(s) in accordance with previously agreed

upon[36] timeframes and formats[37]. If IBAT and/or NLEB are captured, this report should also include the results of subsequent radio-tracking and emergence counts. Reports should include the following:

1. Copy of prior phase reports (if not previously provided).
2. Explanation of any modifications from original survey plan (e.g., altered net locations)[38]
3. Description of net locations (including site diagrams), net sets (include 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 datasheet below) 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 and NLEB and the first 10 little brown bats 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.

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[36] As discussed in the Introduction, we encourage coordination with USFWS FO(s) prior to implementation of any surveys to ensure that all parties agree upon the need for surveys, the methods proposed, and the decisions from various survey results.

[37] In 2016, the USFWS implemented a new standardized approach for reporting of bat survey data. In addition to a traditional written report, federal permit holders are now required to submit their survey data using the standardized permit reporting spreadsheets available on the USFWS website provided in the intro.

[38] If the USFWS previously agreed upon the study plan, we need to understand whether the revised work still accomplished the agreed upon methods.

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Sample Data Sheets for Bat Surveys

Site No.				Project/Firm:								Date:
Location:												
County:				State:	Quad:							Quadrant:
Lat/Long (DMS):	N			W		Zone:						Surveyors:

#	Time	Species	Age	Sex	Repro. Cond.*	RFA (mm)	Mass (g)	Net/ Ht	Guano/ Hair	Wing Score	Band # Type
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
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25											
26											
27											
28											
29											
30											

Moon Phase:		%
	Rise	Set
Moon:		
Sun:		

Time	Temp	Sky	Wind	# Bats
Avg				

Sky Code	
0	Clear
1	Few Clouds
2	Partly Cloudy
3	Cloudy or overcast
4	Smoke or fog
5	Drizzle or light rain
6	Thunderstorm

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)

*Repro. Cond (Reproductive Condition): (P) pregnant; (L) lactating; (PL) post-lactating; (NR) non-reproductive, (TD) testes descended

Sample Data Sheets for Bat Surveys

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				
Total				

No. of Poles X Net length				
A	=		X	
B	=		X	
C	=		X	
D	=		X	

Other Species:

Comments:

APPENDIX C: PHASE 2 ACOUSTIC SURVEYS

SUMMER ACOUSTIC SURVEY SEASON: May 15 – August 15[39]

PERSONNEL[40]

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. NOTE: Appendix C is intended for use within the IBAT range and/or NLEB hibernating range (see Figure 1); also refer to Appendix J for additional guidance on conducting acoustic surveys in the year-round active range of the NLEB.

Detector Deployment: Acoustic surveyors should have a working knowledge of the acoustic equipment and IBAT and/or NLEB 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 IBAT and/or NLEB calls. 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.

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 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.

NOTE: The acoustic survey protocol may also be used for determining P/A of TCBs using the NLEB LOE for the 2024 field season; however, at this time, qualitative analysis is necessary for linear projects when using an approved version of Kaleidoscope Pro if the MLE is > 0.05 for all site-nights and 10 or more passes are auto-classified as potentially belonging to TCB at any site-night to reduce risk of false negatives. If you choose not to manually vet calls meeting these criteria, then you should assume presence of TCB for the project.

COORDINATION WITH USFWS FIELD OFFICES (FOs)

If not already required by federal permit, we recommend that applicants submit a draft study plan for all survey phases to the USFWS FO(s) for review and approval. Study plans should include a map/aerial photo identifying the proposed project area boundaries, suitable bat habitats and acreages within the project area, the proposed number and tentative locations of acoustic monitoring sites, and the identification of the approved (or candidate[41]) acoustic software program(s) (and version #) used for

[39] With prior USFWS FO approval, a survey may be completed after August 15 if it was initiated in time to be completed by August 15 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.
[40] Coordinate with your local FO regarding any state-specific requirements.
[41] At this time, all acoustic software programs are considered 'candidate' for locations identified in Figure 2.

analysis of calls for the specific project. If a single software program is used for analysis, surveyors will not be allowed to switch programs from what was originally identified in their final study plan.

DETECTOR AND MICROPHONE REQUIRED CHARACTERISTICS

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 if desired. Detectors used during surveys must be able to retain detailed information that is important for distinguishing between bat species with overlapping echolocation characteristics (e.g. high frequency component of the call). Multiple detectors capable of recording high-quality data are available for commercial use (e.g. Anabat Swift, Wildlife Acoustics SM4BatFS, Pettersson D500×). 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 and/or NLEB P/A surveys unless otherwise noted on the Service's IBAT Summer Survey Guidance 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 and NLEB typically forage in habitats that do not completely overlap (see species-specific habitat definitions in Appendix A); therefore, acoustic sites should reflect these differences when targeting both 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 that only one species is likely to use. 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 definition of suitable summer habitat in Appendix A), 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). Ponds and large water-filled road ruts can be productive places to deploy detectors when other water sources are limited. Detectors placed on forest edges are less likely to detect NLEB.

Detector/Microphone placement is critical to the successful isolation of high-quality bat call sequences for later analysis. The following locations are likely to be suitable sites for detectors/microphones to sample for IBAT and/or NLEB, 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, effective data analysis may be impossible, and the results of the sampling effort will likely 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 Chenger 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; Chenger and Tyburec 2014, Fraser et al. 2020); (b) in areas without, or with minimal[42], 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[43] (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 gleaning species (see definition of suitable summer habitat in Appendix A), placement of detectors should be as close to clutter as possible but not in clutter.

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.

[42] 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).

[43] If the surveyor discovers a potential roost and wishes to document bat use, refer to Appendix E for guidance on conducting emergence surveys and contact the USFWS FO(s).

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 majority of 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 be oriented horizontally. In some circumstances, it might be desirable to aim a directional microphone straight 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 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 greater than 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 taken for later submittal to the USFWS FO(s) as part of the acoustic 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 repeat the acoustic sampling effort for that night[44]: (a) temperatures fall below 50°F (10°C)[45] during the first 5 hours of survey period; (b) precipitation, including rain and/or fog, that 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 NOAA National Weather Service station and

[44] With prior USFWS FO approval, a survey may be completed after August 15 if it was initiated in time to be completed by August 15 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.

[45] Overnight survey temperatures may be lower in 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.

summarized in the survey reports.

Weatherproofing

Depending on the brand and model, bat detectors may or may not be weatherproof when delivered from the factory or supplier. Recording without after-market weatherproofing is preferred as the addition of these systems may result in some signal degradation. 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.

For directional microphones, the use of a polyvinyl chloride (PVC) tube[46], generally, in the form of a 45-degree elbow the same diameter as the microphone (Britzke et al. 2010) is acceptable, if the situation requires the use of after-market weatherproofing. The microphone should be placed facing the open end of the elbow and as close to the opening as is consistent with the aim of weatherproofing. The microphone should be pointing at an angle below horizontal so water will not collect in it. Corben & Livengood (2014) showed that the direction of greatest sensitivity of tubes like this varies greatly depending on details of the specific tube shape and the exact position of the microphone. Often the greatest sensitivity will be pointed up at a substantial angle (up to 45 degrees) above horizontal when the microphone itself is pointing 45 degrees below horizontal. Users should be aware of the characteristics of the setup they use so they can know what region is being sampled. Again, the preferred option for weatherproofing detectors is to detach the microphone from the detector so that the detector can be placed in a weatherproof container, but the microphone (tethered by a cable) remains unobstructed.

Other after-market weatherproofing systems may become available and approved by the USFWS provided they show that call quality and the number of calls recorded are comparable to those without weatherproofing.

MINIMUM LEVEL OF EFFORT

The level of acoustic survey effort required for a project will be dependent upon the overall acreage of suitable habitat that may be impacted by the action (directly or indirectly). To determine the acoustic survey effort, quantify the amount of suitable summer habitat within the project area.

NOTE: for projects where impacts other than tree removal are likely (e.g., collision), ensure that P/A surveys are designed to cover all suitable habitat within the entire project area and NOT just the locations where tree removal is planned.

IBAT Range-wide Acoustic LOE (See Figure 1 and Table 2)

Linear projects: a minimum of 4 detector nights per km (0.6 miles) of suitable summer habitat (See Appendix F).

At least 1 detector location for at least 2 calendar nights (can sample the same location or move within the km site).

Non-linear projects: a minimum of 10 detector nights per 123 acres (0.5 km^2) of suitable summer habitat.

At least 2 detector locations per 123-acre "site" shall be sampled over the course of at least 2 calendar nights (may be consecutive) until at least 10 detector nights has been completed.

[46] The PVC option has only been tested with AnaBat SD1/SD2 detectors and directional microphones. It may not perform as well with other detector microphone combinations.

NLEB Range-wide Acoustic LOE (See Figure 1 and Table 2)

Linear projects: a minimum of 4 detector nights per km (0.6 miles) of suitable summer habitat (see Appendix F).

At least 1 detector location for at least 2 calendar nights (can sample the same location or move within the km site).

Non-linear projects: a minimum of 14 detector nights per 123 acres (0.5 km^2) of suitable summer habitat.

At least 2 detector locations per 123-acre "site" shall be sampled over the course of at least 2 calendar nights (may be consecutive) until at least 14 detector nights has been completed.

The acoustic sampling period for each site must begin at sunset[47] and ends at sunrise each night of sampling.

ANALYSIS OF RECORDED ECHOLOCATION CALLS

Step 5. Optional coarse screening - for high frequency (HF) or myotid calls (depending on available H/L frequency filters) or Proceed to Step 6.

a) If no positive detection of HF calls[48] (≥35 kHz) or myotid calls, no further summer/active season surveys recommended.

b) If positive detection of HF or myotid calls, then
   i) proceed to Step 6 for further acoustic analysis; **OR**
   ii) assume presence of IBAT and/or NLEB and coordinate with the USFWS FO(s); **OR**
   iii) assume presence and proceed to **Phase 3**.

Step 6. Conduct Automated Acoustic Analyses for each site that had HF or Myotid calls from Step 5 or ALL sites and ALL calls if Step 5 was not conducted.

Use **one or more** of the currently available 'approved' acoustic bat ID programs[49] (use most current approved software versions available and manufacturer's recommended settings for IBAT and/or NLEB P/A surveys) as previously identified in your Phase 2 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. At this time, no acoustic bat ID programs are 'approved' for many western states (Figure 2). Two or more of the currently available 'candidate' programs must be used for surveys conducted in these locations (always use most recent versions of software programs).

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. Beginning with acoustic data

[47] 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

[48] HF calls are defined as individual call pulses whose minimum frequency is ≥35 kHz.

[49] Approved and candidate programs are listed on the USFWS website provided in the intro; note all programs are considered 'candidate' for areas identified in Figure 2.

from night one at each acoustic site, run each night's data for each site through your chosen ID program(s). Review results by site by night from each acoustic ID program used[50].

a) If IBAT and NLEB presence is considered unlikely by the approved and candidate program(s) used in analysis, then no further summer surveys recommended.

b) If IBAT and/or NLEB presence is considered likely at one or more sites on one or more nights by any approved or candidate program(s) used in analysis, then

i) proceed to Step 7 for qualitative ID; **OR**
ii) assume presence of IBAT and/or NLEB and coordinate with the USFWS FO(s); **OR**
iii) assume presence and proceed to **Phase 3**.

Step 7. Conduct Qualitative Analysis of Calls.

At a minimum, for each detector site-night a program identified IBAT and/or NLEB presence likely (i.e., P<0.05), review all HF (i.e., ≥35 kHz) call files (regardless of MLE value and including no ID files) from that site-night. Qualitative analysis (i.e., manual 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 Reporting Requirements below).

a) If no visual confirmation of IBAT and NLEB, then no further summer/active season surveys recommended[51].

b) If visual confirmation of IBAT and/or NLEB, then

i) assume presence of IBAT and/or NLEB and coordinate with the USFWS FO(s); **OR**
ii) assume presence and proceed to **Phase 3**.

SUBMISSION OF ACOUSTIC SURVEY RESULTS

NOTE: All originally recorded (ZC or FS) data MUST be maintained for a period of 7 years and be made available to the USFWS FO(s), if requested. Failure to do so may result in invalidation of survey results. Results of acoustic survey data collected as part of P/A surveys must also be submitted annually in Section 10 reporting spreadsheets to the USFWS.

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)[52]. Each acoustic survey report should include the following[53] (also, see checklist at end of this appendix):

[50] The approved acoustic identification programs all have implemented a maximum likelihood estimator (MLE) at this time. If the analysis of collected calls at a given site on a given night results in the presence of IBAT and/or NLEB with high levels of certainty (P<0.05), then select one of the options available in Step 6b.
[51] If you identify any suspected mis-identifications from programs, the Service will share those results with the software manufacturer(s) and the USGS to assist with future improvements and testing of software.
[52] As discussed in the Introduction, we encourage coordination with USFWS FO(s) prior to implementation of any surveys to ensure that all parties agree upon the need for surveys, the methods proposed, and the decisions from various survey results.
[53] In 2016, the USFWS implemented a new standardized approach for reporting of bat survey data. In addition to a traditional written report, federal permit holders are now required to submit their survey data using the standardized permit reporting spreadsheets available on the IBAT Summer Survey Guidance webpage (http://www.fws.gov/midwest/Endangered/mammals/inba/inbasummersurveyguidance.html).

1. Copy of habitat assessment (if not previously provided)
2. Explanation of any modifications from original survey plan (e.g., altered site locations)[54]
3. Full names of all personnel conducting acoustic surveys, including those that selected acoustic sites and deployed detectors
4. Full name and resume of individual(s) conducting qualitative acoustic analyses (if applicable)
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 but not limited to: detector GPS coordinates for each detector, survey dates, survey hours
7. Map identifying acoustic detector locations and a corresponding table including the GPS coordinates. Include arrow(s) showing direction(s) of microphone(s)
8. Photographs documenting the location of each detector, the orientation of the detector, and the intended sampling area. Include detector and something 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. Discussion of what software program(s) was/were used (including 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 (were additional nights added? was detector functioning? was placement appropriate?)
15. If manual vetting was used, discussion of how this was done (e.g., what keys were used?)
16. If manual vetting was used, detailed analysis and results of any qualitative acoustic analysis conducted on those projects where a program(s) considered IBAT and/or NLEB 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 manual vetting, and rationale for any changes.
17. Any other information requested by the local USFWS FO(s) related to the project

[54] If the USFWS previously agreed upon the study plan, we need to understand whether the revised work still accomplished the agreed upon methods.

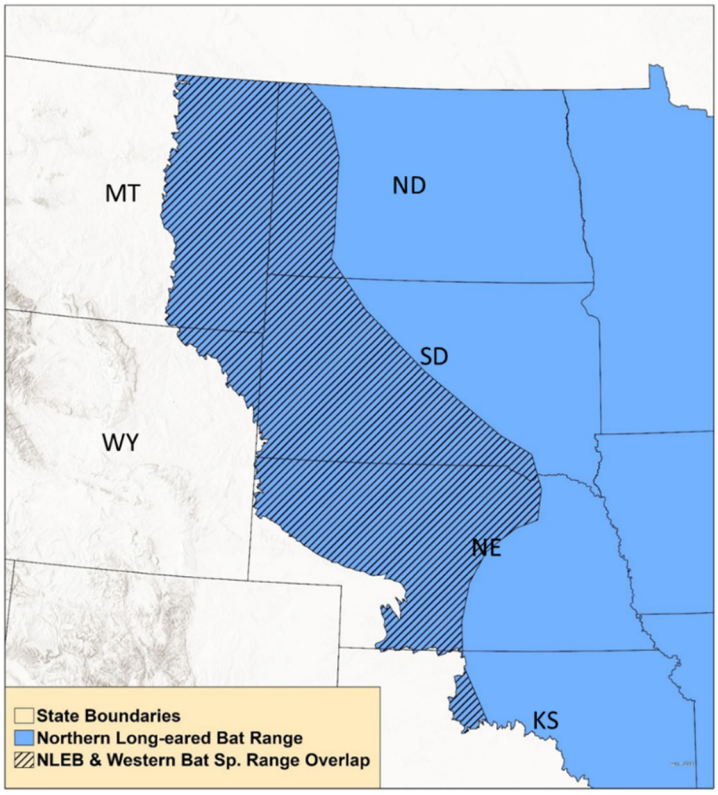

FIGURE 2. Portion of NLEB range overlapping with western bat species.

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General Checklist for Acoustic Surveys of Indiana and/or Northern Long-eared Bats

The following items should be documented and clearly presented within acoustic bat survey reports submitted to the Service

ACOUSTIC SURVEY INFO

- ☐ Project Name
- ☐ Site ID No./Name
- ☐ State and County
- ☐ Site Lat./Long. Coordinates (e.g., decimal degrees, NAD83)
- ☐ Approx. accuracy of Lat./Long. Coordinates
- ☐ Survey Date(s)
- ☐ Person who Selected Acoustic Site(s)
- ☐ Person who Deployed Detector(s)
- ☐ Detector Brand & Model
- ☐ Microphone Brand & Model
- ☐ Microphone Type: Directional/Hemispherical/Omnidirectional
- ☐ Type of Weatherproofing (if any)
- ☐ Microphone Height above Ground-level Vegetation(m)
- ☐ Distance from Nearest Vegetation or other Obstruction (m)(apart from veg. on ground)
- ☐ Horizontal Orientation of Microphone (1-360°)
- ☐ Vertical Orientation of Microphone (assuming 0° is parallel with horizon)
- ☐ Photographs of Detector Set-up at each Site
- ☐ Detector Settings and/or Log Files (all settings used for each brand/model of detector. For example, sensitivity, gain, data division, 16k high filter, sample rate, min/max duration, min trigger freq., trigger level, etc.)
- ☐ Survey Start Time (military)
- ☐ Survey End Time (military)
- ☐ Methods used to Field-test proper Functioning of Detector
- ☐ Were calls collected in Full Spectrum or Zero Crossing?
- ☐ Habitat Type and/or Feature Surveyed
- ☐ Weather Conditions during Survey Period

ACOUSTIC ANALYSIS INFO

- ☐ Program used to convert Full Spectrum to Zero Cross (if applicable)?
- ☐ Filter(s) used (if any) and parameters used (e.g., CFRead, noise, bug, etc.)
- ☐ Name of Service-approved Bat ID Software Program(s) and Version(s) used and Candidate program(s)(if used)
- ☐ Program Settings (if applicable):
  - Min. # of pulses for species ID
  - Min. # of pulses per group ID
  - Min. discrim. prob. for species ID
  - Other relevant settings affecting ID
  - Suite of species/groups included in program analysis
- ☐ Table summarizing Number of Calls ID'd for each Species/Site/Night/Program (including MLE p-values)
- ☐ If Qualitative Analysis was conducted, include Number of Calls Confirmed through Qualitative ID for each Species/Site/Night
- ☐ Full Name of Person(s) who conducted Qualitative Analysis
- ☐ Additional Survey Reporting Requirements
- ☐ Acoustic Report Appendices:
  - data sheets and maps,
  - photographs of detector set-ups,
  - computer screen captures of representative bat species identified during acoustic analyses, and
  - resume(s) highlighting relevant qualifications of person(s) who conducted qualitative analysis (e.g., experience visually identifying *Myotis*, certificates of training, publications etc.)

APPENDIX D: PHASE 4 RADIO-TRACKING

PERSONNEL

Transmitter Attachment: A qualified biologist[55] who is experienced in handling IBAT and/or NLEB 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 transmittered bats must be present and actively involved in all tracking activities for IBAT and/or NLEB as further explained in the protocol below.

NOTE: The radio-tracking protocol may also be used for captured TCBs; however, radio-tracking of TCB should prioritize identification of the immediate roosting area of the transmittered bat given the difficulty in locating the bats exact roosting location.

METHODS

If one or more IBAT and/or NLEB are captured, the following radio-tracking protocols will be applicable:

1. 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. Since the maximum holding times for IBAT and/or NLEB targeted for radio-tracking is 30 minutes[56], or as allowed in federal and state permits, surveyors should be prepared to place transmitters on bats immediately following their capture to minimize holding times.

2. 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-pregnant weight.

3. 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

[55] 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 and/or NLEB. 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.

[56] 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

- https://www.holohil.com/wp-content/uploads/2015/07/carter2009.pdf
- https://www.holohil.com/links/bat-attachment/#:~:text=Transmitters%20should%20be%20attached%20to,the%20fur%20is%20not%20clipped.

4. Adhesives (or "glues") used during radio-tracking and telemetry studies[57] to attach transmitters to bats must be included in the "Approved Adhesives for P/A Telemetry Studies" list (Table 3)[58]. 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. 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 3). For a list of examples of products that are currently not permitted, see Table 4.

TABLE 3. Approved Adhesives

Type	Active ingredients	Name	Manufacturer
Latex-based Surgical Cement[1]	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.
Silicone-based Surgical Adhesive[2]	Silicone solids, ethyl acetate	Uro-Bond III 5000	Urocare Products, Inc.
Butyl-cyanoacrylate Surgical Adhesives[3]	100% n-butyl cyanoacrylate	Vetbond	3M

[1] Liquid, malleable bonding cements that contain latex and take several minutes to cure. Bonds skin to skin.
[2] Liquid, malleable surgical adhesives that contain silicone and takes several minutes to cure. Bonds appliances to skin.
[3] Stiff, cyanoacrylate-based products react quickly with water to form a durable, waterproof bond.

TABLE 4. Examples of Prohibited Adhesives. (This list is not exhaustive)

Type	Active ingredients	Name	Manufacturer
Octyl-cyanoacrylate Surgical Adhesives[1]	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	Locktite 422	Henkel Adhesives

[1] Stiff, cyanoacrylate-based products react quickly with water to form a durable, waterproof bond.

[57] The 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 up pit tag wounds. Therefore, products such as (but not limited to) F2 Adhesive, Lash Grip, Shut Eye, and Locktite Superglues, whose Safety Data Sheets specifically state that the product is not intended for application to skin and may cause skin irritation, should be avoided.
[58] To request a specific product addition to the list of adhesives in Table 3, submit a request to FW4_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.

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 3). Report information to the Guidelines Team (FW4_Bat_Survey_Guidance@fws.gov).

FIGURE 3. A photo of a back of an Indiana bat 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.

5. 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).

   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 for P/A surveys.

6. 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, fall 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 Appendix E for 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.

7. 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

IBAT and/or NLEB Roost Datasheet".

8. 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

Phase 4 radio-tracking results should be included with the Phase 2 or 3 mist-netting report and submitted to the appropriate USFWS FO(s). Each report should include the following information related to radio-tracking efforts[59]:

1. Copy of prior phase reports (if not previously provided)
2. Explanation of any modifications from original survey plan (e.g., number of transmitters used, frequency of transmitters changed)[60]
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 and/or NLEB data collected from summer 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 and/or NLEB 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
8. Any other information requested by the local USFWS FO(s) where work was conducted

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American Society of Mammalogists. 1998. Guidelines for the capture, handling and care of mammals. Journal of Mammalogy 79:1416-1431.

[59] In 2016, the USFWS implemented a new standardized approach for reporting of bat survey data. In addition to a traditional written report, federal permit holders are now required to submit their survey data using standardized permit reporting spreadsheets available on the USFWS website provided in the intro.

[60] If the USFWS previously agreed upon the study plan, we need to understand whether the revised work still accomplished the agreed upon methods.

USFWS INDIANA AND/OR NORTHERN LONG-EARED BAT ROOST DATASHEET

Biologists (Full Name):_____ Date: _____

UTM: Zone_____ Easting _____ Northing_____ *OR*

LAT_____ LONG_____

Property Owner: _____ Phone#_____

State_____ County_____ Site #_____

Roost #_____ Roost Name: _____

Roost Tree Data

Species: _____ Live __ Snag __ Other _

(if other, explain) _____

DBH (in or cm) _____ Total Height (ft or m) _____

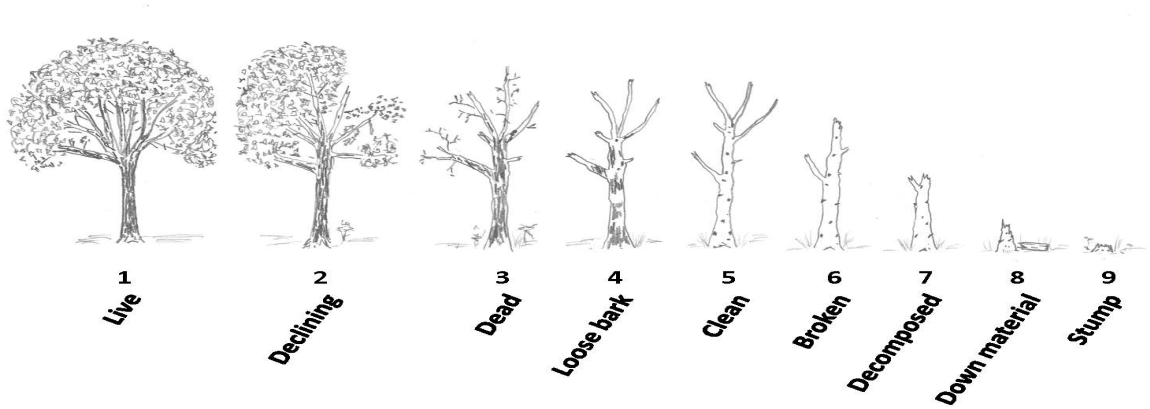
Height of roost area (if known) _____Dist. from capture site_____

Roost position aspect (deg) _____

Exfoliating bark on bole (%) _____ Describe: sloughing _ platy_ tight_

Cavities present? ____ If so, describe: _____

Roost Decay State: 1 2 3 4 5 6 7 8 9 Other



Roost tree or snag canopy position: Dominant __ Co-Dominant __ Suppressed _

Surrounding Habitat Condition

Canopy closure at roost (%) _____

Approximate woodlot size (ac or ha) _____ Distance to non-forest (ft or m) _____

Describe forest/woodlot current condition (mature, partially cut-over, burned, insect damage, etc.)

_____

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Additional Comments_____

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APPENDIX E: PHASE 4 EMERGENCE SURVEYS

PERSONNEL

Qualified biologists[61], biological technicians, and any other individuals deemed qualified by a local USFWS FO may conduct emergence surveys for IBAT and/or NLEB by following the protocols below.

EMERGENCE SURVEYS FOR KNOWN IBAT AND/OR NLEB ROOSTS

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

NOTE: The emergence survey protocol should not be used for radio-tracked TCBs or emergence surveys of identified potential roosts given the variability in roosting locations typically used by the species (e.g., roosting in dead leaf clusters in the canopy of live trees) and difficulty observing bats emerging. 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.

1. Bat emergence surveys should begin one half hour before sunset[62] 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 bats 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 use the attached (or similar) “Bat Emergence Survey Datasheet”.

[61] 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 and/or NLEB. 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.

[62] 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

4. Surveyors should also complete an "IBAT and/or NLEB Roost Datasheet" for each roost known to be used by one or more IBAT and/or NLEB (see Appendix D for an example).

5. Completed datasheets should be included in reports prepared for the USFWS.

EMERGENCE SURVEYS FOR POTENTIAL IBAT AND/OR NLEB ROOSTS

In some limited cases (e.g., individual hazard tree removal during the active season[63]), surveyors may have the option of conducting emergence surveys for individual potential IBAT and/or NLEB roosts to determine use prior to removal. Evaluations whether potential roosts meet the criteria to conduct emergence surveys should be for each individual tree rather than groups of trees. 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/ cleared 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[64]. 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)[65] 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. An online directory of USFWS offices is available at: http://www.fws.gov/offices/.

2. If the USFWS FO(s) approves/concurs with Step 1, then follow the emergence guidelines 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 emergence survey:

    a. If **no** bats were observed emerging from the potential roost(s), then it maybe 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.

[63] The active season periods for IBat and NLEBs are available in Appendix L.
[64] If a potential bat roost tree poses an imminent threat to human safety or property, then emergency consultation procedures should be followed as appropriate. (50 CFR §402.05). If a hazard tree does not pose an imminent threat, then the 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 to avoid potential adverse effects to non-volant pups (see Appendix L for specific inactive and pup season dates for your area).
[65] Areas containing >10 hazard trees will be assessed by the USFWS on a case-by-case basis with the project proponent.

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. Each survey report should include the following information related to emergence survey efforts[66]:

1. Copy of prior phase reports (if not previously provided)
2. Explanation of any modifications from the Phase 4 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 emergence surveys for IBAT and/or NLEB(s) including GPS coordinates
5. Full names of personnel present during emergence survey efforts and who conducted emergence surveys of roosts
6. Photographs of each identified roost
7. Copies of all "Emergence Survey" and "IBAT and/or NLEB Roost" datasheets
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)

[66] In 2016, the USFWS implemented a new standardized approach for reporting of bat survey data. In addition to a traditional written report, federal permit holders are now required to submit their survey data using standardized permit reporting spreadsheets available on the USFWS website provided in the intro.

USFWS BAT EMERGENCE SURVEY DATASHEET

Date: _____ Surveyor(s) Full Name: _____

State: _____ County: _____ Project Name: _____
Site Name/#: _____ Roost Name/# _____ Bat #:_____

Lat/Long or UTM of Roost: _____
Description of Roost/Habitat Feature Surveyed: _____

_____

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

_____

Other Suspected Bat Species (explain): _____
Weather Conditions during Survey (temperature, precipitation, wind speed):

_____

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 infra-red, night vision, or thermal-imaging video camera or spotting scope and an ultrasonic bat detector are strongly recommended but not required.

Time	Number of Bats Leaving Roost*	Comments / Notes

APPENDIX E: PHASE 4 EMERGENCE SURVEYS

Site Name/#: _____ Roost Name/#: _____

Time	Number of Bats Leaving Roost*	Comments / Notes
Total Number of Bats Observed Emerging from the Roost/Feature During the Survey:		

* If any bats return to the roost during the survey, then they should be subtracted from the tally.

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

APPENDIX F: LINEAR PROJECT GUIDANCE

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 along a linear project that do not contain suitable habitat should be skipped until the next patch of suitable habitat is encountered (Figure 4). 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 4, 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 4, 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.

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., an acoustic survey may be substituted). Similarly, if an area of forest habitat that seemed suitable from aerial photography appears to be unsuitable or of particularly low quality 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.

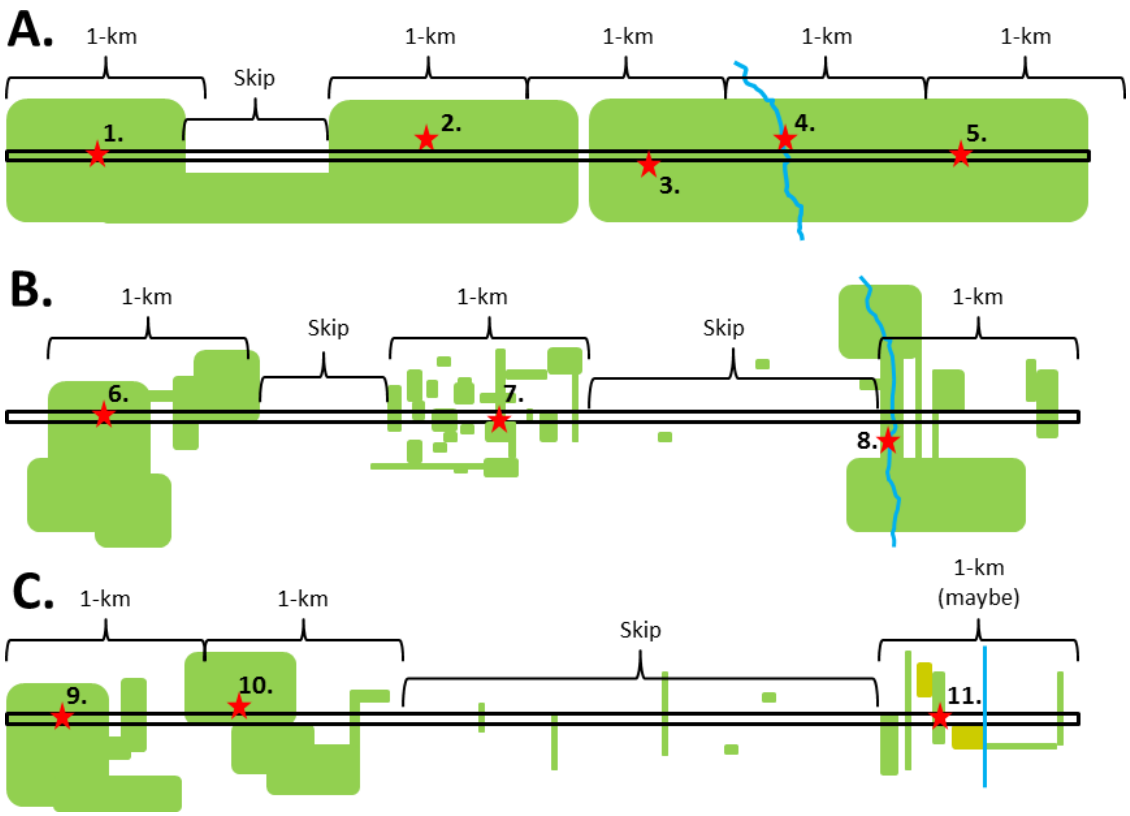

FIGURE 4. Conceptual linear project (black double lines) through relatively contiguous (A.) and fragmented (B. and C.) forested habitats (green patches) delineated into approximate 1-km survey sections. Numbered red stars represent suitable survey sites (1-11) on or near the project boundaries. Blue lines represent natural streams (A. and B.) and a ditch (C.). Yellow-green patches near Site 11 represent low-quality habitat.

APPENDIX G: THE OUTER–TIER GUIDANCE

Since early radio-tracking studies in Illinois, it has become standard practice for USFWS FOs to assume that an IBAT summer maternity colony will utilize suitable habitat within approximately 2.5 miles of its primary roost tree(s)/focal roosting area. However, if a reproductive adult female or juvenile IBAT is captured (or acoustically detected), but not radio-tracked to a roost site, then FOs typically assign its capture site a 5-mile conservation buffer and assume that its roost tree is located somewhere within 2.5 miles of the capture site. This approach is further detailed in the Service's IBAT Section 7 and Section 10 Guidance for Wind Energy Projects[67].

NOTE: The same principles used for the IBAT can be used for the NLEB using a 3-mile conservation buffer around capture/detections. Additionally, the outer-tier guidance may also be used for TCB presence/probable absence surveys using a 3-mile conservation buffer around capture/detections. "Outer-tier" guidance only applies to summer captures/detections (not hibernacula).

Because a 5-mile buffer encompasses four times more area than a 2.5-mile buffer (50,265 acres vs. 12,566 acres), it is reasonable to assume that only approximately 25% of a 5-mile buffered area is actually occupied by the documented IBAT summer maternity colony at any given time and that approximately 75% remains unoccupied or could be used by members of another yet undocumented colony(s). Therefore, if a subsequently proposed project is either ≤123 acres in size or affects ≤1% of existing suitable summer habitat within a 5-mile buffer (whichever is greater) but is situated ≥2.5 miles from the original capture/detection site, then it will have a relatively low probability of being within the true maternity colony home range (assuming suitable habitat is more or less evenly distributed in all directions from the capture site) (See Figures 5 & 6). Allowing project proponents of such "outer tier" projects to conduct a summer P/A survey for IBAT and/or NLEB using the standard survey level of effort (LOE) (as outlined in Appendix B and C) in such cases is reasonable and the additional survey data would 1) help refine the home range boundaries of the original colony, 2) confirm presence of additional colonies if present, 3) provide additional radio-tracking opportunities /roost tree locations, and 4) provide an option for project proponents to survey instead of always assuming presence.

Prior to emergence of WNS, NLEBs were widely distributed throughout much of the eastern U.S. and Canada. Although not nearly as common today, surveys show that the species continues to occur in pockets distributed throughout the WNS-impacted portion of its range. NLEB populations continue to remain stable in portions of the Southeast Coastal Plain (Virginia, North Carolina, and South Carolina) as well as in Alabama, Mississippi, and Louisiana where they are active year-round in forested or wooded habitats due to mild winter temperatures, and these populations, which are not dependent upon caves or mines for hibernation, may not be susceptible to WNS. Similarly, IBATs within the Northeast and Appalachian Recovery Units (RUs) have seen significant declines due to WNS; however, populations remain stable to increasing within the Midwest and Ozark-Central RUs (USFWS unpublished data 2023).

Due to the severity of the impact of WNS on populations across much of the hibernating NLEB and eastern IBAT RUs (i.e., Northeast and Appalachian) ranges, there is uncertainty where surviving NLEBs and IBATs are located in these portions of their ranges. To address this uncertainty, we recommend allowing project proponents whose project is either ≤123 acres in size or affects ≤1% of existing suitable summer habitat within a 5-mile (IBAT) or 3-mile (NLEB) buffer (whichever is greater) the opportunity to survey in both the inner-tier and outer-tier of known Hibernating Range NLEB buffers and IBAT buffers within the Northeast and Appalachian RUs when the buffered occurrence was prior to 2 years[68] after WNS was first confirmed in the state. We recommend coordinating with the local USFWS FO in the state where the proposed project survey is planned to determine whether inner-tier NLEB and/or IBAT

[67] Document is available on the USFWS website provided in the introduction.
[68] An alternative year may be used if the USFWS FO(s) has data to more precisely support when WNS affected abundance and distribution in their state.

buffers can be surveyed or not. Provided proponents use at least the prescribed minimum LOE for NLEBs and/or IBAT in these locations and the survey is approved by the Field Office, the USFWS would accept the results as evidence of presence/probable absence. For example, if WNS was confirmed in 2011, project proponents can survey both inner and outer tiers of a known buffer for presence/probable absence if the occurrence was in 2012 or earlier. For this example, presence/probable absence surveys could not be conducted in the inner tiers of occurrence buffers documented in 2013 and later.

NOTE: 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 (or 3-mile for NLEB) 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 (or 3-mile for NLEB) buffer contains suitable summer habitat; or (3) other site-specific reasons.

If a project proponent of an "outer-tier" project coordinates with the USFWS FO(s) upfront and conducts a valid summer mist-netting (Appendix B) or acoustic (Appendix C) survey using the appropriate LOE and does not capture/detect an IBAT and/or NLEB(s), then no IBAT or NLEB related restrictions will be required for that specific project area. However, all restrictions/ assumptions of IBAT and/or NLEB presence outside of a completed outer-tier project survey area shall remain intact indefinitely within the 5-mile (or 3-mile for NLEB) buffer zone or until additional negative survey data or discovery of roost trees indicate adjustments to a buffer are warranted by USFWS. Negative survey results from "outer-tier" projects are valid for 5 years for that project area. If an IBAT and/or NLEB(s) is captured/detected/radio-tracked during the survey, then the project area will be presumed to be occupied, restrictions will remain in place, and the USFWS FO(s) will reassess/adjust the original buffer(s) if warranted using the newly acquired bat location data.

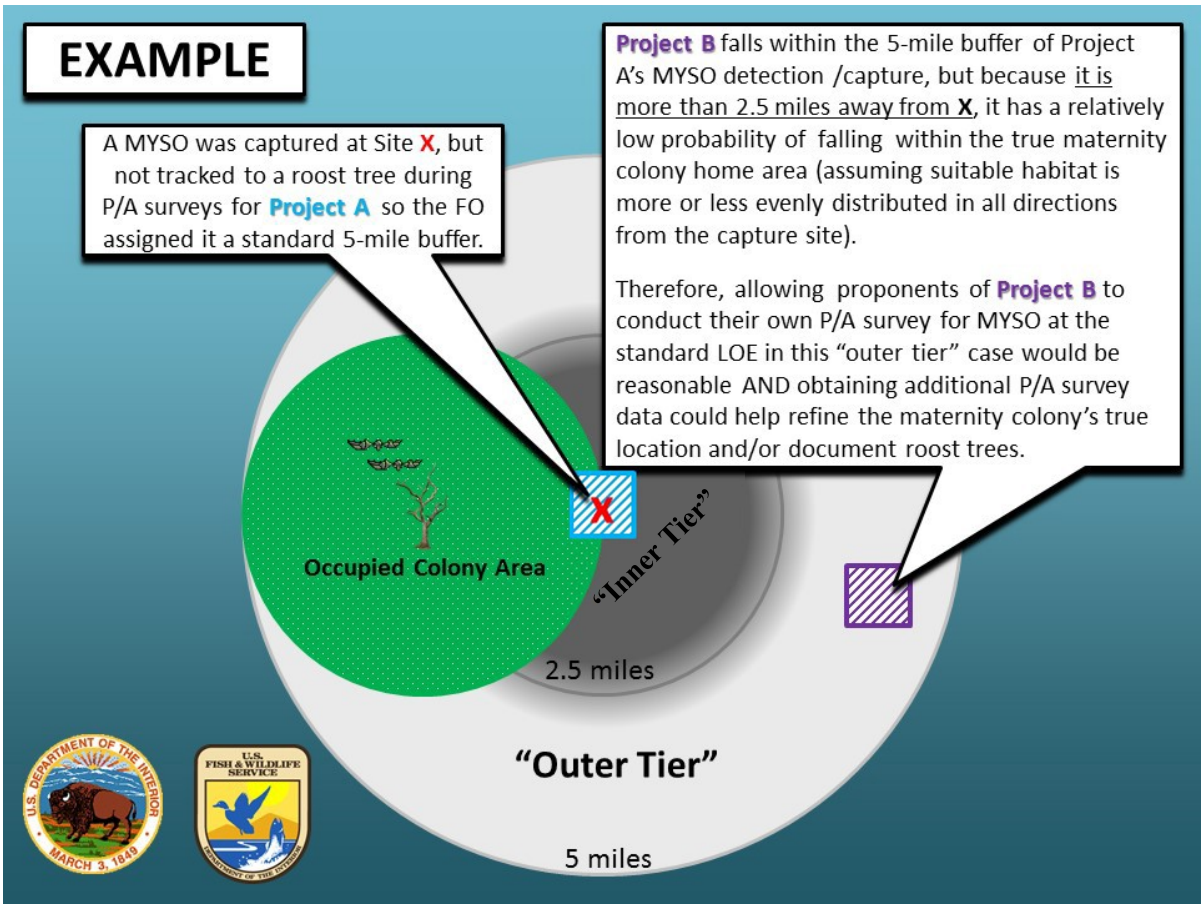

FIGURE 5. Graphical example depicting the proper application of the outer-tier guidance.

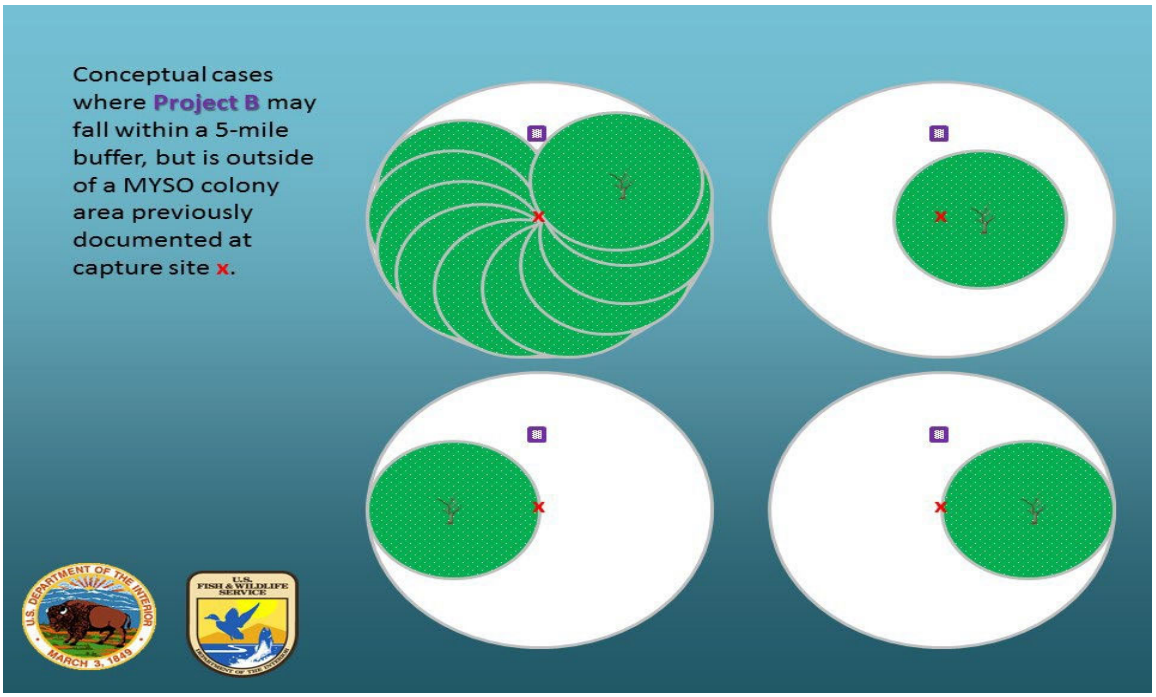

FIGURE 6. Hypothetical outer-tier scenarios where a proposed project area (depicted by a purple square) falls outside of the "true" IBAT maternity colony area(s) (depicted in green).

APPENDIX H: POTENTIAL HIBERNACULUM SURVEY GUIDANCE

Indiana and NLEBs have been documented using caves (and their associated sinkholes, fissures, and other karst features), as well as anthropogenic features such as mines and tunnels as winter hibernation habitat (i.e., hibernacula). Project proponents need to evaluate whether any potentially suitable IBAT and/or NLEB hibernacula exist within a proposed project area. This knowledge will be derived from a variety of sources. The following phased process should be followed to determine presence or probable absence of IBAT and/or NLEB in potential hibernacula:

NOTE: The potential hibernaculum survey guidance may also be used for TCB presence/probable absence surveys, including winter (internal) surveys, in portions of the TCB range that the species hibernates. TCBs use a wider variety and warmer hibernacula than what would often be considered as suitable for IBATs and NLEBs. Coordinate with the local USFWS FO(s) if you are proposing to use this guidance to survey for TCB.

PHASE 1 – INITIAL PROJECT SCREENING

Step 1. Coordinate with the USFWS FO(s) and appropriate state natural resource agencies regarding existing federally listed bat hibernaculum or other occurrence information.

Prior to initiating P/A surveys (Phase 2) of potential IBAT and/or NLEB hibernacula (as determined by the Phase 1 Habitat Assessment), the USFWS FO(s) and appropriate state natural resource agencies must be contacted to determine if any caves or other underground features have been previously documented as hibernacula or other habitat for federally listed bat species. Any proposed surveys of previously documented hibernacula must be coordinated directly with these agencies to ensure that adverse effects to listed species do not occur because of the survey.

Step 2. 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 a solid understanding of karst topography and/or surface features associated with underground mines. These initial assessments can be completed at 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 continues < 50 feet (15.2 m) and terminates with no visible fissures that bats can access;

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 to Step 3. FO- approved results from Step 2 will remain valid for a minimum of five years. **NOTE**: longer time frames may not be appropriate due to cave/mine dynamics.

Step 3. Conduct a Phase 1 Habitat Assessment of Potentially Suitable Hibernacula.

If underground openings are documented during field surveys in Step 2 and cannot be dismissed during initial project screening above, then a qualified biologist[69] will need to conduct a Phase 1 Habitat Assessment to determine whether bats using a potentially suitable hibernaculum within a project area could be adversely affected by the proposed project as described below (see Phase 1 Habitat Assessment Sample Data Sheet).

Habitat assessments should include all entrances or openings that will be directly or indirectly impacted by the proposed project. This would include those caves (and their associated sinkholes, fissures, and other karst features), 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.

The results of a Phase 1 Habitat Assessment should be submitted to the USFWS FO(s) and State regulatory partners (when applicable) for review and approval prior to proceeding to Phase 2. FO-approved results from Step 3 will remain valid for a minimum of five years. **NOTE**: longer time frames may not be appropriate due to cave/mine dynamics.

PHASE 2 – PRESENCE/PROBABLE ABSENCE SURVEYS

Surveys to Confirm Use of Suitable Winter Habitat

If suitable winter habitat is discovered as a result of the Phase 1 Habitat Assessment above, 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 Phase 2 survey. The survey protocols for determining occupancy are detailed below. Some surveys may require modification (or clarification) of these guidelines; 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 summer and/or winter surveys to the appropriate FO(s) prior to clearing or altering of identified bat habitat. The USFWS FO(s) will review the results of P/A surveys conducted according to these guidelines for the purposes of determining whether IBAT and/or NLEB are occupying hibernacula in the project area and whether they may be adversely affected by any proposed actions.

[69] A qualified biologist is an individual who holds a USFWS Recovery Permit (Federal Fish and Wildlife Permit) for IBAT and/or NLEB in the state/region in which they are surveying. Alternatively, in States within Region 5 of the USFWS, state agencies assess qualifications and provide authorization to net, handle, and conduct hibernaculum surveys of/for IBAT and/or NLEB in that State (authorization is only valid in the State that provides the authorization). 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.

WINTER (INTERNAL), FALL, AND SPRING SURVEY PROTOCOLS FOR IDENTIFYING POTENTIAL BAT HIBERNACULA

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. Users of this guidance must follow the recommendations provided in the most recent USFWS Cave Advisory[70] 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) and appropriate state natural resources agencies prior to initiation (see example USFWS Project Proposal Form).

Winter (Internal) Survey

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)[71]. 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. Only sites that are deemed safe should be entered at the surveyor's discretion.

Potential hibernacula that are deemed safe to enter should be entered and all its accessible passages visually surveyed for the presence of IBAT during mid-winter (i.e., beginning January 1st and ending prior to March 1st of the same calendar year (also see Appendix 4 of the USFWS 2007 Indiana Bat Draft Recovery Plan: first revision). **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 for the IBAT. If the qualified biologist, who completed the Phase 1 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. 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 federally listed bat species, including the IBAT and/or NLEB (also see Sample Data Sheet for Fall or Spring Surveys of Potential Hibernacula).

Fall or Spring Emergence Survey

1A. Fall surveys of mine/cave entrances must be conducted between September 15 and October 31[72] and prior to any tree clearing by the project applicant. 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 Phase 1 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 October if forecasted weather conditions

[70] https://www.whitenosesyndrome.org/press-release/updated-cave-advisory-recommendations-for-managing-access-to-subterranean-bat-roosts-to-reduce-the-impacts-of-white-nose-syndrome-in-bats

[71] 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.

[72] Timing of fall surveys may need adjustment based on location and weather conditions leading up to the survey. Coordination with local USFWS FO(s) and State regulatory partners (when applicable) during development of the study plan/project proposal form is required.

require it, at least 3 nights of sampling were completed during the first 3 weeks of the survey 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. Surveys of a potential hibernaculum are in addition to any summer P/A surveys that may be required for a proposed project.

OR

1B. Spring surveys of mine/cave entrances must be conducted between April 1 and April 21[73] and prior to any tree clearing by the project applicant. 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 Phase 1 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) and appropriate state natural resource agencies prior to surveying to ensure that adequate survey results are achieved. Surveys of a potential hibernaculum are in addition to any summer P/A surveys that may be required for a proposed project.

2. Unless otherwise approved by the USFWS FO[74], the capture of an IBAT and/or NLEB 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 to the IBAT and/or NLEB. If the mine/cave survey season (i.e., September 15 to October 31 for fall sampling and April 1 to April 21 for spring sampling) ends prior to the completion of the required additional sampling, then sampling must be completed the following fall or spring.

3. 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 to 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.

4. 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.

5. 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 the 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 over-night.

[73] Timing of spring surveys may need adjustment based on location and weather conditions leading up to the survey. Coordination with local USFWS FO(s) and State regulatory partners (when applicable) during development of the study plan/project proposal form is required.

[74] Additional survey effort 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.

Plastics or other materials used to block the entrances should be removed each night immediately after conducting the survey. Entrances that are not connected (e.g., as determined by existing mine maps) do not have to be surveyed simultaneously.

6. 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 noise, lights and 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.

7. 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.

8. 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.

9. All bats captured during fall or spring surveys must be temporarily marked with a USFWS FO-approved non-toxic material that will last for the remainder of the survey period to identify any recaptures during subsequent survey nights.

10. If IBAT and/or NLEB (or 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.

11. 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 beginning 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.

12. 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.

13. At least one member of each survey crew must hold, and have in his or her possession, a valid endangered species collection permit issued by USFWS[7581] and/or the appropriate state natural resource agency 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 your federal permit, as well as any State 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 as long as the traps/nets are being monitored as defined in bullet 6 above.

14. All survey efforts must follow the most recent USFWS decontamination protocols regarding WNS.

[75] Surveyors working in States within Region 5 of the USFWS only require a permit from the State where the survey is taking place.

Phase I Habitat Assessment Sample Data Sheet

Location _____

Observers (include permit numbers) _____

Latitude _____ **Longitude**[76] _____

Date ___ **Time** _____ **Temp (outside)** _____

	Opening #1	Opening #2	Opening #3	Opening #4
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				
Foraging Signs? (e.g., moth wings)				

Are any portals suspected or known to be connected? Which ones?

Any observable side passages?

Additional comments:

Entry of abandoned mine portals, quarries, or caves can be extremely dangerous because of the potential for ceiling collapse and presence of toxic gases. Safety or health problems may occur as a result of entering abandoned mines. The FWS does not authorize or require anyone to enter any potential hibernaculum that is or could be unsafe while implementing surveys. These guidelines do not require any applicant or applicant employee, consultant, lessee, or other such designee to enter any cave, quarry, or mine portal.

[76] Provide coordinates for each opening.

Sample Data Sheet for Fall or Spring Surveys of a Potential Hibernaculum

DATE:	TEMPERATURE	Start:	End:
PRECIPITATION*:		WIND*:	
MOONLIGHT:	TIME	Start:	End:
PERSONNEL (include permit numbers):		LOCATION (lat/long):	

Time	Species	Age	Sex	Repro Cond.	RFA (mm)	Mass (g)	Flight Direction (in or out)	Notes and General Comments

***Precipitation and Wind should be measured hourly**

****Repro. Cond (Reproductive Condition): (P) pregnant; (L) lactating; (PL) post-lactating; (NR) non-reproductive, (TD) testes descended**

APPENDIX I: CALCULATING LOE FOR A 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). One of the stated objectives of the IBAT and NLEB survey guidelines is to maximize the potential for detection/capture of these species at a minimum acceptable LOE. The USFWS has long recognized that offering a combination acoustic and mist-netting option has advantages over the current single technique options presented in Appendices B and C; however, developing the methodology to calculate an acceptable LOE for a combined approach is challenging because our recommended LOE approaches were calculated based exclusively on either mist-netting or acoustic datasets.

Some advantages of a combined approach are that it provides flexibility to address challenging survey conditions (e.g., situations where mist-net set-ups are limited or the reverse). 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 sites/acoustic locations 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 mist-net nights of effort/123 acres = Y acoustic nights of effort/123 acres

First, determine the proportion of effort that will be applied using either the mist-netting or acoustic method. The decision to use mist-netting or acoustic should be made with consideration to the project area and the total number of high-quality survey sites of each survey method available for the species (i.e., IBAT and/or NLEB) the survey is being conducted for. Next, refer to Table 2 of the guidance and identify the highest LOE for the selected method and species' being surveyed. Finally, use the information above to calculate the total survey LOE that would be accomplished by the previously selected method at high-quality mist-net sets or acoustic locations for the proposed P/A survey.

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

A. PoE using mist-netting x highest mist-netting LOE for surveyed species' = Total survey LOE in nights accomplished by mist-netting

   – or –

   PoE using acoustics x highest acoustic LOE for surveyed species' = Total survey LOE in nights accomplished by acoustics

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

B. (1 - PoE used in A, above) x highest overall species LOE prescribed for the method not used in

A = Total number of survey nights necessary to meet the recommended LOE using the second method.

C. Round nights calculated in A and B up to nearest whole number.

EXAMPLE: The construction of a new bourbon distribution center (non-linear project) in KY falls within the range of IBAT and NLEB according to IPaC. A Phase 1 Habitat Assessment (see Appendix A) determined that 95 acres of suitable habitat for both species would be permanently removed to construct the project. The permitted bat biologist contracted to complete the P/A survey calculated that 35% of the project area could be surveyed with high-quality mist-netting set-ups.
Using the simple equation in A above, a total of 3 nights of mist-netting effort (0.35 x 6 = 2.1; rounded up) are recommended for this project impacting under 123 acres of suitable habitat. Using equation B above, the proposed project would need a total of 10 nights of acoustic effort ([1 – 0.35] x 14 = 9.10; rounded up) for the proposed project.

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 to be accepted by the USFWS FO(s).
2) Each mist-netting set may only be surveyed two nights (either consecutive or otherwise) if a combined mist-netting/acoustic survey is proposed.
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 the 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 Phase 2 surveys to challenge the other methods results. If a 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 a subsequent consultation or other decision-making process.
6) Except for 1-5 above, all other guidance provided in Appendices B and C apply to individual mist-netting sets and acoustic locations under this combined survey approach.

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APPENDIX J: GUIDANCE FOR SURVEYING YEAR-ROUND ACTIVE NLEBs

A portion of the NLEB's range overlaps with coastal areas of the eastern and southern U.S. where NLEB behavior, habits and habitat use differ significantly from the rest of the species' range. Bats may be active in these areas (see Figure 7) at any time of year and have not been documented utilizing traditional hibernation strategies found in the rest of the species range. Because of this, the USFWS collated and analyzed mist-netting data from local partners and worked with USGS and Virginia Tech to calculate year-round active NLEB minimum recommended LOE for mist-net surveys to provide expanded survey opportunities where allowed (also see Armstrong et al. 2023). Both acoustic and mist-netting techniques may be used in this region as a presence/probable absence method (Phase 2 surveys). Alternatively, mist-netting can be conducted for the purpose of attempting to capture NLEBs after detection during acoustic presence/probable absence surveys (Phase 3 surveys). The same recommendations (e.g., habitat assessments, personnel, coordination with USFWS FOs, nightly survey period, equipment, net/detector placement, checking nets, weather and other environmental conditions (temperature and precipitation), analysis of recorded echolocation calls, radio-tracking, emergence surveys, linear project guidance, outer-tier guidance, etc.) provided in other guidance appendices apply for either use of mist-netting or acoustics in the year-round active portion of the NLEB's range unless specifically addressed below.

NOTE: Where we consider the TCB active year-round (see Appendix L, Figure 9), surveyors can use these survey protocols applying the year-round active NLEB level of effort (LOE) with the following limitations: (1) an acoustic or combined acoustic/mist-net survey must be completed in portions of the range where IPaC identifies TCB as the only species; and (2) qualitative analysis is necessary for linear projects when Kaleidoscope Pro software produces an MLE > 0.05 for all site-nights and 10 or more passes are auto-classified as potentially belonging to TCB at any site-night. If you choose not to manually vet calls meeting these criteria, then you should assume presence of TCB for the project. Coordinate with the local USFWS FO(s) if you are proposing to use this guidance to survey for TCB to determine which LOE is appropriate for the specific project area.

SURVEY SEASON FOR YEAR-ROUND ACTIVE NLEBs: March 1 – October 15

While NLEBs may be captured in every month of the year in occupied coastal plain regions, the late fall/early winter is not an optimal time to conduct surveys because of lower and inconsistent temperatures as well as reduced availability of insect prey. Capture of reproductive adult females[77] (i.e., pregnant, lactating, or post-lactating) and/or young of the year between March 1 – October 15 confirms year-round presence of NLEB and the presence of a maternity colony in 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 absence of a maternity colony or large concentrations of bats in the area when only males and/or non-reproductive females are captured.

[77] We recognize that the reproductive condition of captured female NLEBs in early spring may not be possible; however, available data indicates NLEBs 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.

Likewise, detection of NLEBs using acoustic equipment and approved[78] software program(s) confirms year-round presence in the project area.

MINIMUM PRESENCE/ABSENCE LEVEL OF EFFORT

The level of mist-netting or acoustic survey effort required for a project in the year-round active portion of the NLEB range will be dependent upon the overall acreage of suitable habitat that may be impacted by the action (directly or indirectly). To determine the survey effort, quantify the amount of suitable habitat within the project area. For projects where impacts other than tree removal are likely (e.g., collisions with infrastructure), ensure that presence/probable absence surveys are designed to cover all suitable habitat within the entire project area (where exposure to any kind of impacts may be anticipated) and NOT just the locations where tree removal is planned. Additional guidance for linear projects is available in Appendix F.

Year-Round Active NLEB Mist-netting LOE: (also see Figure 1 and Table 2)

Linear projects: a minimum of 2 net nights per km (0.6 miles) of suitable habitat (see Appendix F).

Non-linear projects: a minimum of 6 net nights per 123 acres (0.5 km2) of suitable habitat.

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.

a) If no capture of NLEB(s), then no further surveys are recommended.

b) If capture of NLEB(s), then stop or proceed to Phase 4 as previously decided in coordination with the FO.

Range-wide NLEB Acoustic LOE: (also see Figure 1 and Table 2)

Linear projects: a minimum of 4 detector nights per km (0.6 miles) of suitable habitat (see Appendix F).

Non-linear projects: a minimum of 14 detector nights per 123 acres (0.5 km2) of suitable habitat.

A minimum of 2 detector locations per 123 acre "site" shall be sampled until at least 14 detector nights has been completed over the course of at least 2 calendar nights (may be consecutive).

[78]For surveyors planning optional TCB P/A acoustic surveys in western states where the TCB range overlaps with western bat species and TCBs are year-round active for 2024, note that no acoustic ID software programs are approved for this portion of the TCB range. Refer to optional TCB survey guidance (see FAQ) and use of candidate software programs for 2024.

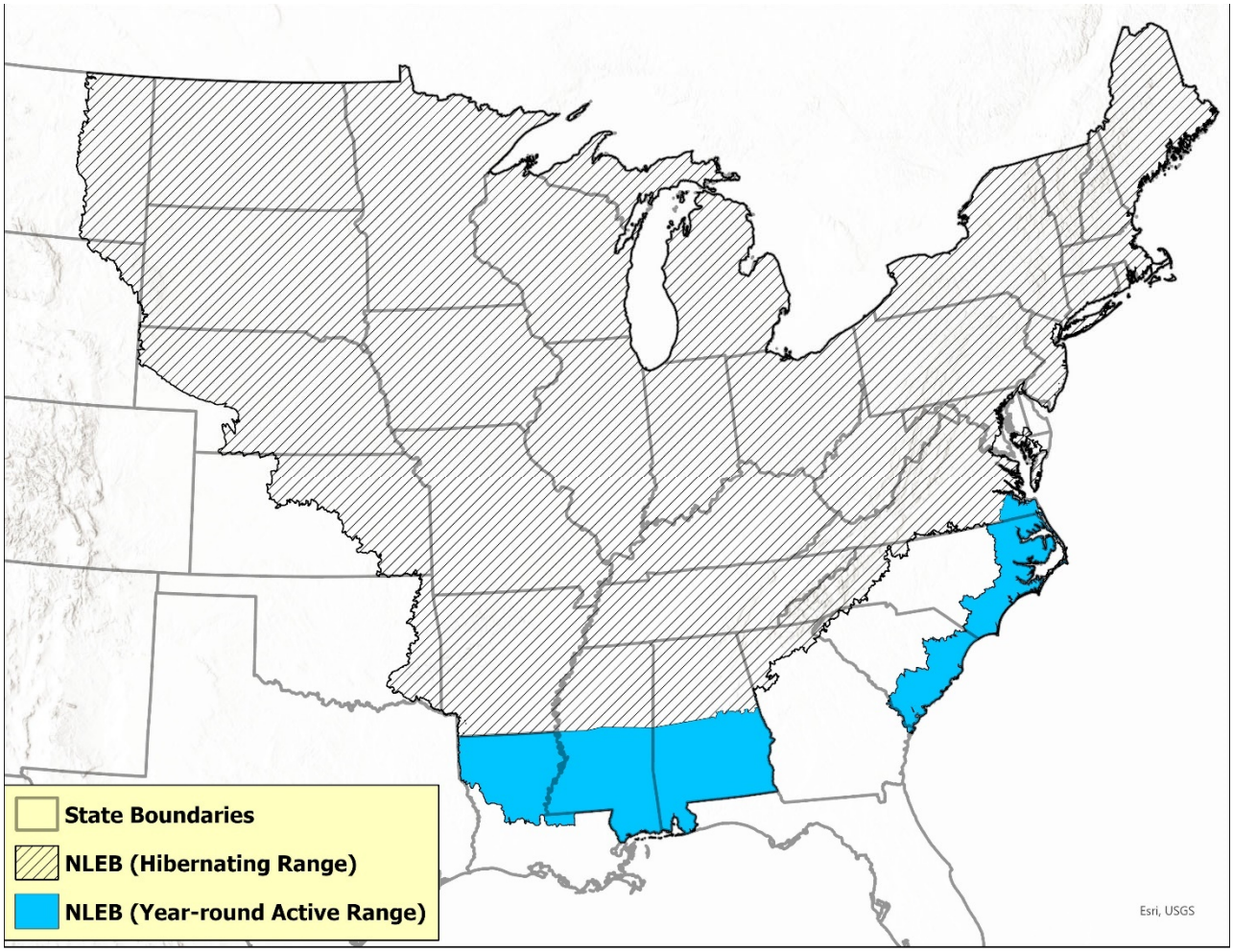

FIGURE 7. Areas delineated for use of year-round active NLEB survey guidance.

APPENDIX K: ASSESSING AND SURVEYING BRIDGES AND CULVERTS FOR BAT USE

Roadway transportation structures, specifically bridges and culverts, can provide suitable roosting habitat for bats. At least 24 North American bat species have been documented using bridges and culverts as roosting sites (Keeley and Tuttle 1999) and our understanding of the frequency of use improves as efforts increase to consider transportation structures as potential bat habitat. Georgia Department of Natural Resources reports presence of bats or guano at 20% of surveyed bridges and > 30% of surveyed culverts (GADNR, unpublished data 2023). Detweiler and Bernard (2023). conducted a literature review of 75 published studies finding that the use of bridges varies greatly across the landscape due to climatic factors, availability of natural roosts, and structural design. NLEBs and IBATs have been found using bridges and/or culverts throughout their ranges, as well as other species of conservation concern, such as the proposed endangered TCB. Use of this protocol is acceptable for TCB in 2024. Bats have been documented throughout the United States using bridges and culverts as maternity sites, hibernation sites, temporary resting sites during foraging, and during periods of staging and swarming. Often bridges are documented as important roosting locations during the active seasons (staging, maternity, and swarming; Detweiler and Bernard 2023, Keeley and Tuttle 1999) whereas culverts are often 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[79] 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 (Figure 8). Roadway culverts are usually composed of concrete or corrugated metal but can also be constructed of timber or PVC piping. Bridges[80] 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 (Figure 9).

These guidelines describe who and what is needed to conduct surveys, and when and how to determine if bats, including IBAT, NLEB, and/or TCB, are using bridges and/or culverts as habitat. Bats' use of bridges and culverts as roosts varies considerably and depends on numerous factors such as structure type (including design and structural condition), area geography, surrounding habitat, availability of natural bat roosts in the

[79] 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. In comparison, a bridge typically uses structural components and elements in the deck, superstructure and substructure (abutments and piers) to support those dead and live loads.

[80] 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.

vicinity, and seasonality of activity (e.g., year-round active range vs. hibernating range).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) and respective state wildlife agency(ies). Surveys resulting in probable absence for IBAT and NLEB are valid for two years[81] 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) and respective state wildlife agency(ies). Those practitioners utilizing the Programmatic Biological Opinion in conjunction with Federal Highway Administration, Federal Railroad Administration, and Federal Transit Administration for Transportation Projects in the Range of the IBAT and NLEB, should follow these guidelines for completing assessments of bridges or culverts.

PERSONNEL

Before performing assessments for bats on bridges or culverts, surveyors should coordinate with their local USFWS FO(s) and respective state wildlife agency(ies) regarding potential field training opportunities that may be required. At a minimum, surveyors should view the USFWS's virtual bat and transportation structures training[82] before conducting field assessments. Additional trainings may be available in specific states.[83] We recommend individuals conducting reviews for bats use the included sample data form at the end of this Appendix to submit with your survey report as it will ensure all the necessary information is provided to the USFWS FO(s) and expedite review of your study plan and survey report. If you choose to submit a different data form with your survey report, please ensure, at a minimum, it includes all information requested in the sample data form. We also encourage the incorporation of the minimum data field requirements for contributing bridge and culvert assessment data into the North American Bat Monitoring (NABat) database; however, it is not required. Individuals assessing bridges and culverts should employ appropriate safety measures in conducting these reviews and avoid touching any bats.

EQUIPMENT

The following equipment is highly recommended at a minimum to complete bridge or culvert assessments for bats.

- A high-powered flashlight, headlamp, or spotlight (> 600 lumens)
- Binoculars and/or spotting scope
- Digital camera with video recording capability
- Data forms and writing utensil
- Sturdy footwear. Depending on conditions, waders or muck boots may be preferred
- Decontamination[84] equipment if within white-nose syndrome positive area
- Personal protective equipment, according to organizational or agency requirements

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[81] 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

[82] Virtual Training available at: https://www.youtube.com/watch?v=w3g9HDQFi3A

[83] In Georgia: To express interest in annual field training or additional online materials, please contact the USFWS Georgia Field Office or the Georgia Department of Natural Resources Nongame Conservation Section
In New Jersey: To express interest in field training, please contact the USFWS New Jersey Field Office or the New Jersey Department of Environmental Protection's Endangered and Nongame Species Program
In Indiana: Online training required by Indiana Department of Transportation is available here.

[84] Please refer to the White-nose Syndrome Decontamination Protocol available here.

APPENDIX K: ASSESSING & SURVEYING BRIDGES & CULVERTS FOR BAT USE

The following equipment may be beneficial or advisable depending on conditions at the site, level of difficulty in completing a thorough assessment, safety requirements of your institution, or other site-specific factors.

- Mirror with telescoping handle for viewing tight spaces
- Acoustic bat detectors
- Dust mask or KN95/N95 mask
- Cellular phone
- Handheld GPS
- Easily removed, protective coveralls and change of clothes if access requires crawling
- Guano sample collection materials
- Endoscope, borescope, or similar camera and light, perhaps attached to a telescoping pole. It is recommended to choose a camera with the option to view live footage in real time
- Specialized equipment such as ladders, kayaks or other floating equipment, or under bridge inspection vehicles, etc. may be useful in some circumstances

FIGURE 8. Representative culvert structures of various types, including a box culvert in Indiana (top; photo by USFWS); a round, concrete pipe culvert design in Georgia (bottom left; photo provided by Georgia Department of Natural Resources); and a corrugated metal pipe culvert design in Missouri (bottom right; photo provided by L. Droppelman).

FIGURE 9. Representative bridges with documented bat use, including a bridge with metal struts in Indiana (top; photo provided by Indiana Department of Transportation) and a concrete bridge in North Carolina (bottom; photo provided by North Carolina Wildlife Resources Commission).

ASSESSING BRIDGES/CULVERTS FOR BATS

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, thus allowing bats to use for extended periods of torpor, particularly in areas where natural cave-like habitats may be limited.

Step 1. 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.

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 5 includes the minimum diameter measurements for each species for consideration (adapted from USFWS 2022). The minimum length culvert that any of the species of interest has been documented is 23 feet (N. Anderson, personal communication), and should generally be considered the minimum suitable length for all three species. 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) and respective state wildlife agency(ies) to determine if local guidance deviates from these minimums when additional species may need to be considered. 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) and respective state wildlife agency(ies).

TABLE 5. Suggested minimum culvert dimensions for determining IBAT, NLEB, and TCB suitability. If a site meets 1) the minimum entrance height/diameter for a particular species and 2) is 23 feet or greater in length*, it may be considered suitable to survey.

Species	Minimum Culvert Entrance Height/Diameter (feet)	Source
IBAT	4	L. Pattavina & E. Ferrall, personal communication, Georgia 2022
NLEB	4.5	N. Anderson, personal communication, Louisiana 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.

Step 2. Inspections of Bridges/Culverts and Indicators of Bat Presence

After an initial assessment if the bridge/culvert would be suitable for bats, surveyors should submit a completed USFWS Project Proposal Form or Study Plan to the local USFWS FO(s) for approval before they begin inspecting it for evidence of bat occupancy. 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 most 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.

Visual

- ***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 will 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 (see Figure 10). 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) and respective State Agency(ies).

Figure 10 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 11). 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 11. 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[85](Figure 12). 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 13). 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

[85] 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.

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 of this Appendix). 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 12. Examples of guano accumulations on bridges. (photos provided by Georgia Department of Natural Resources (top) and Indiana Department of Transportation (bottom)).

Figure 13. 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).

Sound and Smell

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.

Step 3. 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, State Agency(ies), and/or local Department of Transportation to determine if any of the following inspection methods or alternate assessment methods included here are recommended.

- ### Acoustic Surveys

  Note: 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 (refer to Appendix C for performing acoustic surveys to determine P/A of IBAT and NLEB). 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 IBAT and/or NLEB 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 Appendix E of the Survey Guidelines is 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.; Figure 14) to access high areas of structures or areas over deep water may be necessary in certain situations.

Figure 14. Biologists use a snooper truck to assess expansion joints and concrete caps over deep water (photo provided by Georgia Department of Transportation).

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 IBATs or NLEBs. 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. If possible, guano should be collected in sufficient amounts to maximize the ability for species to be properly identified.

Recommended standard equipment for performing guano sampling includes a high-powered flashlight (> 600 lumens, preferably a headlamp), hard hat, dust mask, digital camera, writing utensil(s) (e.g., fine- to medium-point permanent marker or pen; pencil for sketches), disposable latex gloves, collection vials (*e.g.*, 1.5 or 15 ml in size), and a collection utensil (e.g., plastic spoon).

Guano collections should only be performed after coordinating with the local USFWS FO(s) and respective State Agency(ies) 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 15); 4) photographs of structure, guano deposits, on the ground at the time of sample collection; 5) time of year[86] 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.).

The following protocols* should be followed when collecting guano samples (**check with the institution, lab, or entity you are using to perform guano analysis for any additional protocols, if needed*). Collect the freshest guano possible (freshest guano is likely on walls/sides of the structure, as well as piers vs. the ground). Old guano deposits may be too degraded to be identifiable.

1) Obtain a minimum sample size of 6 pooled samples or 10 individual samples. However, additional pellets and/or more samples covering each location is ideal (for smaller sample sizes, coordinate with local USFWS FO(s) and respective State Agency(ies)). Each sample must be labeled with a unique identifier to link it to the specific location where it was collected.
2) Number of vials collected should be proportional to the surface area of guano under a bridge; 10-20 pellets per ft^2 is ideal. For a linear line of guano, collect 10 pellets per 15feet or collect a few pellets every 5 feet, depending on the length of the guano deposit. For individual guano piles, collect pellets off the top and around the entire surface of the pile (NOTE: If possible, fill an entire sample

[86] 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.

vial per single guano pile; do not combine multiple, separate guano pile samples into one vial so that specific roost sites of federally listed bats can be identified.)

3) Per the guano collection plan, work with your local USFWS FO(s) and respective State Agency(ies) to determine which institution or entity will analyze the guano results for species identification.

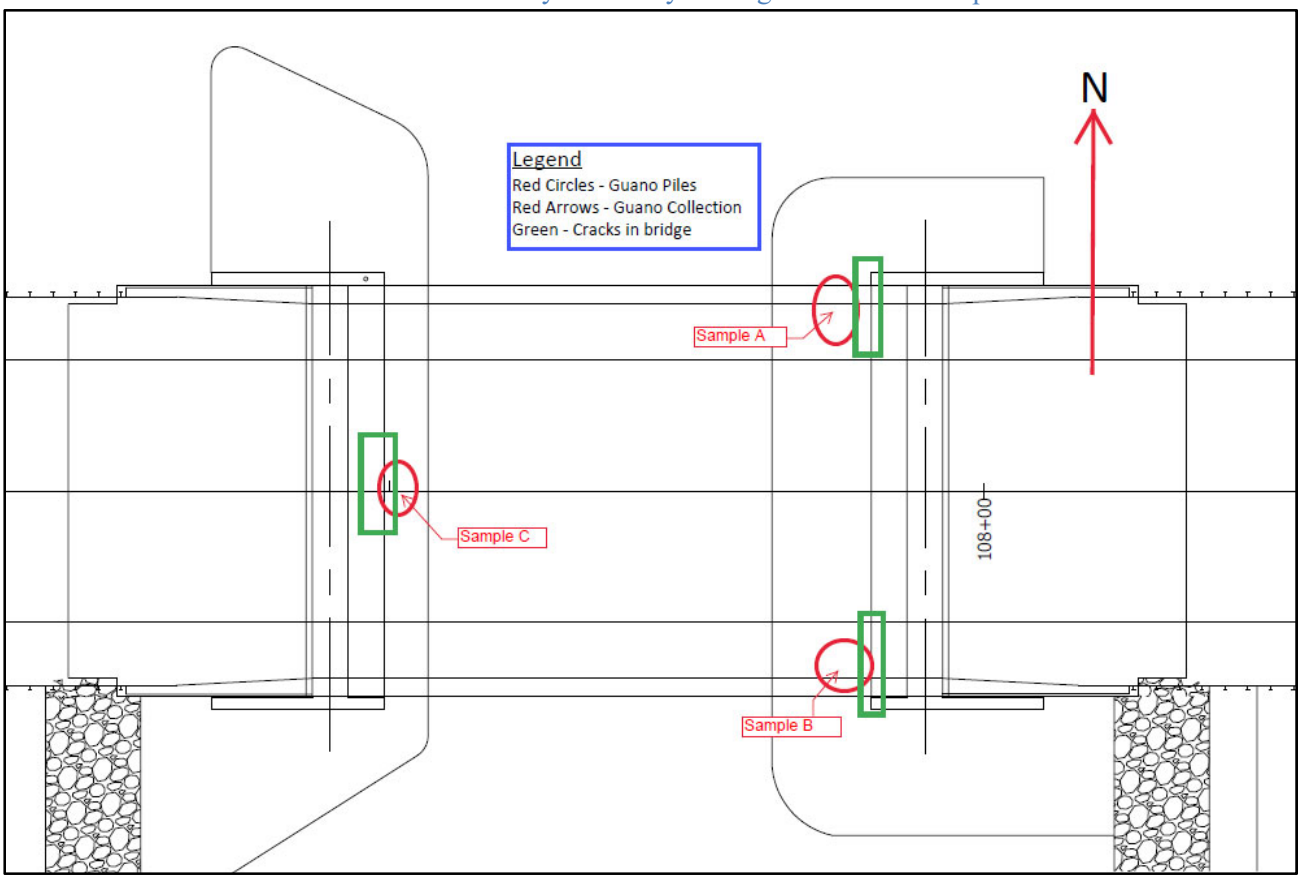

Figure 15. Example map for a guano collection plan, showing top-down view of a bridge, showing linear guano piles located along the abutment walls (underneath the structure's expansion joins). Arrows indicate proposed sample collection locations (Photo provided by Indiana Department. of Transportation).

NEXT STEPS—WHAT TO DO IF BATS ARE FOUND

Findings of bridge or culvert assessments should be submitted to the local USFWS FO(s) and respective State Agency(ies) in a survey report. If IBAT, NLEB, 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 24 hours to determine next steps. For other species, coordinate with your appropriate state agency(ies) (e.g., state wildlife and transportation agencies).

SURVEY REPORTING CHECKLIST

- Completed survey data form
- Annotated photo log w/representative images of surveyed structure (including areas with no indication of bat presence)
- Detailed information on location(s) where roosting bats and/or signs of bat use (e.g., staining, guano, etc.) was documented
- Information pertaining to any guano samples collected and locations within the structure where samples were obtained.

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[87]

USFWS FOs and respective state wildlife agency(ies) may prefer that bridge and culvert assessment data be submitted electronically, in hard copy survey reports, or both. An example data form that can be printed is available on the next page [8889].

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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.

U.S. Fish and Wildlife Service (USFWS). 2019. New Jersey Guidance on Surveying Transportation Structures for Bat Occupancy. September 2019. 3 pp.

[87] The submission procedures are not required to be used under the Guidance but are highly recommended. Use of these forms will ensure all the necessary information is provided to the USFWS FO and expedite review of your study plan and survey report. Regardless of the form that is used, please ensure that the necessary data is submitted to the local USFWS FO and appropriate state wildlife agency(ies).

[88] Data submission from bridge and culvert assessments to the North American Bat Monitoring Program (NABat) database is encouraged but not required. The minimum required fields for submission to NABat are highlighted on the sample form.

[89] A template electronic data form that incorporates the minimum fields required for submission to NABat is found at: https://drive.google.com/drive/folders/1U3wCk6EIb8ZtWXSXUlBhkfANOHMJytW4?usp=sharing

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Bridge/Culvert Bat Assessment Form

Date & Time of Assessment	DOT Project Number or IPaC Code	Route/Facility Carried	County
Federal Structure ID	Structure Coordinates (latitude and longitude)	Structure Height (approximate)	Structure Length

Structure Type (check one)

Bridge Construction Style

☐	Cast-in-place	☐	Pre-stressed Girder
☐	Flat Slab/Box	☐	Steel I-beam
☐	Truss (Side View)	☐	Covered
☐	Parallel Box Beam	☐	Other:

Culvert Type

☐	Box
☐	Pipe/Round
☐	Other:

Other Structure

☐	

Structure Material (check all that apply)

Deck Material	*Beam Material*	*End/Back Wall Material*
☐ Metal	☐ None	☐ Concrete
☐ Concrete	☐ Concrete	☐ Timber
☐ Timber	☐ Steel	☐ Stone/Masonry
☐ Open grid	☐ Timber	☐ Other:
☐ Other:	☐ Other:	

Creosote Evidence

☐	Yes	☐	No
☐	Unknown		

Culvert Material

☐	Metal
☐	Concrete
☐	Plastic
☐	Stone/masonry
☐	Other:

Notes:

Crossings Traversed (check all that apply)

☐	Bare ground	☐	Open vegetation
☐	Rip-rap	☐	Closed vegetation
☐	Flowing water	☐	Railroad
☐	Standing water	☐	Road/trail - Type:
☐	Seasonal water	☐	Other:

Surrounding Habitat (check all that apply)

☐	Agricultural	☐	Grassland
☐	Commercial	☐	Ranching
☐	Residential-urban	☐	Riparian/wetland
☐	Residential-rural	☐	Mixed use
☐	Woodland/forested	☐	Other:

Areas Assessed (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.

Area (check if assessed)	Assessment Notes	Evidence of Bats (include photos if present)			
☐ All crevices and cracks: **Bridges/culverts**: rough surfaces or imperfections in concrete **Other structures**: soffits, rafters, attic areas	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ Concrete surfaces (open roosting on concrete)	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ Spaces between concrete end walls and the bridge deck	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ Crack between concrete railings on top of the bridge deck (Gap, Railing)	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ Vertical surfaces on concrete I-beams	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ Spaces between walls, ceiling joists	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ Weep holes, scupper drains, and inlets/pipes	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ All guiderails	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species
☐ All expansion joints	☐ Not present	☐ Visual - live # dead #	☐ Guano	☐ Staining	☐ Audible ☐ Odor ☐ Photos ☐ Species

Name:	Signature:

APPENDIX L. BAT ACTIVITY PERIODS TABLE FOR IBAT, NLEB, AND TCB

State	Hibernation	Winter Torpor[90]	Spring Staging[91]	Summer Occupancy	Pup Season	Fall Swarming[92]
	Timeframe when most bats are hibernating (i.e., inactive[93] season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor[94]	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[95]	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)[96]	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

[90] Only applies in Zone 1 of the year-round active range (see Figure 16).
[91] 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.
[92] 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.
[93] The "active season" is the inverse of the hibernation period. If no hibernation period is listed, bats in this area are active year-round.
[94] State of lowered body temperature and metabolic activity.
[95] IBAT (rangewide) and NLEB (hibernating range) often remain in colonies until the end of Summer Occupancy. TCB (rangewide) and NLEB (year-round active range) roost singly once young can fly and forage independently (i.e., the end of the pup season).
[96] 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).

APPENDIX L: BAT ACTIVITY TABLE

State	Hibernation	Winter Torpor[90]	Spring Staging[91]	Summer Occupancy	Pup Season	Fall Swarming[92]
	Timeframe when most bats are hibernating (i.e., inactive[93] season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor[94]	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[95]	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
Delaware	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
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	May 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

APPENDIX L: BAT ACTIVITY TABLE

State	Hibernation	Winter Torpor[90]	Spring Staging[91]	Summer Occupancy	Pup Season	Fall Swarming[92]
	Timeframe when most bats are hibernating (i.e., inactive[93] season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor[94]	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[95]	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
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
Massachusetts (Coastal)[97]	Dec 1 – Mar 14		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	N/A	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	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Minnesota	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Mississippi: Hibernating Range	Nov 16 – Mar 14	N/A	Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
Mississippi: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Mississippi: Year-round Active Range (Zone 2)	N/A	N/A	N/A	Mar 15 – July 15	May 1 – July 15	N/A
Missouri	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Oct 15	May 15 – July 31	Aug 16 – Nov 15
Montana	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
Nebraska	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15

[97] Coastal Massachusetts includes Martha's Vineyard, Nantucket, and Cape Cod.

APPENDIX L: BAT ACTIVITY TABLE

State	Hibernation	Winter Torpor[90]	Spring Staging[91]	Summer Occupancy	Pup Season	Fall Swarming[92]
	Timeframe when most bats are hibernating (i.e., inactive[93] season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor[94]	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[95]	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 Hampshire	Nov 1 – Apr 14	N/A	Apr 15 – May 14	Apr 15 – Sept 30	June 1 – Aug 15	Aug 16 – Oct 31
New Jersey	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
New Mexico: Hibernating Range	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
New Mexico: Year-round Active Range (Zone 1)	N/A	Dec 15 – Feb 15	N/A	Apr 1 – July 15	May 1 – July 15	N/A
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	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Oklahoma	Nov 16 – Mar 14	N/A	Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Pennsylvania	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15

APPENDIX L: BAT ACTIVITY TABLE

State	Hibernation	Winter Torpor[90]	Spring Staging[91]	Summer Occupancy	Pup Season	Fall Swarming[92]
	Timeframe when most bats are hibernating (i.e., inactive[93] season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor[94]	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[95]	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
Rhode Island	Nov 1 – Apr 14	N/A	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	N/A	May 1 – June 1	May 1 – Aug 31	June 15 – Aug 31	Aug 16 – Sept 30
Tennessee	Nov 16 – Mar 31	N/A	Apr 1 – May 14	Apr 1 – Sept 30	May 15 – July 31	Aug 16 – Nov 15
Texas: Hibernating Range	Nov 16 – Mar 14	N/A	Mar 15 – Apr 30	Mar 15 – Sept 30	May 15 – July 31	Sept 1 – Nov 15
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

APPENDIX L: BAT ACTIVITY TABLE

State	Hibernation	Winter Torpor[90]	Spring Staging[91]	Summer Occupancy	Pup Season	Fall Swarming[92]
	Timeframe when most bats are hibernating (i.e., inactive[93] season)	Timeframe when mean winter temperatures fall below 40° F and bats roosting in trees are in torpor[94]	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[95]	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
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

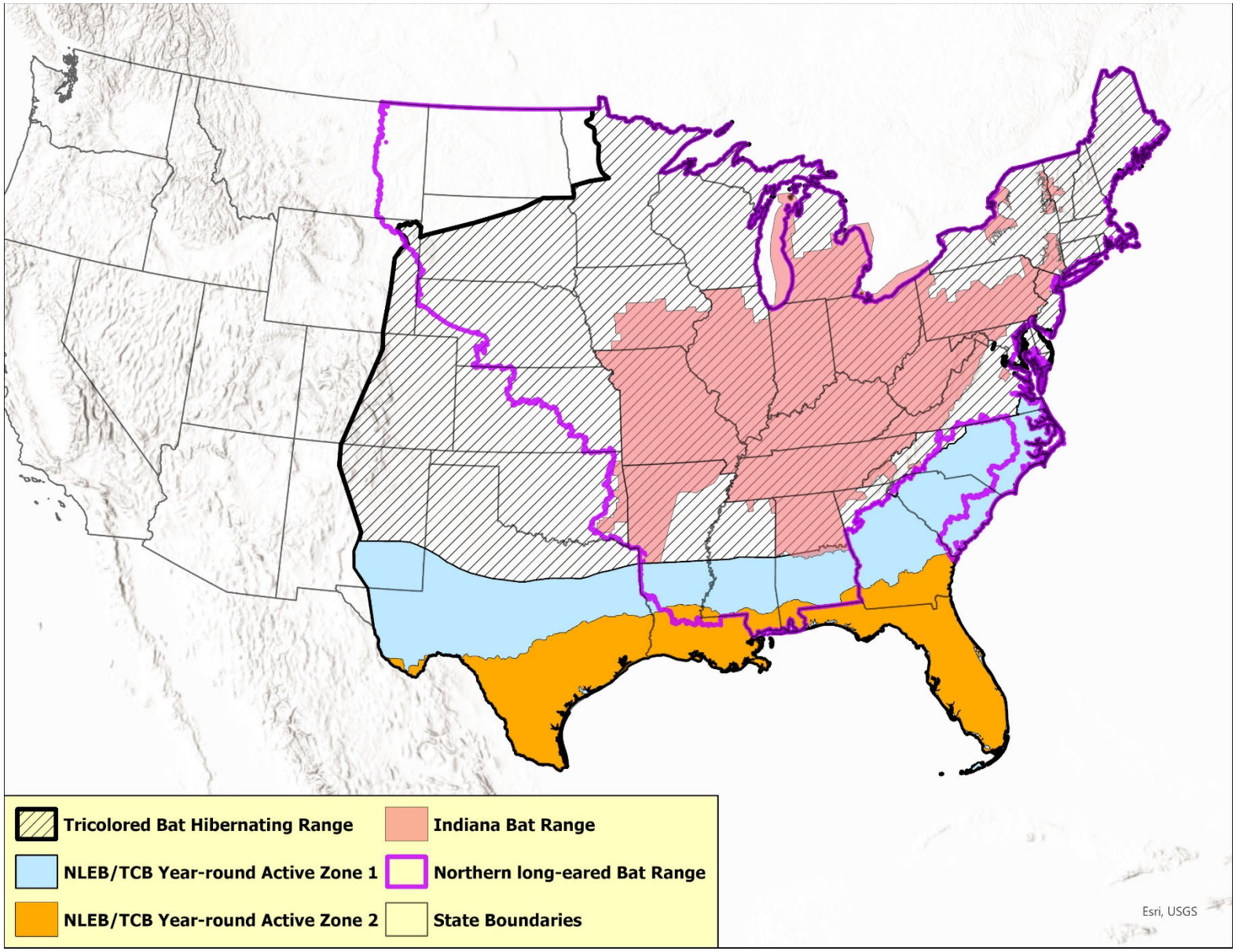

FIGURE 16. Hibernating and/or year-round active ranges of IBAT, NLEB, and TCB.

APPENDIX M: GLOSSARY OF TERMS

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.

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.

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.

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 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 ≥ 1 km (0.6 mi) of suitable habitat; may contain contiguous and fragmented patches of suitable habitat, but only segments at least ≥ 1 km in length can be considered for presence/probable absence survey sites.

Manual-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 ≤ 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 rangewide 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 of 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 (manual 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 manual 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), although see Appendix J regarding year-round active populations.

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.