Biological Opinion

Reinitiation of Consultation on Tennessee Valley Authority's Programmatic Strategy for Routine Actions that May Affect Endangered and Threatened Bats

FWS Log #: 04ET1000-2018-F-0017
FWS ECOSphere Project Code: 2023-0042342

Prepared by:

U.S. Fish and Wildlife Service
Tennessee Ecological Services Office
446 Neal Street
Cookeville, Tennessee 38501

DANIEL ELBERT Digitally signed by DANIEL ELBERT
Date: 2023.05.01 17:05:46 -05'00'

Daniel Elbert, Field Supervisor | Date

TABLE OF CONTENTS

CONSULTATION HISTORY

This section lists key meetings and correspondence (events) during the course of this consultation. A complete administrative record of this consultation is on file in the U.S. Fish and Wildlife Service's (Service) Tennessee Ecological Services Field Office (TNFO).

Date	Event	Participants	Discussion Topic
Oct. 27, 2022	E-mail correspondence	Service's AL, GA, KY, MS, NC, TN, VA FO staffs, TVA staff	TVA requested designation of contact person to reinitiate consultation due to the pending uplisting of the northern long-eared bat from threatened to endangered status, rendering compliance null for previously exempted activities.
Nov. 4, 2022	Conference call	TNFO staff, Service SE RO staff, TVA staff	Discussion included a summary of the existing consultation, status of "Take" used to date, and establishment of process and deliverables for reinitiation of Programmatic Consultation.
Nov. 2022 – Jan., 2023	Conference calls and phone calls	AL, GA, KY, MS, NC, TN, VA FO staffs, TVA staff	TVA had individual discussions with each FO regarding current bat population status and trends in population data since 2018.
Jan. 9, 2023	Email correspondence	AL, GA, KY, MS, NC, TN, VA FO staffs, Service SE RO staff, TVA staff	TVA provided letter of intent to reinitiate programmatic consultation.
Feb. 3, 2023	Email correspondence	TVA staff, TNFO staff	TVA provided a first draft programmatic reinitiation BA to the TNFO for review.
Feb. 8, 2023	E-mail correspondence	TNFO staff, TVA staff	TNFO provided a letter to TVA in response to their letter of intent to reinitiate programmatic consultation, indicating that reinitiation of consultation is appropriate and the Service would be willing to provide technical assistance in development of a BA, and initiated informal consultation.
Feb. – Mar. 2023	Virtual meetings	AL, GA, KY, MS, NC, TN, VA FO staffs, Service SE RO staff, TVA staff	Service staff and TVA staff coordinated weekly to discuss the draft BA and pending BO. This included reviewing and providing

Date	Event	Participants	Discussion Topic
			comments on TVA's second draft BA.
Mar. 31, 2023	E-mail correspondence	TVA staff, TNFO staff	TVA requested initiation of formal consultation and provided a final BA to TNFO.
Apr. 13, 2023	E-mail correspondence	TNFO staff, TVA staff	TNFO provided a letter to TVA, initiating formal consultation and indicated that the subject draft BO would be provided to TVA in an abbreviated time period prior to August 25, 2023.
Apr. 20, 2023	E-mail correspondence	TNFO staff, TVA staff	TVA provided additional information on their conservation measures to minimize incidental take of occupied roosts during pup season.
Apr. 25, 2023	E-mail correspondence	AL, GA, KY, MS, NC, TN, VA FO staffs, Service SE RO staff, TVA staff	TNFO provided a draft BO to AL, GA, KY, MS, NC, TN, VA FO staffs and TVA staff for review and comment.
Apr. 28, 2023	E-mail correspondence	TNFO staff, TVA staff	TVA provided comments along with minor edits to draft BO and final BA.
May 1, 2023	E-mail correspondence	TNFO staff, TVA staff	TNFO forwarded the signed, final BO to TVA.

BIOLOGICAL OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act (ESA) of 1973, as amended, as to whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated critical habitat.

A BO evaluates the effects of a Federal Action, which include all consequences of the Action and from non-Federal actions unrelated to the proposed Action (cumulative effects), relative to the status of listed species and critical habitat. A Service opinion that concludes a proposed Federal action is not likely to jeopardize species and is not likely to destroy or adversely modify critical habitat fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA. "Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

The Federal action addressed in this BO is the *Reinitiation of Consultation on Tennessee Valley Authority's Programmatic Strategy for Routine Actions that May Affect Endangered and Threatened Bats* (the Action). Tennessee Valley Authority (TVA) provided a Biological Assessment for the Action in September 2017 (TVA 2017), hereafter referred to as the 2017 BA, which describes how 10 overarching actions and 96 routine activities that TVA authorizes, funds, or carries out, may affect ESA-listed bats and their designated critical habitat over 20 years. The 2017 BA does not address the effects of the 96 routine activities on other listed species and critical habitats, and these activities are subject to the consultation requirements of ESA §7(a)(2). As necessary, TVA must consider the effects of these activities on other listed species and critical habitats through additional programmatic or project-level consultations.

In the 2017 BA, TVA determined that 21 of the 96 routine activities have no effect on gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*) (Ibat), northern long-eared bat (*Myotis septentrionalis*) (NLEB), and Virginia big-eared bat (*Corynorhinus townsendii virginianus*). TVA determined that the other 75 routine activities may affect but are not likely to adversely affect (NLAA), the gray bat and Virginia big-eared bat, and designated critical habitat for the Ibat and Virginia big-eared bat. Of these 75 activities, TVA determined that 72 (all but three) are NLAA for the Ibat and NLEB. By letter dated March 8, 2018, the Service concurred with TVA's NLAA determinations, which concluded the consultation relative to gray bat and Virginia big-eared bat, critical habitats for Ibat and Virginia big-eared bat, and NLAA activities for all four bat species. This letter also formally initiated consultation on the three activities that were likely to adversely affect (LAA) the Ibat and NLEB. However, because take resulting from these activities was not prohibited under the NLEB 4(d) rule of the ESA and were addressed under the Service's January 5, 2016, "Programmatic Biological Opinion on Final 4(d) Rule for the Northern long-eared bat and Activities Excepted from Take Prohibitions", the Service did not issue special exemption for NLEB through compliance with the terms and conditions (T&Cs) of an incidental take statement (ITS).

On November 30, 2022, the Service published a final rule reclassifying the NLEB from threatened to endangered (87 FR 73488). The final reclassification rule became effective on March 31, 2023 (88 FR 4908). Because 4(d) rules are only available for threatened species, the 4(d) rule for NLEB is removed upon the effective date of the reclassification rule. Due to this change, TVA reinitiated consultation for the 2018 BO (# 04ET1000-2018-F-0017, Programmatic Strategy for Routine Actions that May Affect Endangered or Threatened Bats) on January 9, 2023. On February 8, 2023, the Service agreed that reinitiation of consultation is appropriate because: 1) new information indicates that the Action may affect listed species or critical habitat in a manner or to an extent not previously considered, and 2) it is likely that a new species will be listed or critical habitat designated that may be affected by the identified Action that were not previously considered. TVA provided the Service with a reinitiation BA (TVA 2023) on March 31, 2023, addressing the change in status to the NLEB (hereafter referred to as the 2023 BA).

This is not a new consultation, but rather reinitiation of an ongoing consultation. This BO is limited in scope to new information pertaining to how the Action may affect the NLEB, for a 15-year period beginning the effective date of this BO in 2023 through the duration of the original 2018 BO to 2038. In re-evaluating effects of the Action for NLEB, we also considered whether new information would alter our 2018 BO effects analysis on Ibat and determined changes in the expected impact of these effects would not result in additional or more severe adverse effects to Ibat. Therefore, the original duration of the Action and numbers and amounts included in tables and figures for the Ibat in this document remain consistent with those included in the 2018 BO. The Ibat effects are assessed over a 20-yr period (2018-2038) and the NLEB effects are reassessed over the remaining 15-yr period (2023-2038).

Accordingly, the 2018 BO will continue to evaluate the effects of the three proposed routine activities that TVA determined are likely to adversely affect (LAA) the Ibat and this 2023 BO replicates the 2018 BO for Ibat (for ease of reference) and will evaluate the effects of the three proposed routine activities on the NLEB. The Action does not affect any designated critical habitat for listed bat species; therefore, this BO does not further address critical habitat.

2. PROPOSED ACTION

TVA proposes *Reinitiation of Consultation on Tennessee Valley Authority's Programmatic Strategy for Routine Actions that May Affect Endangered and Threatened Bats* (the Action) to update information regarding the NLEB due to its reclassification to endangered and continue to streamline the manner in which the agency fulfills its responsibilities under ESA §7 relative to ESA-listed bat species. TVA's 2023 BA for the Action describes various routine activities that may affect listed bat species and the conservation measures that TVA will apply to avoid and minimize adverse effects. The 2023 BA also describes various ongoing activities, such as monitoring, habitat enhancements, and public education, that promote the recovery of one or more listed bat species. Addressing these activities programmatically is intended to promote consistency, predictability, and efficiency of project-level consultations, and to address the conservation needs more effectively of listed bats at local and landscape scales.

The Action is comprised of 96 routine activities under the following 10 general action categories that TVA authorizes, funds, or carries out:

1) manage for biodiversity and public use;
2) protect cultural resources;
3) manage land use and disposal;
4) manage permitting under section 26a of the TVA Act;
5) operate, maintain, retire, construct, and expand power plants;
6) maintain existing transmission line assets;
7) convey electric transmission property;
8) expand or construct new transmission assets;
9) promote economic development; and
10) promote small and mid-scale solar generation sites.

The Action does *not* include activities associated with:

- construction of, or purchase of power from, a wind farm;
- utility-scale solar projects (*i.e.,* projects that generate and feed solar power directly into the grid, supplying a utility with energy);
- TVA's ownership of mineral reserves; and
- nuclear power plant relicensing (the Nuclear Regulatory Commission typically serves as lead agency).

Of the 96 routine activities that occur under the 10 general action categories listed above and identified by Activity # in the 2023 BA, TVA determined that 75 may affect listed bats or their designated critical habitats. Of these 75 activities, only three are LAA the Ibat or NLEB:

1) removal of hazardous trees or tree branches (Activity #33);
2) mechanical vegetation removal that includes trees or tree branches three inches or greater in diameter (Activity #34); and
3) prescribed burns (Activity #23).

In this BO, we do not further address the 93 activities described for the Action that TVA determined have no effect or are NLAA listed bats or their critical habitat. The scope of the BO is limited to the three activities listed above that are LAA the Ibat and NLEB, and to the proposed conservation actions that are relevant to these species. Because the effects of hazardous tree removal and other tree removal on bats are similar, we combine these two activities in our description of the proposed action in Section 2.2 and in our effects analyses.

The 2023 BA estimates the spatial extent of tree removal and prescribed burning activity during a calendar year and cumulatively over the 20-year (2018–2038) consultation period but does not identify the location or timing of such activity at the project-level. In the context of consultation under ESA §7(a)(2), the Action is consistent with the regulatory definition at 50 CFR §402.02 of a "framework programmatic action," which is a Federal action that approves a framework for the development of future actions that are authorized, funded, or carried out at a later time, and are subject to further consultation.

2.1. Action Area

For purposes of consultation under ESA §7, 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 §402.02). The 96 activities of the programmatic Action will occur on lands associated with the 10 general action categories listed in the previous section. Table 2-1 reports the ownership, approximate total acreage, and estimated annual acreage affected by project activity on these lands.

Table 2-1. Ownership, total acreage, and annual affected acreage of the 96 activities described for the Action (source: 2017 BA Table 3-1).

Ownership	Acres	Annual Affected Acres
TVA Retained Land: *Reservoir Land*	293,000	12,782
TVA Retained Land: *Power Property*	38,000	1,089
TVA Transmission Easements: *Existing ROW[a] & Maintenance Buffer*	545,201	79,186–80,935
TVA Transmission Easements: *New ROW*	23,800	1,190
Public Land: *Economic Development Sites*	75,220	3,761
Private Land: *Solar Sites*	40,000	2,000
Total	**1,015,221**	**100,008–101,757**

[a] Right-of-Way

The 1.015-million acres reported in Table 2-1 are distributed throughout the 82.8-million acre TVA Region (Figure 2-1) in Tennessee, northern Alabama, northern Georgia, southern Kentucky, eastern Mississippi, western North Carolina, and southwestern Virginia. The 2023 BA does not provide maps delineating Action lands within the TVA Region, because some are not yet identified (*e.g.,* future small and mid-scale solar sites on private land, new transmission substations), and many are difficult to display effectively at a regional scale (*e.g.,* the existing transmission right-of-way [ROW] network). Although the Action Area is large, it represents only 1.23% of the total area within the TVA Region.

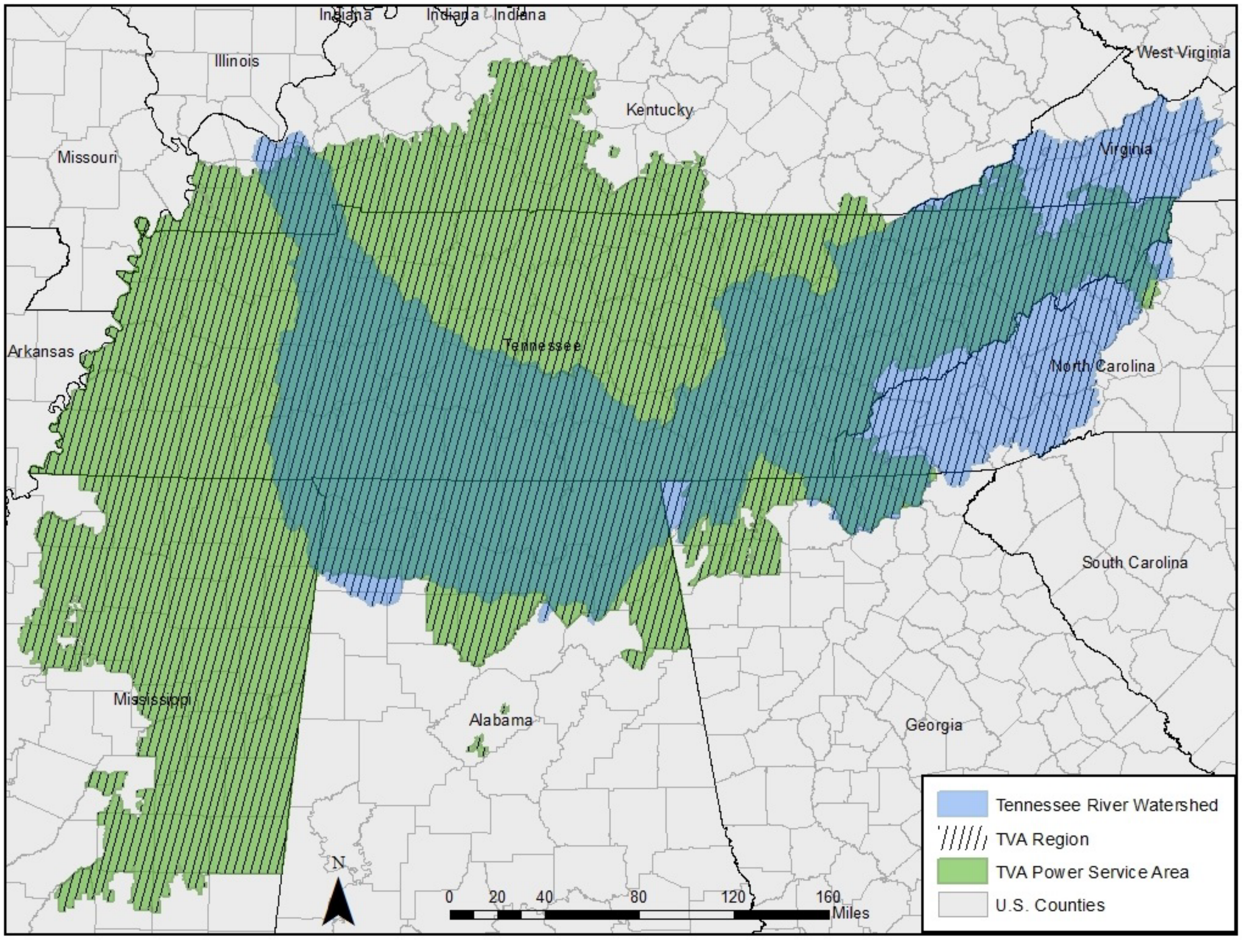

Figure 2-1. The 1.015-million acre Action Area is distributed throughout the 82.8-million acre TVA Region, which is comprised of the Tennessee River Watershed and the TVA Power Service Area (source: 2017 BA, Figure 2-1).

The 2023 BA does not provide a project-specific schedule or map of activities over the 20-year Action duration. Annually, TVA estimates that about one-tenth (100,008–101,757 acres [ac]) of the lands for which the programmatic Action is formulated will receive direct and indirect effects from project activity. Cumulatively over 20 years, TVA estimates that the routine activities described for the Action will affect about 45.5% of the Action lands; therefore, more than half of the 1.015-million acres will not be affected by the Action. Some lands may receive project activity on multiple occasions (*e.g.,* prescribed burning, ROW vegetation management). Recognizing the variable and uncertain distribution of the routine activities, TVA describes the 1.015-million acres of lands that may receive effects of project activity at any time during the 20-year Action duration as the "Action Area" for this consultation. Although it includes areas that the Action will not affect, the Service adopts the TVA definition of the Action Area for the purposes of this programmatic consultation.

Chapter 2 of the 2023 BA, "Description of the Action Area," provides data about land cover and other characteristics of the 82-million-acre TVA Region, which contains the 1-million-acre Action Area distributed in patches (e.g., TVA reservoirs, power plants) and linear corridors (e.g., transmission ROWs) throughout the region. About 36 million acres (44%) of the Region has forest cover that is potentially suitable habitat for tree-roosting bats (2023 BA). The Action Area is proportionally less forested than the Region as a whole, with 240,103 ac (23.65%) of forest cover (H. LeGrand, pers. comm., 2017).

2.2. Tree Removal Activities

Eight of the ten general TVA action categories identified in Section 2 routinely involve a need to remove trees, either to eliminate a hazard to human life or property (Activity #33) or to manage the structure and composition of the plant community on a site (Activity #34). Action category #2, "protect cultural resources," and category #7, "convey electric transmission property," do not involve tree removal.

The 2023 BA described three general sideboards for TVA's anticipated routine tree removal activity. First, TVA estimated the total acreage of routine tree removal annually and cumulatively over 20 years (2018–2038). Second, TVA estimated the proportion of tree removal that would result in a permanent alteration of local habitat conditions (*i.e.,* the percentage of the acreage in which trees are not planted or allowed to regenerate following tree removal). Third, TVA estimated the temporal distribution of tree removal acreage (either permanent or temporary) relative to three functional seasons of the bat life cycle:

- Inactive season, hibernation (mid-November to mid-March or April)
- Active season, all bats are volant (able to fly).
- Active season, bat pups are non-volant (June and July).

Table 2-2 summarizes these estimates of tree removal activity by action category.

The 20-year cumulative estimates in Table 2-2 are exactly or approximately 20 times a single annual acreage estimate reported for each action category except #6, "maintain existing transmission line assets," for which TVA initially provided two annual estimates. TVA's initial estimates anticipated a substantial reduction in tree removal from 1,835 to 86 ac per year beginning in the year 2022, after most existing ROW's had been cleared to their full extent to ensure reliability. However, due to litigation, a legal injunction prevented this from occurring and TVA instead removed approximately 85 acres per year from 2018 to present (spring 2023). TVA used light detection and ranging (LiDAR) technology to focus on areas of extreme concern to the safety and reliability of the network. Once the legal injunction is lifted, TVA anticipates the original 20-year cumulative estimate of tree removal (8,716 ac) over the remaining duration of the consultation will resume because the need for this removal remains unchanged. Tree removal acreages would be more evenly split over a longer duration (15 years) but still result in the same overall amount of tree removal by the end of the consultation for existing transmission line maintenance. The cumulative acreage of tree removal for all action categories is 47,204 ac, of which 92% is permanent removal.

2.2.1. Tree Removal Settings and Methods

Section 3.2 of the 2023 BA describes two of the 96 activities included under the programmatic Action as tree removal:

Activity #33, “Removal of hazardous trees or tree branches,” occurs as necessary throughout the year to address imminent threats to public safety, facilities, or private property. Settings for hazardous tree removal include, but are not limited to, campgrounds, day use areas, access corridors between private property and TVA reservoirs, and transmission line ROWs. Hazardous tree removal may involve the use of a feller buncher, bulldozer, bush-hog, chainsaw, and other hand tools.

Activity #34, “Mechanical vegetation removal, includes trees or tree branches three inches or greater in diameter,” serves a variety of purposes and occurs during daylight hours throughout the year, with a possible duration of days to weeks at a particular location. The physical settings for non-hazardous tree removal include, but are not limited to, public/recreational use areas, natural areas (*e.g.,* to create openings for wildlife habitat enhancement), lawn maintenance, and areas for the construction of new buildings, roads, transmission lines, or substations. TVA removes trees along existing ROWs and access roads to ensure the integrity of operations and reduce risks to human safety. The equipment employed may include a feller buncher, bulldozer, track or bucket hoe, scrapper, bush-hog, mower, logging and boom trucks, chainsaw, and hand tools.

Table 2-2. Extent (acres) of TVA tree removal activity (annual, permanent, seasonal, and cumulative) for 2018–2038 (data source: 2017 BA, Table 3-2). Percentages are relative to values in the same row under "Annual Total Tree Removal," except in the last row, where the percentages are relative to 47,204 acres ("Total Cumulative Tree Removal").

Action Category		Annual Total Tree Removal	Permanent Tree Removal	Seasonal Distribution			Cumulative Total Tree Removal 2018-2038
				Inactive Season	Active Season; All Bats Volant	Active Season; Pups Non-Volant	
1. Manage for Bio-diversity, Public Use		59	35 (60%)	12 (20%)	30 (50%)	18 (30%)	1,186
3. Manage Land Use, Disposal		630	504 (80%)	315 (50%)	189 (30%)	126 (20%)	12,600
4. Manage 26a Permitting (Shoreline)		104	73 (70%)	83 (80%)	10 (10%)	10 (10%)	2,080
5a. Operate and Maintain Plants		35	35 (100%)	28 (80%)	5 (15%)	2 (5%)	700
5b. Retire, Construct, Expand Plants		75	75 (100%)	60 (80%)	11 (15%)	4 (5%)	1,500
6. Maintain Existing TL[a] Assets:	2018–2021	1,835	1,835 (100%)	734 (40%)	459 (25%)	642 (35%)	8,716
	2022–2038	86	86 (100%)	34 (40%)	22 (25%)	30 (35%)	
8. Expand or Construct New TL Assets		595	595 (100%)	357 (60%)	119 (20%)	119 (20%)	11,900
9. Promote Economic Development		376	376 (100%)	338 (90%)	38 (10%)	0 (0%)	7,522
10. Promote Small and Mid-Scale Solar Generation		50	50 (100%)	40 (80%)	10 (20%)	0 (0%)	1,000
Annual Total	2018–2021	3,759	3,578 (95%)	1,967 (52%)	871 (23%)	921 (25%)	N/A[b]
	2022–2038	2,010	1,829 (91%)	1,267 (63%)	434 (22%)	309 (15%)	
Cumulative Total 2018–2038		N/A	43,576 (92%)	28,140 (60%)	10,428 (22%)	8,628 (18%)	47,204

[a] TL = transmission line
[b] N/A = not applicable

2.2.2. Conservation Measures for Tree Removal

To avoid or reduce adverse effects to bats resulting from tree removal, TVA proposes to apply several conservation measures when conducting Activities #33 and #34. Generally, these measures are intended to: 1) reduce the intensity of, or the probability of exposure to, stressors caused by tree removal that may affect bats or their habitat resources, including the elimination of roost trees (while currently occupied or not), and 2) the introduction of sediment or other pollutants to waters that bats drink or that support bat prey resources.

The 2023 BA identifies noise as a stressor caused by tree removal activity. The "noise/vibration" conservation measure that TVA assigns to tree removal (labeled as NV1) states:

> NV1 = Noise is expected to be short-term, transient, and not significantly different from urban interface or natural events (*i.e.,* thunderstorms) that bats are frequently exposed to when present on the landscape; bats thus are unlikely to be disturbed.

This statement suggests that the noise associated with tree removal activity is unlikely to disturb bats due to its brief duration and similarity to ambient noise. However, TVA indicates that Activity #34 may include the use of various large or loud equipment (*e.g.,* bulldozer, chainsaw) "with [a] possible duration of days to weeks" (2023 BA). While we do not know when, where, or how noise associated with tree removal will occur on the landscape, we do anticipate that noise originating from large or loud equipment will temporarily disturb bats in the near vicinity of its source.

<u>General Measures</u>

TVA proposes nine conservation measures (TR1–TR9; 2023 BA) for tree removal activity. Some deal with the timing and location of tree removal activity relative to the seasonal life cycle and known occurrences of the listed bats. The proposed measures are (copied from the 2023 BA):

- TR1 = Removal of potentially suitable summer roosting habitat during time of potential occupancy has been quantified and minimized programmatically. TVA will track and document alignment of activities that include tree removal (*i.e.,* hazard trees, mechanical vegetation removal) with the programmatic quantitative cumulative estimate of seasonal removal of potentially suitable summer roost trees for Indiana bat and northern long-eared bat.
- TR2 = Removal of suitable summer roosting habitat within 0.5 mile (mi) of Priority 1/Priority 2 Indiana bat hibernacula, or 0.25 mi of Priority 3/Priority 4 Indiana bat hibernacula or any northern long-eared bat hibernacula will be prohibited, regardless of season, with very few exceptions (*e.g.,* vegetation maintenance of TL ROW immediately adjacent to Norris Dam Cave, Campbell County, TN).
- TR3 = Removal of suitable summer roosting habitat within documented habitat (*i.e.,* within 10 mi of documented Indiana bat hibernacula, within five miles of documented northern long-eared bat hibernacula, within 2.5 mi of documented Indiana bat summer roost trees, within five miles of Indiana bat capture sites, within 1.5-mi of documented northern long-eared bat summer roost trees, within three miles of northern long-eared bat capture sites) will be tracked, documented, and included in annual reporting.

- TR4 = Removal of suitable summer roosting habitat within potential habitat for Indiana bat or northern long-eared bat hibernacula will be tracked, documented, and included in annual reporting.
- TR5 = Removal of any trees within 150 feet (ft) of a documented Indiana bat or northern long-eared bat maternity summer roost tree during non-winter season, rangewide pup season or swarming season (if site is within known swarming habitat), will first require a site-specific review and assessment. If pups are present in trees to be removed (determined either by mist netting and assessment of adult females or by visual assessment of trees following evening emergence counts), TVA will coordinate with the Service to determine how to avoid direct and minimize indirect impacts to pups to the extent possible. This may include delay of project execution and establishment of artificial roosts before loss of roost tree(s).
- TR6 = Removal of a documented Indiana bat or northern long-eared bat roost tree that is still suitable and that needs to occur during non-winter season, rangewide pup season, or swarming season (if site is within known swarming habitat) will first require a site-specific review and assessment. If pups are present in trees to be removed (determined either by mist netting and assessment of adult females or by visual assessment of trees following evening emergence counts), TVA will coordinate with the USFWS to determine how to avoid direct and minimize indirect impacts to pups to the extent possible. This may include delay of project execution and establishment of artificial roosts before loss of roost tree(s).
- TR7 = Tree removal within 100 ft of existing transmission ROWs will be limited to hazard trees as defined in Section 3-2.
- TR8 = Requests for removal of hazard trees on or adjacent to TVA reservoir land are inspected by staff knowledgeable in identifying hazard trees per International Society of Arboriculture and TVA's checklist for hazard trees. Approval is limited to trees with a defined target.
- TR9 = Internal controls will be in place to further reduce potential for site-specific direct adverse effects to Indiana bat and northern long-eared bat associated with tree removal. This includes promoting presence/absence surveys (mist netting or emergence counts) that allows for positive detections but without resulting in increased constraints in cost and project schedule. Internal controls are intended to facilitate willingness and financial feasibility to conduct surveys amidst increasing budget constraints without the risk for increased financial penalty if Indiana bat or northern long-eared bat individuals are caught. This enables TVA to contribute to increased knowledge of bat presence on the landscape while continuing to carry out TVA's broad mission and responsibilities.

<u>Sedimentation, Spills, Pollutants, and Contaminants (SSPC)</u>

Six conservation measures (SSPC1–5 and SSPC7) deal with protecting water quality while conducting tree removal activities, which are described in Section 5.2.6 of the 2017 BA. These measures are standard TVA best management practices (BMPs) that avoid or minimize inputs of sediment and other pollutants into waterways and cave/cave-like entrances. Although TVA determined that tree removal activity under the programmatic Action is LAA the Ibat and NLEB, TVA concluded that the stressors causing such adverse effects do not include sediments and contaminants (2017 BA). The Service agrees that implementing water quality protection measures, SSPC1–5 and SSPC7 during tree removal activities would limit any adverse effects to bats from sediment to an insignificant scale and that any changes in water quality due to pollutants would be reduced to a discountable probability. Therefore, we do not further address the SSPC conservation measures in this BO.

2.3. Prescribed Burning

Of the ten general TVA action categories listed in the introduction to Section 2 of this BO, only "manage for biodiversity and public use" involves prescribed burning (Activity #23). This activity is limited to portions of TVA Reservoir Lands. TVA uses fire to maintain and establish high quality wildlife habitat, reduce the risk of wildfires, stimulate growth of targeted vegetation, and recycle nutrients back into the soil.

From 2013 to 2018, TVA has burned about 750 to 1,000 ac each year, of which 60% was on open lands and 40% on forested lands. The annual extent of burning will rarely exceed 1,500 ac. TVA estimates that 26,247 ac of its reservoir lands could use prescribed fire over a 20-year period (2018–2038). Of this total, 17,677 ac (86 parcels that range in size from 2–4,649 ac) are identified for prescribed burning (potential burn sites) but are not currently included in a burn plan due to budget and staff limitations. The remaining 8,570 ac (66 parcels that range in size from 2–1,659 ac) are currently managed with fire (active burn sites) or are slated for fire management within 5 years (2018-2022).

2.3.1. Prescribed Burning Methods

TVA intends to conduct most burns in early winter to early spring (approximately November–April). Weather conditions that are not conducive to controlled burning generally preclude burns during September and October. Burn season and frequency on a parcel range from 1–5 years, depending on site-specific objectives. Table 2-3 provides examples of the objectives associated with burns conducted at various times of year.

Table 2-3. Seasonality and example objectives of prescribed burning on TVA lands (source: 2017 BA Table 3-3).

SEASON	OBJECTIVES
Fall-Winter-Spring; Spring	Invasive control - conversion to native early successional - maintain early successional (in partnership with state agency at some locations)
Fall-Winter; Winter-Spring; Spring	Maintain early successional seral stage (*e.g.,* dam safety level protection; hay/row crop production; Native warm season grass production; research partnership with local university, state agency or non-profit organization; reduce encroaching canopy - expanding barrens habitat; reduction of density coverage; understory maintenance- shortleaf pine initiative)
Fall-Winter	Maintain Pine-savannah - early successional seral stage
Winter-Spring	Mix upland hardwood selective thinning and understory control-Partnership research with Mississippi State University
Fall-Winter-Spring	Mixed hardwood-pine local wildfire suppression-understory maintenance-Shortleaf Initiative
Spring	Pine-Cedar local wildlife suppression-invasive and woody suppression-revert to early succession
Fall-Winter-Spring	Pine-hardwood local wildfire suppression-understory maintenance-hardwood regeneration
Fall-Winter-Spring; Fall-Winter	Pine-Oak local wildfire suppression (invasive understory control; early succession maintenance; shortleaf initiative; afforestation preparation)
Fall-Winter-Spring	Planted shortleaf (understory maintenance; maintain early successional seral stage
Winter-Spring	Site prep (conversion to native, early successional stage; maintain early successional seral stage
Fall-Winter-Spring	Undesirable woody suppression - desirable woody regeneration maintenance; early-successional conversion and maintenance)
Fall-Winter; Spring	Upland hardwood local wildfire suppression (undesirable woody control; understory maintenance; invasive control)

TVA has previously established BMPs for conducting prescribed burns, which are appended to the 2017 BA as Appendix C ("BMPs for Silviculture Activities on TVA Lands") and apply to this Action. The description of Activity #23 in Section 3-2 of the 2017 BA lists the following guidance (conditions and considerations) for prescribed burning that specifically deal with caves and bats (paraphrased from 2017 BA):

1) Caves are smoke-sensitive environments. TVA assumes that federally listed bats use a cave until surveys show otherwise.
2) Considering relevant site-specific conditions, prescribed burn managers must ensure that smoke does not enter caves or cave-like structures when bats are present.

3) Where feasible, burn larger acreages in smaller units at a time to reduce the risk of smoke entering sensitive sites.
4) Tractor-constructed fire breaks, mechanical site preparation, vegetation cutting, and construction of new roads (including temporary roads) are prohibited within 200 ft of cave portals, cave collapse areas, mines, and sinkholes. Use site-specific data to determine whether wider buffers are necessary to protect water and air quality in caves and mines.
5) Use existing barriers (*e.g.,* streams, lakes, wetlands, roads, and trails) as fire lines whenever possible.
6) Prescribed burning in known and potential maternity roosting habitat is prohibited from June 1–July 31, except where site-specific data indicate that Ibats and NLEBs are not likely present.

TVA has provided a seasonal breakdown of the 20-year cumulative extent of prescribed burning relative to the three bat life-cycle seasons: inactive season (winter), non-volant pups (June and July), and the remainder of the active season (H. LeGrand, pers. comm., 2018a). Although not listed as an avoidance and minimization measure applicable to burning, this breakdown specifies no burning during June and July, 90% during the inactive season, and 10% in the remainder of the active season.

2.3.2. Conservation Measures for Prescribed Burning

In addition to the burning BMPs and the methods described in Section 2.3.1, TVA proposes nine conservation measures to avoid and minimize the adverse effects of smoke and heat from prescribed burning on bats. Some of these measures, listed below (copied from the 2017 BA, Section 5.2.3), overlap with the proposed methods.

- SHF1 = Firebreaks are used to define and limit burn scope.
- SHF2 = Site-specific conditions (*e.g.,* acres burned, transport wind speed, mixing heights) are considered to ensure smoke is limited and adequately dispersed away from caves so that smoke does not enter cave or cave-like structures.
- SHF3 = Acreage is divided into smaller units to keep the amount of smoke at any one time or location to a minimum and reduce risk for smoke to enter caves.
- SHF4 = Planned timing for prescribed burns minimally overlaps with time of potential occupancy by bats (See 2017 BA, Table 3-3). If burns need to be conducted during April and May, when there is some potential for bats to be present on the landscape and more likely to enter torpor due to colder temperatures, burns will only be conducted if the air temperature is 55° or greater, and preferably 60° or greater.
- SHF5 = Firebreaks are plowed immediately prior to burning, are plowed as shallow as possible and are kept to minimum to minimize sediment.
- SHF6 = Tractor-constructed firelines are established greater than 200 ft from cave entrances. Existing logging roads and skid trails are used where feasible to minimize ground disturbance and generation of loose sediment.
- SHF7 = Burning will only occur if site-specific conditions (e.g., acres burned, transport wind speed, mixing heights) can be modified to ensure that smoke is adequately dispersed away from caves or cave-like structures. This applies to prescribed burns and burn piles of woody vegetation.

- SHF8 = Brush piles will be burned a minimum of 0.25-mi from documented, known, or obvious caves or cave entrances and otherwise in the center of newly established ROW when proximity to caves on private land is unknown.
- SHF9 = A 0.25-mi buffer of undisturbed forest will be maintained around: 1) documented or known gray bat maternity and hibernation colony sites, 2) documented or known Virginia big-eared bat maternity, bachelor, or winter colony sites, 3) Indiana bat hibernation sites, and 4) northern long-eared bat hibernation sites. Undisturbed forest is important for gray bats to regulate temperatures at the mouth of the cave and provide cover for bats as they emerge from the cave. Prohibited activities within this buffer include cutting of over-story vegetation, construction of roads, trails or wildlife openings, and prescribed burning. Exceptions may be made for maintenance of existing roads and existing ROW, or where it is determined that the activity is compatible with species conservation and recovery (*e.g.,* removal of invasive species).

The 2017 BA reports that 74 caves occur within one mile of the active, planned, and potential burn sites on TVA reservoir lands. Of these, 11 have documented bat occupancy (current or historic), 25 are within 500 ft of active burn sites, and 15 are within the boundaries of potential burn sites (3 of the 15 have documented bat occurrence). TVA determined that prescribed burning conducted in a manner consistent with the proposed Action, which includes the BMPs and the conservation measures listed above, is NLAA listed bats while they inhabit caves.

The Service previously concurred with this TVA determination relative to the gray bat and Virginia big-eared bat (see Consultation History), which roost in caves year-round. We agree also that the BMPs and proposed conservation measures will limit any adverse effects of burning on Ibats and NLEBs while they inhabit caves to a discountable probability. Therefore, we do not further address in this BO the effects of burning on these two species while they inhabit caves, which is during their inactive winter (hibernation) season. Further analysis of the effects of prescribed fire is limited to burns conducted during the active season of these two bat species.

2.4. Additional Conservation Measures

In addition to the impact avoidance and minimization measures specified for each of the 96 activities, Section 5.3 of the 2017 BA and Section 3.3.4 of the 2023 BA describe various ongoing TVA efforts that promote the recovery of listed bats in the TVA Region. These efforts include:

- monitor gray bat caves on TVA-managed lands;
- collaborate with partners to survey bridges and potential summer use (e.g., maternity colonies) areas;
- support bat ecology research (*e.g*., spring migration radio tagging and tracking, location, and assessment of roost trees);
- monitor bat use following habitat enhancement and artificial roost projects on TVA lands;
- install, monitor, and maintain gates and signage at bat caves on TVA lands;
- serve on State white-nose syndrome (WNS) planning committees (*e.g*., AL, TN);
- maintain a database of listed bat occurrences within the TVA Region (*i.e*., mist net captures, cave, bridge, and tree roosts, *etc.*) to inform project-specific environmental reviews and Bas;

- manage invasive plants that threaten rare species habitats (*e.g*., cave entrances); and
- conduct bat habitat identification workshops for TVA staff;
- install and maintain cave gates to protect roosting bats and minimize human disturbance to bats utilizing caves.

TVA also addresses listed bat conservation needs to some extent in the following policies, plans, and processes:

- 2021 Biodiversity Policy, which commits TVA to working proactively to protect biodiversity through stewardship of public lands, management of the Tennessee River system, local and regional partnerships, and integration of species and habitat conservation in project planning;
- 2020 Environmental Policy, which enhances land and water resources to provide multiple benefits in the TVA Region, fosters public health and safety by improving air and water quality and protecting the TVA Region's natural resources, reduces consumption of water resources and the generation of waste and by-products, and aligns with TVA's threefold mission;
- 2020 Integrated Resource Plan (IRP), which guides TVA's electricity generation planning;
- 2020 Natural Resource Plan (NRP), which guides management and stewardship activities on TVA lands;
- 2006 Land Policy, which guides management of the reservoir system and surrounding reservoir lands;
- 1999 Shoreline Management Policy (SMP), which guides the protection of shoreline and aquatic resources while allowing reasonable access to the water by adjacent property owners;
- 1933 Three-pronged Mission, which addresses the TVA Region's most important issues in energy, environmental stewardship, and economic development;
- TVA's Environmental Review Process, which ensures actions proposed by TVA are subject to an environmental review process at multiple levels to comply with the National Environmental Policy Act (NEPA), ESA, and other environmental laws.

This consultation is an example of a proposed TVA Action being subjected to TVA's environmental review process at a regional programmatic level for ESA compliance purposes with respect to listed bats. The programmatic Action addresses multiple routine activities that are common components of actions funded, authorized, or carried out with additional project-level environmental review as necessary and appropriate.

The 2023 BA does not provide data about the various additional conservation measures listed above that would inform an analysis of their beneficial effects on listed bat numbers, reproduction, or distribution. The Service recognizes the inherent value of these efforts to the recovery of listed bats. Several provide information that is critical to formulating effective conservation actions, but do not directly improve the status of listed bats. Therefore, lacking data that would allow us to determine the scale of their beneficial effects relative to those of the proposed activities that are LAA the Ibat and NLEB, we do not further address the "additional conservation measures" in this BO.

2.5. Project-Level Process

Chapter 6 of the 2017 BA and 2023 BA describe the procedures TVA proposes for activities funded, authorized, or carried out under the programmatic Action to rely on this programmatic consultation for ESA compliance with respect to the listed bats that such activities may affect. These procedures specify a sequence of TVA project-specific determinations using best available data, and the documentation, notification, and reporting processes that are associated with these determinations. Table 2-4 reiterates these procedures.

Table 2-4. Proposed steps to document and report alignment of TVA activities with the bat programmatic consultation (source: 2023 BA Table 6-1).

#	STEP
1.	Site-specific project will be screened via TVA's environmental review process.
2.	Project will be reviewed to determine if associated activities are within the scope of TVA's bat programmatic consultation (BPC).
3a.	Projects with activities that are outside BPC scope will be subject to project-specific consultation if warranted. ***END***
3b.	Projects with activities that are within BPC scope will be reviewed for potential to impact covered species. ***Go to 4.***
4a.	Project-specific activities that are determined in the BPC to have No Effect will be documented as aligning with the BPC and documented in TVA's environmental management system. ***END***
4b.	Project-specific activities determined in the BPC to have potential to NLAA covered species will be reviewed further to determine if project exposes covered species to stressors. If so, conservation measures identified in the BPC will be implemented and documented. If no exposure to stressors will occur as part of the project, activity will be documented as having no effect on covered species. In either case, documentation of the proposed project, alignment with the BPC, and project-specific determinations will be saved in TVA's administrative record. All projects with effects determinations of these types will be summarized in annual reporting associated with the BPC. ***END***
4c.	Project-specific activities determined in the BPC to have potential to LAA covered species will be reviewed further to determine if project exposes covered species to stressors. ***Go to 5.***
5a.	If no exposure to stressors will occur as part of this project-specific activity, activity will be documented as aligning with the BPC, having no effect on covered species, and will be included in annual reporting associated with the BPC. ***END***
5b.	If project-specific activity aligns with LAA determination, project conducts presence/ absence surveys, and detections are negative, TVA will document a NLAA determination and alignment with BPC and save documentation in TVA's administrative record. All projects with effects determinations of these types will be summarized in BPC annual reporting. ***END***
5c.	If project-specific activity aligns with LAA determination, project assumes presence, or project conducts presence/absence surveys and detections are positive, TVA will document a LAA determination and alignment with BPC. If surveys are positive or if the proposed actions are within known habitat, TVA will notify the appropriate USFWS FO (via email or letter) of the proposed project, alignment with BPC, survey outcome (if surveys conducted), and determination. Documentation will be recorded in TVA's administrative record. All projects with effects determinations of these types will be summarized by species in annual reporting associated with the BPC. ***END***

[a] NLAA = may affect; not likely to adversely affect.

[b] LAA = may affect; likely to adversely affect.

3. STATUS OF THE SPECIES

This section summarizes best available data about the biology and current condition of the Indiana bat (*Myotis sodalis*) (Ibat) and the northern long-eared bat (*Myotis septentrionalis*) (NLEB) throughout their range that are relevant to formulating an opinion about the Action.

The Ibat was among several animals identified in 1967 (32 FR 4001) as threatened with extinction under the Endangered Species Preservation Act of 1966, and subsequently classified as endangered when the ESA of 1973 superseded the earlier statute. The Service approved a recovery plan for the Ibat on October 14, 1983 (USFWS 1983), and issued a draft first revision, on April 13, 2007 (USFWS 2007). Critical habitat is designated for the Ibat but is not relevant to this consultation.

The Service has issued the following decisions regarding ESA protections for the NLEB:

Date	Federal Register	Decision
04/02/2015	80 FR 17973–18033	Threatened species status with interim 4(d) rule
01/14/2016	81 FR 1900–1922	Final 4(d) rule
04/27/2016	81 FR 24707–24714	Determination that designation of critical habitat is not prudent
11/30/2022	87 FR 73488-73504	Final rule published to reclassify the northern long-eared bat as endangered
03/31/2023	88 FR 4908 4910	Final rule for designating the northern long-eared bat as endangered will go into effect

The Service has not yet approved a recovery plan for the NLEB.

3.1. Species Description

The Ibat is a medium-sized bat that closely resembles the little brown bat (*Myotis lucifugus*) but has a darker brown to black pelage. Adults weigh about one-quarter of an ounce (the weight of three pennies) and have a wingspan of 9 to 11 inches.

The NLEB is also a medium-sized bat, also weighing about one-quarter of an ounce. As indicated by its common name, the NLEB is distinguished from other *Myotis* species by its large ears, which extend beyond the nose when laid forward.

3.2. Life History

The Ibat and NLEB are both insectivorous migratory species that hibernate in caves and mines during winter and forage in wooded areas during summer. Foraging activity and travel is mostly nocturnal. Ibat average life span is 5–10 years, but recapture of banded individuals has documented Ibats up to 15 years old (Humphrey and Cope 1977). NLEB longevity is up to 18.5 years (Hall *et al.* 1957). Prior to the arrival of WNS, Caceres and Pybus (1997) attributed the highest age-specific annual mortality rates for the NLEB and many other species of bats to the juvenile stage. Hall (1962), Myers (1964), and LaVal and LaVal (1980) report sex ratios of 1:1 for the Ibat. NLEB sex ratios at the population level are not reported in the literature, but as a species similar to the Ibat in many other respects, a 1:1 ratio is likely.

The key phases in the Ibat and NLEB annual life cycle are:

- hibernation;
- spring staging and migration;
- pregnancy and lactation;
- pup volancy (able to fly); and
- fall migration and mating (swarming).

Although the timing varies with latitude and weather conditions, both bat species generally hibernate from mid-fall to mid-spring each year. Upon emerging from hibernation, bats forage for a few days or weeks near their hibernaculum (spring staging). Spring migration occurs from mid-March to mid-May. Females depart shortly after emerging from hibernation and are pregnant when they reach summer areas. Males tend to stay closer to hibernacula during summer. Adult females give birth to a single pup in late May to early June. Pups are weaned from nursing shortly after becoming volant in mid- to late-July. Fall migration occurs from mid-August to mid-October. Upon arriving at hibernacula, both species exhibit the "swarming" behavior. Large numbers of bats fly in and out of hibernacula entrances from dusk to dawn, roosting during the day in trees, but occasionally within the hibernacula. Swarming continues for several weeks, and mating occurs during the latter part of the period. After mating, females enter hibernation, but not necessarily at the same hibernaculum where mating occurred. Most individuals of both sexes are hibernating by the end of November (by mid-October in northern areas).

The following subsections discuss in greater detail the aspects of the Ibat and NLEB life history that are most relevant to this consultation. We do not further discuss hibernation or hibernacula, because the Action is NLAA this life stage or habitat.

3.2.1. Summer Habitat and Ecology

Summer habitats for Ibat and NLEB bat consists of a wide variety of forested areas where they roost, forage, and travel. These habitats may include portions of adjacent and interspersed non-forested areas such as wetlands, the edges of agricultural fields, old fields, and pastures. Areas containing potential roosts include forests and woodlots, as well as linear features such as fencerows, riparian forests, and other wooded corridors. Tree density and canopy cover in areas used for roosting or foraging is variable. NLEBs are typically associated with upland forests with generally greater cover than Ibats and appear to favor mature upland forests (Caceres and Pybus 1997), but occasionally forage over forest clearings, water, and along roads. However, most NLEB hunting occurs on forested hillsides and ridges, rather than along riparian areas preferred by the Ibat (Brack and Whitaker 2001; LaVal *et al.* 1977).

Wing morphology of both species suggests they are adapted to moving in cluttered habitats. Many species of bats, including the Ibat and NLEB, consistently avoid crossing or foraging in large open areas, choosing instead to use tree-lined pathways or small openings (Patriquin and Barclay 2003; Yates and Muzika 2006). Therefore, small patches of trees are unlikely to provide suitable foraging or roosting habitat unless connected to other patches by a wooded corridor.

Many male Ibats appear to remain at or near the hibernacula in summer with some fanning out in a broad band around the hibernacula (Whitaker and Brack 2002). Because males typically roost individually or in small groups, the average size of their roost trees is generally smaller than the roost trees used by female maternity colonies, which we discuss in the following subsection. Males may occasionally roost in caves. Males exhibit summer site fidelity and have been recaptured in foraging areas from prior years (USFWS 2007).

Maternity Colonies and Roosts

Following a variable-length period of foraging near hibernacula in the spring, females seek suitable habitat for maternity colonies, which appear essential for reproductive success. Based on estimates of data from 30 states, after accounting for the effects of WNS, the size of NLEB maternity colonies varies from 20-45 females (USFWS 2016). Ibat maternity colonies are generally larger, but most contain fewer than 100 adult females (USFWS 2007). The mean maximum emergence count from Ibat maternity roosts after young began to fly (measured in 12 studies) was 119 bats (Kurta 2005), suggesting a colony size of 60–70 adult females (assuming that most adult females successfully raise one pup to volancy).

For purposes of this programmatic BO, we use 60 adult Ibat females per colony as the basis for estimating the number of Ibat colonies on the summer landscape. For each colony, we assume the local Ibat population is comprised of 60 adult females, 60 sympatric adult males, and 60 juveniles following parturition. We use 33 adult NLEB females (the mean of five states in the TVA Region [Kentucky=39, Mississippi=45, North Carolina=39, Tennessee=20, and Virginia=20] that were included in the analysis of the summer adult population size of NLEB in 30 states (USFWS 2016) as previously discussed in the above paragraph and assume that the local population is comprised of 33 adult females, 33 sympatric adult males, and 33 juveniles following parturition.

Both species exhibit a degree of inter-annual fidelity to particular roost trees and/or maternity areas (Ibat: Humphrey *et al.* 1977; Gardner *et al.* 1991a, 1991b; Gardner *et al.* 1996; Callahan *et al.* 1997) (NLEB: Perry 2011; Johnson *et al.* 2009; Jackson 2004; Foster and Kurta 1999). Males are occasionally found with females in NLEB maternity colonies, but only rarely in Ibat maternity colonies. Maternity colonies of both species use networks of roost trees often centered around one or more primary (Ibat) or central-node (NLEB) roost trees. Ibat maternity colonies use a minimum of 8–25 roost trees per season (Callahan *et al.* 1997; Kurta *et al.* 2002). NLEB roost networks also include multiple alternate roost trees. Male and non-reproductive female NLEBs may also roost in caves and mines (Barbour and Davis 1969; Amelon and Burhans 2006).

Roost tree preferences vary between the two species. Ibats are known to use a wide variety of tree species ≥ 5 inches diameter at breast height (DBH) that have cracks, crevices, or peeling bark. A typical Ibat primary roost is located under the exfoliating bark of a dead ash, elm, hickory, maple, oak, or poplar, but any tree that retains large, thick slabs of peeling bark is potentially suitable. Primary Ibat roosts are usually in trees that are in early-to-mid stages of decay. NLEBs use a wider variety of trees for roosts. NLEBs roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags that are ≥ 3 inches DBH. Ibats and

NLEBs (more frequently) occasionally roost in barns and sheds, particularly when suitable tree roosts are unavailable.

3.2.2. Migration

Males and non-reproductive females may remain near hibernacula or migrate to summer habitat some distance from their hibernaculum. Female Ibats commonly migrate hundreds of miles from their hibernacula (USFWS 2007), whereas NLEBs typically migrate 40-50 mi (USFWS 2014). Long-distance migration is energetically demanding. Fall migration occurs following months of summer foraging and building fat reserves. Spring migration occurs when fat reserves are depleted from hibernation, prey abundance is low, and females are pregnant; therefore, spring migration is possibly the most stressful period in the Ibat and NLEB life cycles.

3.2.3. Fall Swarming/Spring Emergence Habitat

The area around a winter hibernaculum necessarily serves as the location for the spring emergence from hibernation and the fall return from summer habitats. During spring staging and fall swarming, Ibat and NLEB roost in trees and forage in habitats that are similar to their summer habitats (see Section 3.2.1), typically within five miles of their hibernaculum. Fall swarming activity lasts for several weeks. The duration of spring staging is more variable. Individual bats may spend a few days or a few hours around their hibernacula following emergence or may migrate immediately to summer habitat.

3.2.4. Home Range

Ibats and NLEBs are migratory species that establish seasonal residency within a distinct home range. Summer home range includes roosting, foraging, and drinking areas, and the travel pathways between those habitats for a duration of several months. Fall home range includes the hibernaculum entrance for swarming behavior, but must also include roosting, foraging, and drinking areas for a duration of several weeks. For individuals (most females) that migrate to more distant summer habitats, spring home range is likely a subset of the areas used in the fall, but only for a few hours or days.

Studies using radio telemetry tagging and various analysis methods (e.g., mean convex polygons, 95% adaptive kernel, 95% fixed kernel) have estimated average individual Ibat summer home range sizes of 205–917 ac (Jachowski *et al.* 2014; Kniowski and Gehrt 2014; Menzel *et al.* 2005; Sparks *et al.* 2005; Watrous *et al.* 2006). One study near a hibernaculum during spring and fall (Rommé *et al.* 2002), and two during fall (Brack 2006; Kiser and Elliot 1996), estimated average home range sizes of 156–3,825 ac. Average individual NLEB summer home range size appears smaller than Ibat, with estimates of 161 and 179 ac (Owen *et al.* 2003, Lacki *et al.* 2009, respectively). No published studies have examined spring or fall home range sizes of NLEB. The average home range sizes reported in the studies cited above are each associated with substantial variability among the sample of individuals tracked in a particular study area. The sample size ranges from 3–32 bats. None reported the collective spatial extent of bat activity of all individuals tracked, and none attempted to track all members of a maternity colony, or all bats engaged in fall swarming at a hibernaculum.

Depending on local habitat conditions, the home ranges of members of a maternity colony may or may not overlap substantially outside of the immediate area around shared roost trees. Some studies have documented summer habitat movements exceeding one mile (e.g., NLEB travel between roost tree and foraging area of 5,640 ft, Sasse and Pekins 1996), which imply a home range larger than a few hundred acres. For these reasons, the Service conservatively advises using a radius of 2.5 mi (Ibat) and 1.5 mi (NLEB) around a summer survey detection to delineate the area in which foraging and roosting activity of a maternity colony may occur. The area of a circle with a 2.5-mi radius is 12,566 ac, which is about 14 times larger than the largest Ibat individual summer home range reported in the literature. Similarly, a 1.5-mi circle (4,524 ac) is 25 times larger than the largest NLEB individual summer home range reported in the literature. A radius of 2.5 and 1.5 mi is likely to encompass all the roosts and foraging areas associated with a summer Ibat and NLEB detection, which is the purpose of this guidance, but likely exceeds the area on the landscape that a maternity colony actually uses regularly, which is not its purpose.

Likewise, the home ranges of very large numbers of individuals swarming at a hibernaculum probably do not overlap substantially much beyond the hibernaculum entrance, unless suitable habitat in the vicinity is very limited. To delineate potential foraging and roosting activity around known Ibat hibernacula, the Service uses a 10-mi radius for Priority 1 and 2 hibernacula, and a five-mile radius for Priority 3 and 4 hibernacula. This recognizes the importance of these areas in bat conservation, and the variability associated with larger (P1 and P2) and smaller (P3 and P4) numbers of bats. For all known NLEB hibernacula, the radius is five miles, because NLEB winter aggregations are comparable to or less than Ibat numbers at P3 and P4 hibernacula.

Ibat males and females generally roost separately in the summer, but NLEB males are known to roost with females in maternity colonies to some extent. Some of the studies cited above suggest differences in summer home range size between males and females, both Ibat and NLEB. Despite some differences, male and female NLEB may share a large fraction of their foraging habitat within the occupied forested landscape. An analysis of mist net survey data in Kentucky found that the majority of NLEB males and non-reproductive females were captured in the same locations as reproductively active females, indicating a 90.43% overlap in the summer home range of reproductive females and other individuals (USFWS 2016). This data is discussed in more detail in Section 4.1.2.

3.3. Numbers, Reproduction, and Distribution

3.3.1. Indiana Bat

Ibats are concentrated in relatively few hibernacula during the winter. Biennial winter surveys in 2017 estimated a total of 530,705 Ibats in 229 hibernacula in 17 states (USFWS 2017). Four states accounted for 96% of the total population estimate: Missouri (41.1%), Indiana (34%), Kentucky (11%), and Illinois (9.9%).

Emerging from hibernation, female Ibats disperse across a broad range in 19 States (Figure 3-1). Males are found during the summer throughout the range of the species, but most commonly in areas near known hibernacula (Gardner and Cook 2002). Males typically roost alone in the summer, but occasionally with maternity colonies. The Recovery Plan (USFWS 2007) reports 269 known extant maternity colonies in 16 states. Of these, 54% were discovered between 1997 and 2007, mostly using mist-netting surveys. Surveys continue to discover maternity colonies, but the Service has not compiled a rangewide tally since 2007. Using a 1:1 female/male sex ratio and an average maternity colony size of 60 adult females (see Section 3.2.1), the 2017 winter survey population estimate yields an estimate of 530,705 ÷ (2 ×60) = 4,423 extant maternity colonies. The 269 Ibat maternity colonies known as of 2007 represents only 6% of this possible total.

The 2017 rangewide population estimate of 530,705 Ibats is a 3.5% decrease from the 2015 estimate of 550,224 bats (Figure 3-2). The biennial population estimates had been increasing from 2001 to 2007, suggesting that the species' long-term decline had been reversed (USFWS 2017). The decline since 2007 is likely attributable to WNS (see Section 3.4 under "Threats"), especially in the Northeast Recovery Unit.

3.3.2. Northern long-eared bat

The range of the NLEB extends across much of the eastern and north central US (37 states), and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Figure 3-3). Most historical records of NLEBs are from winter hibernacula surveys (Caceres and Pybus 1997). Before the onset of WNS, the species was most frequently observed in the northeastern U.S. and the Canadian Provinces of Quebec and Ontario, and surveys of many hibernacula detected only a few individuals (Whitaker and Hamilton 1998). Prior to the introduction of WNS, the NLEB was considered common in the northern portion of its range, uncommon in the south, and rare in the west (Amelon and Burhans 2006). The NLEB still occurs across much of its historical range, but with many gaps where the species is apparently extirpated or sparse due to WNS. More recent surveys in upland areas have revealed that this species is more common in Arkansas, Kentucky, Missouri, and Tennessee than indicated by previous work (NatureServe Explorer 2022) and has only been recently discovered in coastal North Carolina (within the Middle Atlantic Coastal Plain ecoregion) (Jordan 2020).

According to the recently completed "Status Assessment Report for the Northern Long-eared Bat" (SSA) (USFWS 2022), available evidence indicates NLEB abundance has and will continue to decline substantially over the next 10 years under current conditions. Evidence of the past decline is demonstrated in available data in both winter and summer. For example, historical rangewide winter abundance declined by 49% by 2020, and the number of historically extant winter colonies (populations) by 81% by 2020. There has also been a noticeable shift towards smaller colony sizes, with a 96–100% decline in the number of large hibernacula (≥100 individuals). Although the declines are widespread, the magnitudes of the winter declines vary spatially. In the Eastern Hardwoods Representation Unit (RPU), the core of NLEB range, abundance declined by 56% and the number of sites by 88%. Abundance and the number of sites also declined in the remaining four RPUs (87% and 82% - East Coast RPU, 90% and 44% - Midwest RPU, 24%, and 70% - Southeast RPU, and 0% and 40% - Subarctic RPU, respectively). The winter colony sizes also become reduced, with the number of large hibernacula (≥100 bats) declining from 53 in 2000 to 20 in 2020.

Declining trends in abundance and occurrence are also evident across much of the NLEB summer range (USFWS 2022). Based on derived rangewide summaries from Stratton and Irvine (2022), rangewide occupancy has declined by 80% from 2010–2019. Although these declines attenuate westward, the probability of occupancy declined in all RPUs. Similarly, Whitby et al. (2022), using data collected from mobile acoustic transects, found a 79% decline in rangewide relative abundance from 2009–2019. Measurable declines were also found in the Midwest RPU (91%) followed by the Eastern Hardwoods (85%), East Coast (71%), and Southeast (57%) RPUs; data were not analyzed in the Subarctic RPU due to a lack of observations (USFWS 2022). Finally, Deeley and Ford (2022) observed a significant decrease in mean capture rate post-WNS arrival. Estimates derived from their results indicted a 43–77% decline in summer mist net captures when comparing pre and post arrival of WNS. Collectively, these data indicate the NLEB has declined and given the declining trajectories, will continue to decline (USFWS 2022).

Given the dramatic declines across its range and current very low numbers, the Service does not have reasonable certainty that NLEB may be present in suitable, nearby habitat or within historic documented occurrences prior to WNS. Therefore, the Service in each state has established a post-WNS year for their documented occurrences of NLEB based on trend data of when the bottleneck in population counts occurred. These post-WNS years range from 2013 to 2022, depending on the state, and represent the year after the bottleneck, whereby the area within documented occurrences from this date to present have a reasonable certainty of NLEB presence.

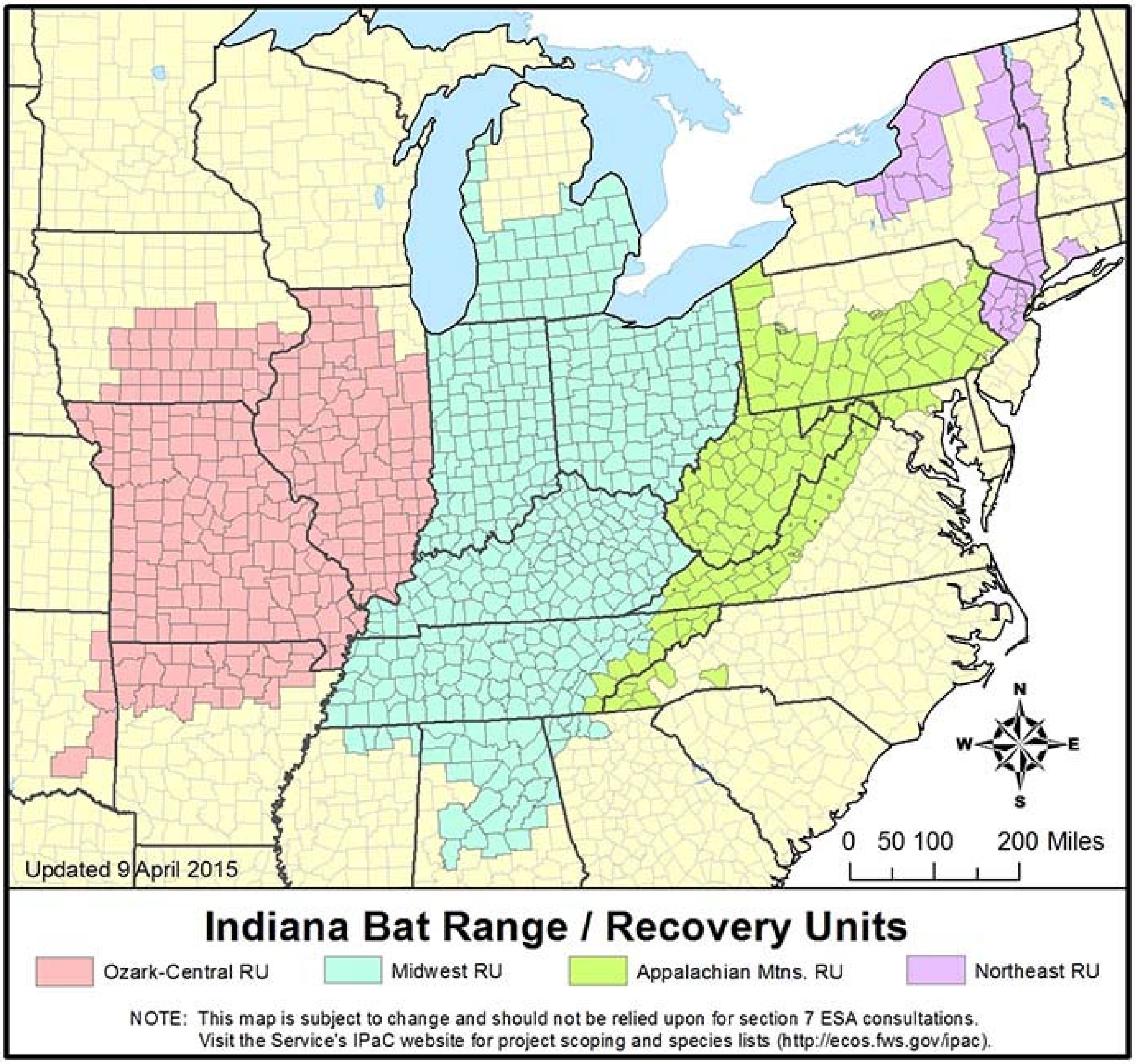

Figure 3-1. Range of, and Recovery Units for, the Indiana bat.

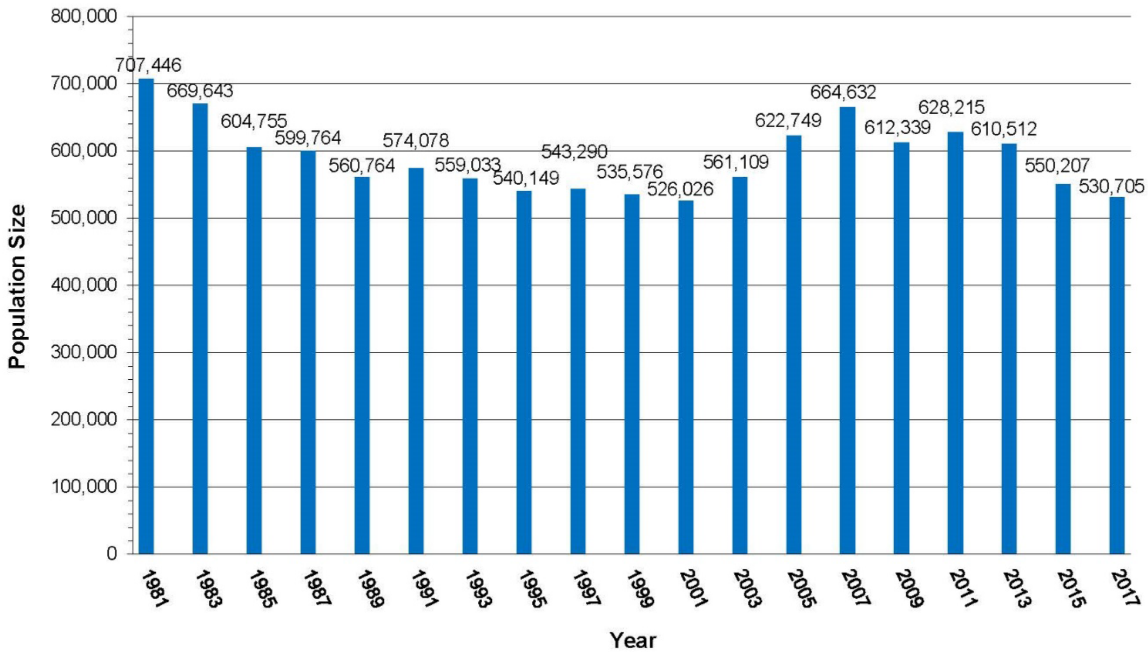

Figure 3-2. Indiana bat 1981–2017 rangewide population estimates (source: USFWS 2017).

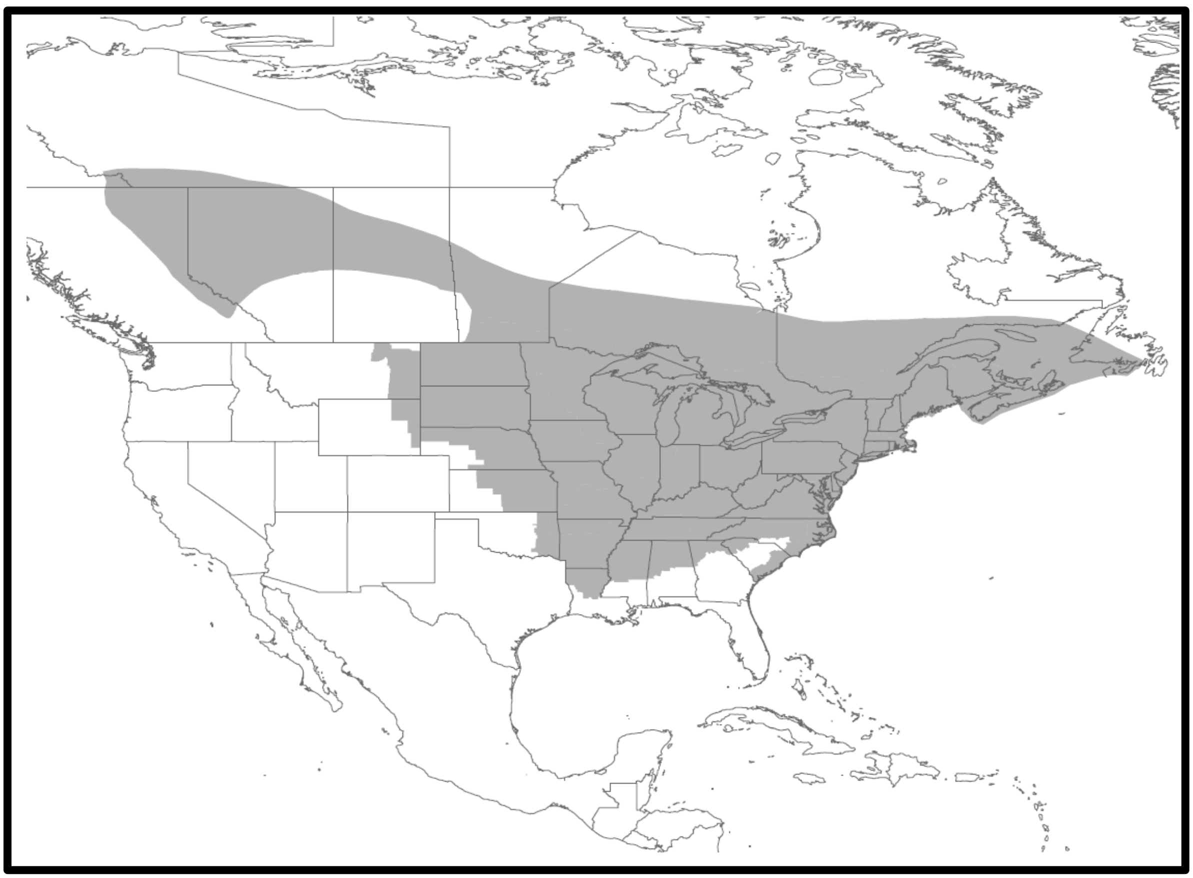

Figure 3-3. Range of the NLEB (source: SSA for the Northern Long-eared Bat, Figure 2-2 (USFWS 2022).

3.4. Conservation Needs and Threats

The conservation needs of and threats to the Ibat are discussed in detail in the 2007 Draft Recovery Plan (USFWS 2007) and the most recent 5-Year Review (USFWS 2009). These documents describe habitat loss and degradation, forest fragmentation, hibernacula disturbance and alteration, and environmental contaminants as the greatest threats to Ibats. The Draft Recovery Plan also identified collisions with wind turbines as an emerging threat.

WNS, wind related mortality, effects from climate change, and habitat loss are recognized in the SSA (USFWS 2022) as the primary threats to the NLEB that have led to its current condition. For over a decade, WNS has been considered to be the foremost stressor on the NLEB. The Service has not yet approved a recovery plan for the NLEB.

White-nose Syndrome
In recent years, no other threat is more severe and immediate for the both the Ibat and NLEB than WNS. As of summer 2022, the causative WNS fungal pathogen, *Pseudogymnoascus destructans* (Pd), had spread to 38 states and eight Canadian provinces, and WNS has inflicted 12 species of bats (White-Nose Syndrome Response Team 2022). It is unlikely that NLEB populations would be declining so dramatically without the impact of WNS. Since first observed in New York in 2006, WNS has spread rapidly in bat populations from the Northeast to the Midwest and Southeast. Cheng et al. (2021) used data from 27 states and two provinces to conclude WNS caused estimated population declines of 97–100% across 79% of the NLEB's range. WNS-related declines in Ibat populations are estimated at up to 75%, with the disease recently moving into the Midwest core of the species' range. It appears likely that WNS will spread throughout most of the range of both species and addressing the threat of WNS is their first and foremost conservation need. Additional information on WNS, which is constantly evolving, is available at http://whitenosesyndrome.org/.

Wiens et al. (2022) used available data from hibernacula surveys to estimate the annual impacts of WNS relative to the year of arrival of Pd; their analysis predicted Pd is present at 99–100% of documented NLEB hibernacula. Although variation exists among sites, an overwhelming majority of hibernating NLEB colonies have developed WNS and experienced serious impacts within 2–3 years after the arrival of Pd (Cheng et al. 2021; Wiens et al. 2022). The vast majority of NLEB colonies exposed to Pd have developed and will continue to develop WNS and experience impacts from the disease (Cheng et al. 2021; Wiens et al. 2022).

The coastal plain of North Carolina is a possible refuge from the WNS epidemic for the NLEB. Studies using radio telemetry are revealing seasonal behavior that is different from other portions of the species' range. These coastal plain bats are not migrating to hibernacula in the fall (caves do not occur in this part of North Carolina), are active during most of the winter, and do not yet show any symptoms of WNS (Girder et al. 2016; Jordan 2020). Torpor for NLEBs on the coastal plain was observed, but time spent in torpor was very short with the longest torpor bout (i.e., hibernation period) for each bat averaging only 6.8 days (Jordan 2020).

WNS is the clear cause of significant NLEB population declines and the recent downturn in Ibat numbers. However, other stressors that had no discernable population-level impacts previously, combined with the impact of the disease, could become factors influencing Ibat and NLEB probability of persistence in particular areas or regions. In general, smaller populations are more vulnerable to extirpation resulting from direct impacts or adverse habitat changes than larger populations, especially those that rely on colonial behaviors for critical life history functions. A single bat maternity colony, for example, reduced in size by WNS-related mortality and with the remaining individuals weakened by the disease, is much less likely to adapt to the loss or reduction of suitable roosting trees and foraging habitat in its traditional home range than a larger and healthier colony. Repeating this scenario with multiple colonies across a landscape could accelerate the population-level declines caused by WNS alone.

Forest Fragmentation and Habitat Modifications

Forests used by foraging and roosting Ibats and NLEBs during spring, summer, and autumn have changed dramatically from pre-settlement conditions (USFWS 1999).The U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS) summary of forest trends (USFS 2014) reported a decline in forest acreage from 1850 to the early 1900s, when forests were converted to other land cover types or native plant communities were altered. Thereafter, the conversion from forest to other land cover types (mostly cropland) were converted through tree planting or pioneer-field succession. From 2001 to 2006, the U.S. lost 1.2% of its total forest acreage, mostly in the Southeast and West. Interior forest (40-ac parcels comprised of at least 90% forest cover) experienced a net loss of 4.3%. Although it is difficult to quantify the resultant impacts, this forest fragmentation has resulted in modifications to Ibat and NLEB habitats, especially summer habitats, and is suspected in contributing to the decline of both species' populations (USFWS 1999, 2022). These changes in landcover may be associated with losses of suitable roosting or foraging habitat, longer flights between suitable roosting and foraging habitats due to habitat fragmentation, fragmentation of maternity colony networks, and direct injury or mortality (USFWS 2022).

Summer habitat can include extensive forests or small woodlots connected by hedgerows. The removal of such habitats is occurring rapidly in some portions of the Ibat and NLEB's ranges due to residential and commercial development, mining, oil and gas development, and infrastructure development, including roadways and utility corridors. Even in areas of relatively abundant habitat, permanent and temporary impacts to forest habitat pose mortality risks to Ibats and NLEBs during tree felling activities. Impacts from forest habitat removal may range from minor (e.g., removal of a small portion of foraging habitat in an unfragmented forested area with a robust bat population) to significant (e.g., removal of roosting habitat in a highly fragmented landscape with a small, disconnected population). Adverse impacts are more likely in areas with little forest or highly fragmented forests, as there is a higher probability of removing roosts or causing loss of connectivity between roosting and foraging habitats (USFWS 2022). Furthermore, the ongoing, permanent loss of forests and woodlots may have a significant cumulative effect on bats, as habitat is lost, fragmented and/or degraded, and as maternity colonies are displaced from habitat to which they exhibit fidelity (USFWS 2012).

Wind Turbines

The construction and operation of wind turbines are estimated to kill close to one million bats (various species, including Ibats and NLEBs) per year and can present a significant local threat to populations (Smallwood and Bell 2020). Bats are vulnerable to mortality and injury associated with the rotating turbine blades, either by collision or barotrauma (pressure-change injury). Ibat mortality has been documented at multiple wind turbine installations.

There are many ongoing efforts to improve our understanding of bat interactions with wind turbines and explore additional strategies for reducing bat mortality at wind facilities (USFWS 2022). To date, operational strategies, such as "feathering" turbine blades (i.e., pitching turbine blades parallel with the prevailing wind direction to slow rotation speeds at low wind speeds when bats are most likely to be active) (Hein and Straw 2021) are the only broadly proven and accepted measures to reduce the severity of impacts.

Climate Change

The capacity of climate change to result in changes in the range and distribution of wildlife species is recognized, but detailed assessments of how climate change may affect specific species, including Ibats and NLEBs, are limited. Bats are sensitive to changes in temperature, humidity and precipitation (Adams and Hayes 2008), especially in their hibernacula. For example, during winter only a small proportion of caves provide the right conditions for hibernating Ibats because of the species' very specific temperature and humidity requirements.

Climate change may affect bats through changes in food availability, timing of hibernation and reproductive cycles, frequency and duration of torpor, rates of energy expenditure, and rates of juvenile bat development (Sherwin *et al.* 2013). Surface temperature is directly related to cave temperature, so climate change that involves increased surface temperatures may affect the suitability of hibernacula. Clawson (2002) suggested that climate change may shift Ibats from southern to northern hibernacula.

Although we lack species-specific observations for Ibats and NLEBs, observed climate-related impacts to date for other insectivorous bats, such as the little brown bat, include reduced reproduction due to drought conditions leading to decreased availability of drinking water (Adams 2010) and reduced adult survival during drought years in the Northeast (Frick *et al.* 2010). While sufficient moisture is important, too much precipitation during the spring can also result in negative consequences to insectivorous bats. During the anticipated heavier precipitation events there may be decreased insect availability and reduced echolocation ability (Geipel *et al.* 2019) resulting in decreased foraging success. Precipitation also dampens bat fur, reducing its insulating value (Webb and King 1984; Burles *et al.* 2009) and increases a bat's metabolic rate (Voigt *et al.* 2011). Bats are likely to reduce their foraging bouts during heavy rain events and reduced reproduction has been observed during cooler, wetter springs in the Northwest (Grindal *et al.* 1992; Burles *et al.* 2009). Responses will vary throughout Indiana bat and northern long-eared bat ranges based on the extent of annual temperature rise in the future.

The Service currently has no evidence demonstrating population-level climate change impacts to Ibats and NLEBs. The rapid spread of WNS across the ranges of the two species is likely to mask any effects of climate change on their status.

4. ENVIRONMENTAL BASELINE

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Ibat and the NLEB, their habitats, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation and does not include the effects of the Action under review.

4.1. Action Area Numbers, Reproduction, and Distribution

4.1.1. Indiana Bat

Figure 4-1 shows the outline of the TVA Region on a map of the range of the Ibat. About 64% of the 82-million acre TVA Region (52,947,795 ac) is within the Ibat's range, and that portion represents about 17% of the Ibat range. The 1.015-million acre Action Area is distributed throughout the TVA Region (see Section 2.1); however, the 2017 BA does not partition the Action Area relative to the range of the Ibat. For purposes of describing the Ibat baseline and analyzing action-caused effects to Ibat in this BO, TVA proposes that we use the proportion of the TVA Region that is within the Ibat range (63.93%) as the proportion of the Action Area that is within the Ibat range (H. LeGrand, pers. comm., 2018b). We agree. This is a conservative approach that errs on the side of overestimating effects, because TVA anticipates that a disproportionate share of Action activity during the next 20 years will occur in portions of Mississippi that are outside the Ibat range.

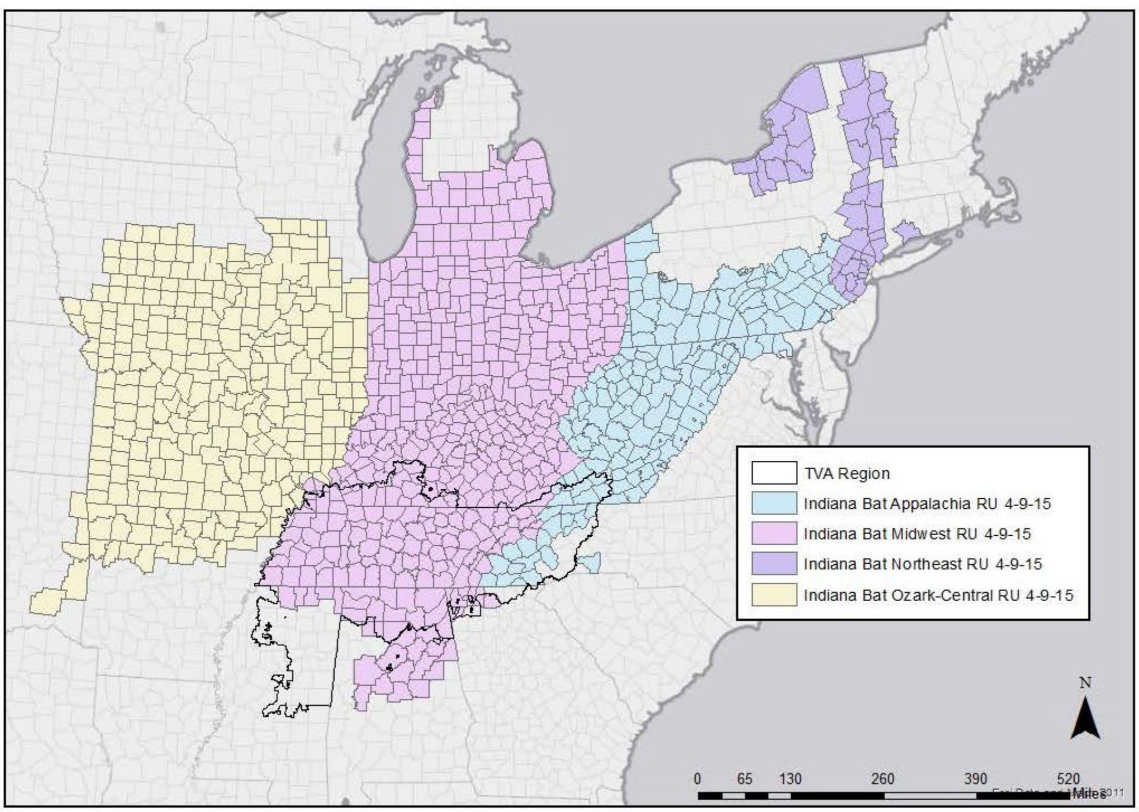

Figure 4-1. Range of the Indiana bat showing the TVA Region (source: 2017 BA, Figure 4-1).

The 1.015-million acre Action Area is distributed throughout the TVA Region (see Section 2.1); however, the 2017 BA does not partition the Action Area relative to the range of the Ibat. For purposes of describing the Ibat baseline and analyzing action-caused effects to Ibat in this BO, TVA proposes that we use the proportion of the TVA Region that is within the Ibat range (63.93%) as the proportion of the Action Area that is within the Ibat range (H. LeGrand, pers. comm., 2018b). We agree. This is a conservative approach that errs on the side of overestimating effects, because TVA anticipates that a disproportionate share of Action activity during the next 20 years will occur in portions of Mississippi that are outside the Ibat range.

TVA reports that 240,103 ac of the Action area are forested (see Section 2.1). We assume that this forest cover is distributed uniformly or nearly so both within and outside the range of the Ibat; therefore, the distribution of forest cover within and outside the Ibat range is the same as the distribution of the Action Area as a whole within (63.93%) and outside the Ibat range. Forested acreage of the Action Area within the Ibat range is 0.6393 × 240,103 ac = 153,498 ac.

Figure 4-2 shows documented Ibat occurrence records within and near the TVA Region, including numerous hibernacula. Based on the 2013 winter surveys of hibernacula within the TVA Region, TVA reported (2017 BA, Table 4-2) that 25,434 Ibats (4.4% of the 2013 rangewide population) hibernated within the TVA region. Hibernacula counts provide the best census method for Ibat numbers (see Section 3.3.1). Although adults disperse widely from hibernacula,

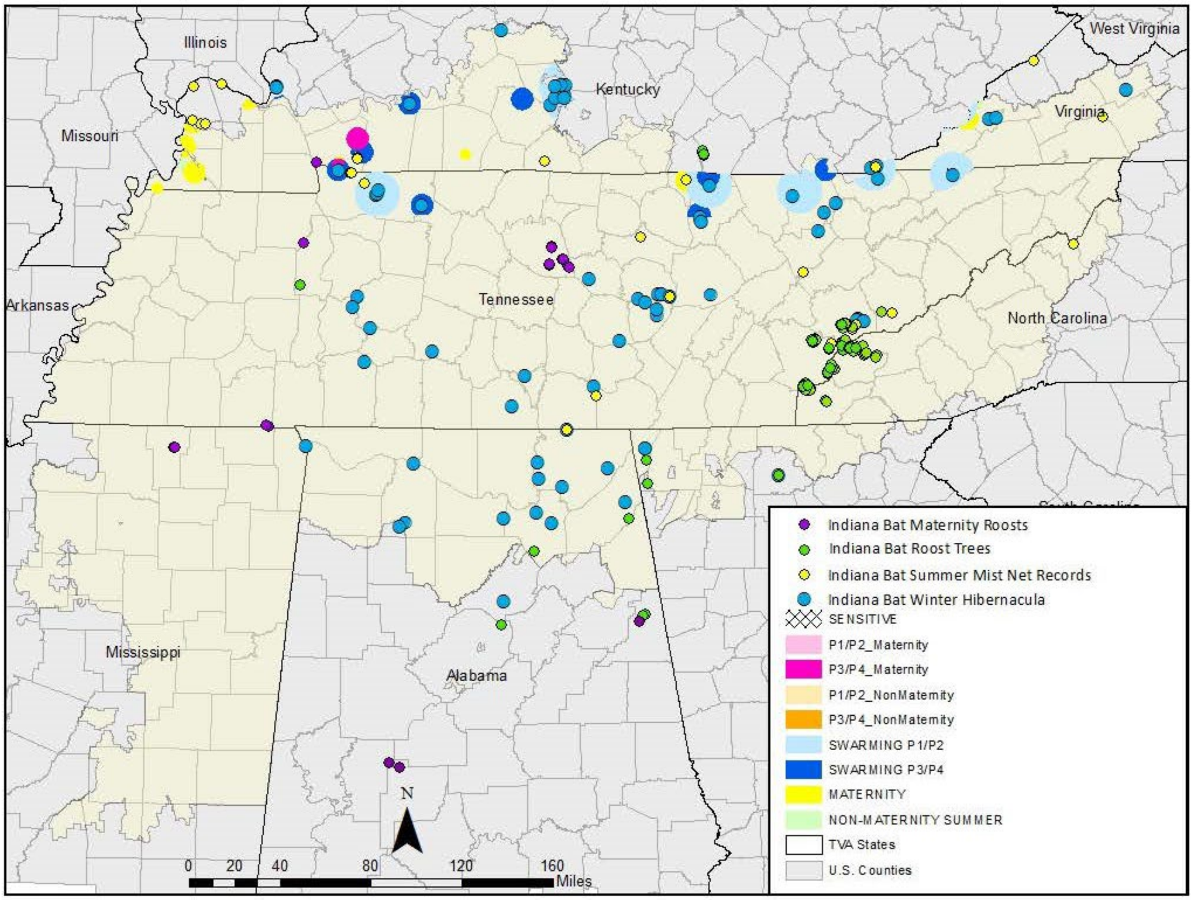

Figure 4-2. Documented occurrences of Indiana Bat in the TVA Region (source: 2017 BA Figure 4-2).

hibernacula counts are likely a reasonable approximation of Ibat numbers within the TVA Region. Ibat hibernacula are widely distributed in the portion of the Ibat range that is within the TVA Region and occur in every TVA state except Mississippi.

Hibernacula-specific counts from the 2015 or 2017 winter surveys, which each reflected a decline in rangewide total numbers relative to the previous biennial survey, are not yet compiled in a report that is available for use in this consultation. Therefore, for purposes of this consultation, we consider that the TVA region supports the same percentage observed for the 2013 rangewide census (4.4%) relative to the 2017 census total (530,705), or 23,244 adult Ibats. Assuming a 1:1 sex ratio, and 60 adult females per maternity colony (see Section 3.2.1), the Ibats hibernating within the TVA Region would form about 194 maternity colonies ($23,244 \div (2 \times 60) = 194$).

As discussed in the first paragraph of this section, we assume that the Action Area and its forested acreage are uniformly distributed in the TVA Region. This means that the fraction of the Action Area that is within the range of the Ibat is same as the fraction of the Action Area in the TVA Region as a whole: 1.015 million acres in 82 million acres, or 1.226%. We do not assume that the Action Area supports a disproportional share (more or less) of the TVA Region's Ibat population. Therefore, the Action Area supports 1.226% of TVA Region's Ibat population, or 0.01226 × 23,244 = 285 adult Ibats. Assuming a 1:1 sex ratio, and 60 adult females per maternity colony, these bats would constitute about 2–3 colonies (285 ÷ (2 × 60) = 2.375), which we round up to 3 colonies.

The size of the area that all individuals belonging to an Ibat colony use for roosting and foraging is not reported in the literature. As we discussed in Section 3.2.4, studies using radio telemetry tagging have estimated average *individual* Ibat summer home range sizes of 205–917 ac. Callahan (1993) reported a range of 0.81–1.48 kilometer (km) (0.5–0.9 mi) for minimum-radius circles that encompassed all roost trees of four Ibat colonies in MO, which corresponds to areas of 509–1,700 ac. The Service uses a radius of 2.5 mi around an Ibat summer survey detection to delineate the area in which the foraging and roosting activity of a maternity colony may occur. This corresponds to and area of 12,566 ac, which is several orders of magnitude greater than individual home range or the area encompassing documented roost trees reported in the literature. For purposes of this BO, we use 1,700 ac (the largest roost-tree area reported by Callahan 1993) as the area in which a single Ibat colony roosts and forages. Three non-sympatric Ibat colonies residing fully within the Action Area would occupy 3 × 1,700 = 5,100 ac. Forested habitat of the Action Area within the range the Ibat is about 153,498 ac (see second paragraph of this section). We expect that three Ibat colonies would occupy 5,100 ÷ 153,498 = 3.3% of the Action Area's forested habitat within the Ibat range.

Relatively narrow (75–200 ft) transmission line ROWs represent about 80% of the Action Area (see Section 2.1), and the remainder is patchy and widely dispersed throughout the TVA Region (e.g., power plants, TVA reservoir lands). Therefore, it is unlikely that the home range of an Ibat maternity colony lies fully within the Action Area, except perhaps on TVA Reservoir lands. It is more likely that the Action Area overlaps a portion of the home range of several of the 194 Ibat colonies that we estimate may occur in the TVA Region based on hibernacula counts. However, it is still useful to treat the programmatic Action Area as a unit that we expect to support the equivalent of three whole Ibat maternity colonies.

4.1.2. Northern Long-Eared Bat

The TVA region lies at the southern limits of, but entirely within, the broad range of the NLEB. In 2016, the Service reported a total of 387 known maternity roost trees for the six States that are partially within the TVA Region, and 50 for the State of Tennessee, which is wholly within the TVA Region and constitutes about half of this area (USFWS 2016).

Hibernacula counts, such as those described previously for the Ibat, are not a reliable means of estimating NLEB population size, either rangewide or in the Action Area (see Section 3.3.2). To estimate NLEB numbers, we must instead make inferences based on the extent of forested habitats, observed occupancy rates from summer surveys, and the characteristics of NLEB summer colonies. TVA reports that the 1.015-million acre Action Area contains 240,103 ac of forest cover (see Section 2.1). The following paragraphs describe the occupancy rates and colony characteristics that we apply to this forest acreage to estimate NLEB numbers in the Action Area.

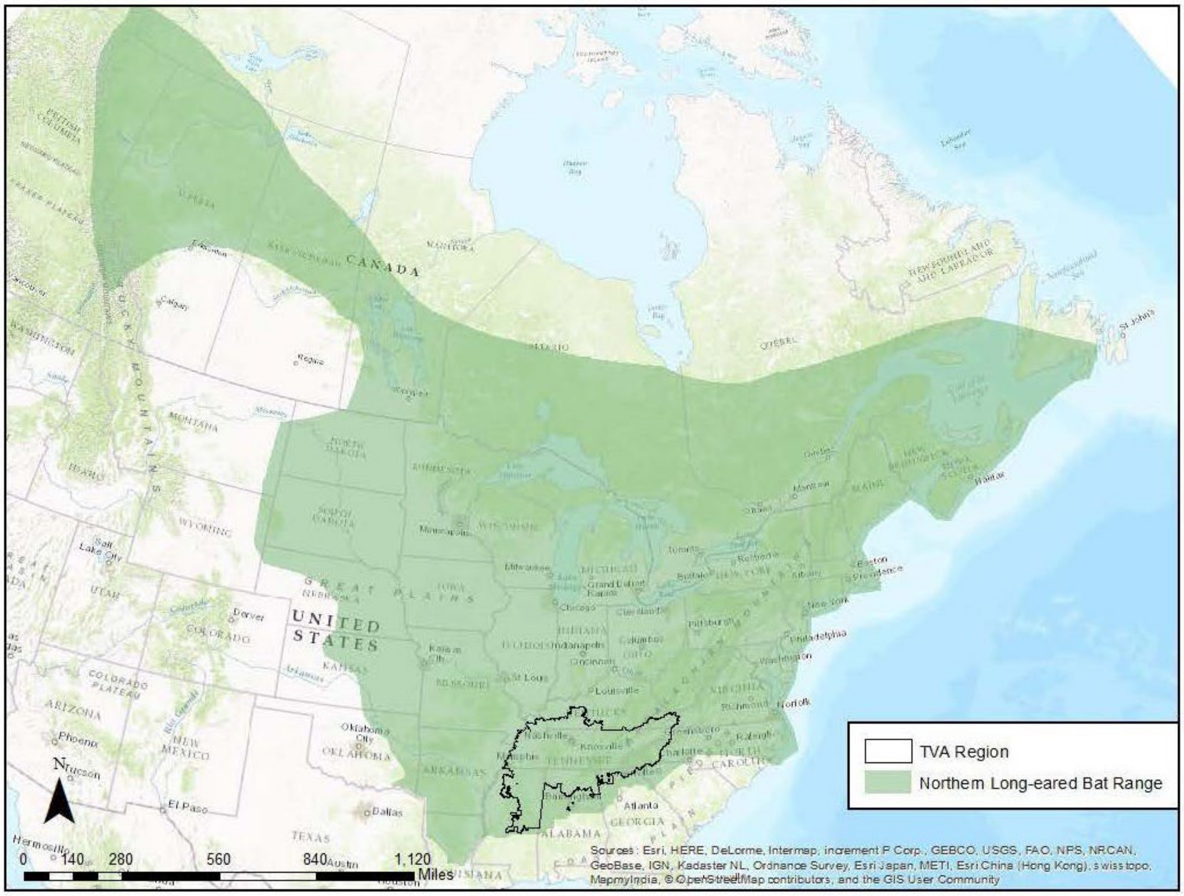

Figure 4-3. Range of the northern long-eared bat showing the TVA Region (source: 2023 BA Figure 4-13).

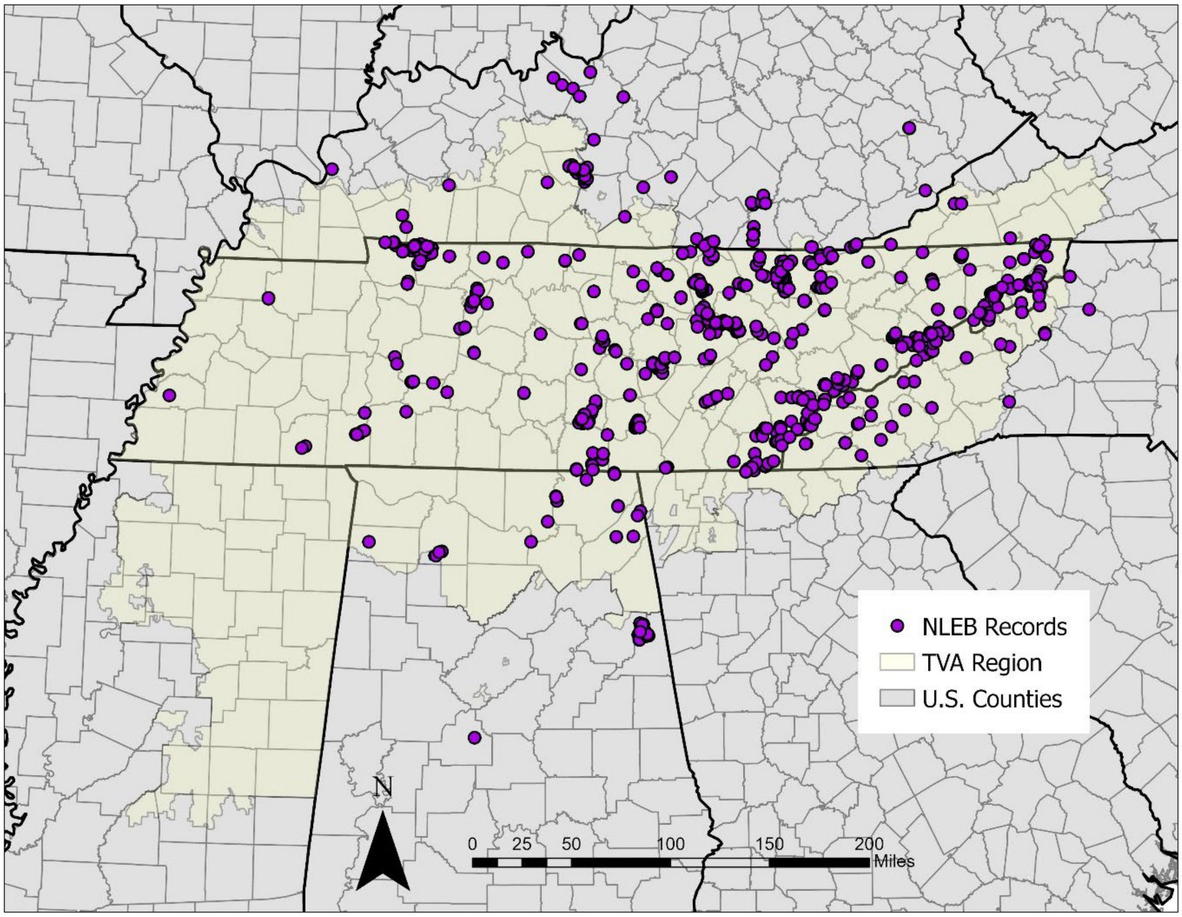

Figure 4-4. Historic and Current Documented occurrences of NLEB in the TVA Region (source: 2023 BA Figure 4-14).

<u>Occupancy Rates</u>

The Service compiled data (mostly collected after 2014) and estimated an NLEB occupancy rate for the TVA Region by dividing the total number of mist-net nights where at least one bat of any species was captured by the total number of mist-net nights that captured at least one NLEB (K. Lott, pers. comm., 2023). Based on the best available information when the data were analyzed, the NLEB occupancy rate was estimated to be 1.49% for the TVA Region. When the 1.49% occupancy rate is applied to the Action Area, NLEB would be expected to occupy up to approximately 3,578 ac of the available 240,103 forested acres (from Section 2.1) in the Action Area.

<u>Estimated Number of NLEB Colonies</u>

Summer home range includes both roosting and foraging areas, and range size may vary by sex. Studies of maternity roosting areas have reported sizes that vary from a mean of 21–179 ac (Owen *et al.* 2003; Broders *et al.* 2006; Lacki *et al.* 2009) to a maximum of 425 ac (Lacki *et al.* 2009). Foraging areas are six or more times larger (Broders *et al.* 2006; Henderson and Broders 2008). The distance traveled between consecutive roosts varies widely from 20 ft (Foster and

Kurta 1999) to 2.4 mi (Timpone *et al.* 2010). Likewise, the distance traveled between roost trees and foraging areas in telemetry studies varies widely, e.g., a mean of 1,975 ft (Sasse and Perkins 1996) and a mean of 3,609 ft (Henderson and Broders 2008). Circles with a radius of these distances have an area of 281 and 939 ac.

Based on reported maximum individual home range (425 ac) and travel distances between roosts and foraging areas described above (corresponding to circular areas up to 939 ac), we use 1,000 ac for purposes of this BO as the area a NLEB colony uses; this is also consistent with the NLEB maternity colony acreage size described in the Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities from Take Prohibitions (USFWS 2016). Within this 1,000-ac area, one or more members of a maternity colony and sympatric adult males/non-reproductive females would likely appear in a mist net(s).

The literature we have reviewed reports no information about the degree of spatial overlap between NLEB maternity colonies. Due to limited habitat, we assume habitat availability would not contribute to substantial colony-range overlap in the Action Area. However, mist net survey data collected in Kentucky indicate that there is substantial overlap in the summer home range of reproductive females and that of males and non-reproductive females (USFWS 2016). Of 909 capture locations for males and non-reproductive females, only 87 (9.57%) did not have reproductively active females and were more than three miles from captures of reproductive females. This data suggests a 100 – 9.57 = 90.43% overlap between the home range of individuals belonging to maternity colonies and other individuals, which we adopt for use in this BO. Because the 1.49% occupancy rate includes captures of males and non-reproductive females, we multiply the occupied forest acres of the Action Area by 0.9043, and then divide by 1,000 ac to compute the number of probable maternity colonies in the Action Area:
3,578 occupied (both sexes) acres × 0.9043 = 3,236 ac, which supports up to four maternity colonies (3,236 ÷ 1000 = 4 maternity colonies [after rounding the fractional remainder up to the next whole number]).

Relatively narrow transmission line ROWs represent about 80% of the Action Area (see Section 2.1), and the remainder is patchy and widely dispersed throughout the TVA Region (e.g., power plants, TVA reservoir lands). As we discussed in the last paragraph of Section 4.1.1, regarding Ibat colonies that we expect to occur in the Action Area, it is unlikely that the home range of four NLEB maternity colonies lie entirely within the Action Area. It is more likely that the Action Area overlaps a portion of the home range of a larger number of colonies that occur in adjacent portions of the TVA Region. However, it is still useful to treat the programmatic Action Area as a unit that we expect to support the equivalent of four whole NLEB maternity colonies.

Estimated Number of Individuals

We assume that each of the 1,000 ac areas occupied by a NLEB maternity colony supports 33 adult females, 33 adult males, and 33 juveniles following parturition (see Section 3.2.1). Therefore, the annual active season population associated with four maternity colonies within the Action Area includes 33 × 4 = 132 adult females, 132 adult males, and 132 juveniles after July 31.

4.2. Action Area Conservation Needs and Threats

The conservation needs of and threats to the Ibat and NLEB in the Action Area are a regional subset of the rangewide needs and threats discussed in Section 3.4. WNS is in the Action Area is a threat for the Ibat (based on over 90% declines in the Appalachian RU) and the greatest threat for the NLEB. Therefore, eliminating this threat has been determined to be their greatest conservation need. All seven states within the TVA Region have reported detecting the disease and fungus in hibernacula that are within the TVA region (https://whitenosesyndrome.org/where-is-wns). The 2023 BA reports that TVA monitors caves on TVA-managed lands and cooperates with other agencies to monitor caves elsewhere in the TVA region. This monitoring tracks bat populations and the spread of WNS.

Section 5.3 of the 2023 BA indicates TVA would continue to carry out conservation measures at larger scales, including population-level initiatives that "promote recovery of one or more bat species (e.g., land acquisition, habitat improvement and protection) as well as mission-level holistic and strategic steps that strive to keep environmental stewardship in check with operational and economic goals (e.g., managing lands specifically for sensitive resources)".

5. EFFECTS OF THE ACTION

This section analyzes the effects of the proposed Federal Action on the Ibat and NLEB, which includes all consequences to listed species that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR §402.02). Our analyses are organized according to the description of the Action in Section 2, which lists tree removal (Section 2.2) and prescribed burning (Section 2.3) as the components of the Action that may affect the Ibat and NLEB that require this BO for ESA compliance purposes. For the reasons we discussed in Section 2.4, we are unable to quantitatively assess meaningfully the beneficial effects to bats resulting from the "additional conservation measures" that TVA describes as part of the programmatic Action. However, we acknowledge that these measures qualitatively benefit the species and help offset the adverse effects of tree removal and prescribed burning.

5.1. Effects Analysis Methods

In the following two activity-specific sections (5.2 Tree Removal and 5.3 Prescribed Burning), we identify the stressors (alteration of the environment that is relevant to the two species) that each activity will cause based on the description of the proposed Action. We then review the best available science and commercial information about how individual Ibats and NLEBs are likely to respond to each stressor. Lastly, we identify the circumstances for an individual bat's exposure to each stressor (overlap in time and space between the stressor and an Ibat or NLEB, considering the proposed conservation measures), and estimate the amount or extent of individual responses at the Action Area scale. This section explains the methods we apply to the last step under each activity-specific analysis.

Estimating the Spatial Extent of Bat Exposure

TVA projects will affect about 100,000 ac annually within a 1.015-million acre Action Area that is not delineated in the 2017 BA, and this Action Area is distributed throughout the 82-million acre TVA Region (see Section 2.1). The 2017 BA provides the maximum annual acreage, and the 20-year cumulative acreage, of various activities that may occur during seasons that are relevant to the bats' life history (see sections 2.2 and 2.3). Ibat and NLEB are not ubiquitous in the Action Area, and we do not assume that all Action activities will occur in occupied habitats. Instead, our effects analyses compute the expected degree of spatial overlap between activities and occupied areas as the product of two independent event probabilities within the same space. We multiply a total area by the percentage of the area that will receive an activity and by the percentage of the area that a species occupies. The resulting acreage is the expected overlap (intersection) between the activity and the species' occupied habitat.

The area for the NLEB analyses is the forested acreage of the entire Action Area, which is 240,103 ac, and the NLEB occupancy rate within this area is 1.49% (see Section 4.1.2). The area for the Ibat analyses is the forested acreage of the Action Area within the Ibat range, which is 153,498 ac (63.93% of the full Action Area), and the Ibat occupancy rate within this area is 3.3% (see Section 4.1.1). For the Ibat analyses, we prorate the acreage of activities according to the percentage of the Action Area that is within the Ibat range (63.93%). Table 5-1 shows these calculations for tree removal activity. Such proration of the acreage of activities is not necessary for the NLEB analyses because the range of the species encompasses the entire Action Area.

Table 5-1. Estimated acreage of seasonal tree removal activity that is within the range of the Ibat (63.93% of the total Action Area acreage from Table 2-1).

Years	Inactive Season[a]	Active Season; All Bats Volant[b]	Active Season; Pups Non-Volant[c]	Total
Annual 2018-2021	1,258	557	589	2,403
Annual 2022-2038	810	277	198	1,285
Cumulative 2018-2038	17,990	6,667	5,516	30,172

[a] Mid-November to mid-March
[b] Mid-March to April 30, and August 1 to mid-November
[c] June and July

Table 5-2 shows the amount of seasonal tree removal activity that will occur in the Action Area expressed as a percentage of the total amount of forested acreage (240,103 ac) in the Action Area. These percentages apply to both the Ibat and NLEB analyses because we have prorated both the amount of tree removal activity and the amount of forested acreage within the range of the Ibat by the same fraction (63.93%).

Table 5-2. Seasonal tree removal activity expressed as a percentage of the total acreage of forest cover within the Action Area (240,103 ac within NLEB range, and 153,498 ac within Ibat range).

Years	Inactive Season[a]	Active Season; All Bats Volant[b]	Active Season; Pups Non-Volant[c]	Total
Annual 2018-2021	0.82%	0.36%	0.38%	1.57%
Annual 2022-2038	0.53%	0.18%	0.13%	0.84%
Cumulative 2018-2038	11.72%	4.34%	3.59%	19.66%

Estimating Numbers of Bats Exposed

Our analyses examine effects to Ibats and NLEBs while they are in their day-time roost trees, which constitute a fraction of the total number of trees in the forested habitats they use for foraging and travel during the spring, summer, and fall. The broadly defined Action Area and programmatic nature of this consultation precludes any attempt to estimate effects at the scale of roost trees, or to partition the effects of Action activities between areas that contain roosts for pregnant females, solitary males, fall swarming, spring staging, etc. A substantial majority of the available data on Ibat and NLEB home range describes summer habitat and roost characteristics; therefore, we use summer home range and roost characteristics to represent the possible intersection between Action activities and the bats' active season occupied habitats.

Although male Ibats generally remain closer to hibernacula during the active season than females (see Section 3.2.1), we cannot attempt separate effects analyses for males and females without a partitioning of the Action Area relative to known Ibat hibernacula. NLEB migrate shorter distances from hibernacula than Ibats, and both sexes are frequently observed in the same summer habitats (see Section 3.2.4). Therefore, we include both Ibat and NLEB adult males in an analysis based on maternity colony characteristics, recognizing that maternity colonies may occur in areas that are both close to and far from known hibernacula. Projects located closer to Ibat hibernacula would likely affect a higher percentage of Ibat males and cause fewer effects to pups, and vice versa for projects located farther from hibernacula.

We estimate numbers of bats affected in the expected area of overlap between Action activities and occupied habitats as the product of:

(a) the overlap area;
(b) the density of bats in a maternity colony home range, including sympatric males and non-reproductive females; and
(c) an expected response rate.

For adult Ibats, the density under (b) above is 60 females and 60 males in 1,700 ac, or 120 ÷ 1,700 = 0.0706 bats per acre (see Section 4.1.1). Following the birth of up to 1 pup per adult female during the active season, this density increases to a maximum of 180 ÷ 1,700 = 0.1056 bats per acre. The density we use for NLEBs is 33 females and 33 males in 1,000 ac, or 66 ÷ 1,000 = 0.066 bats per acre (see Section 4.1.2). Following the birth of up to 1 pup per adult female during the active season, this density increases to a maximum of 99 ÷ 1,000 = 0.099 bats per acre. The response rates we use under (c) above are stressor and life-stage specific. We explain the basis for the response rates we use in the discussion for each stressor caused by tree removal and by prescribed burning.

5.2. Tree Removal

In Section 5.2 we examine the direct and indirect effects on Ibat and NLEB of the proposed tree removal associated with various routine activities over a 20-year period. Section 5.2.1 reviews best available data about stressors associated with tree removal and the responses of bats to these stressors. Section 5.2.2 provides our estimation of the amount or extent of bat exposure to these stressors caused by the Action. In this introduction to Section 5.2, we first dismiss from further analysis potential stressors that are not likely to have measurable or detectable effect on bat numbers, reproduction, or distribution.

TVA determined that its BMPs and other conservation measures for protecting water quality during tree removal operations would reduce the introduction of sediments and contaminants to drinking water sources to levels that are NLAA listed bats. The Service previously concurred with this determination relative to the gray bat, Virginia big-eared bat, and Ibat critical habitat (see Section 1). We also concur with this determination relative to the Ibat and NLEB (see Section 2.2.2; discussion under "Sedimentation, Spills, Pollutants, and Contaminants"). Therefore, we do not further address changes in water quality resulting from tree removal as a stressor to bats.

The removal of substantial amounts of forest cover may reduce the local availability and quality of foraging habitat for the Ibat and NLEB. However, analyzing such effects for projects implemented under this programmatic Action is not feasible, because we have no data on the availability or quality of forest cover at the project scale. Further, we estimate that the Ibat and NLEB occupy only 3.3% and 1.49%, respectively, of all forest cover at both the Action Area and TVA Region scales; therefore, it is unlikely that foraging habitat is limiting for these species at these scales. In this BO, we assume that the individuals associated with Ibat and NLEB summer colonies forage and roost in an area of about 1,700 and 1,000 ac, respectively (see sections 4.1.1 and 4.1.2). Maximum annual tree removal under the Action is currently 2,010 ac (Section 2.2.1). This tree removal will occur on multiple projects distributed throughout the 1.015-million acre Action Area. We consider the potential for a project under this Action to cause a measurable or detectable response by Ibat or NLEB individuals through reducing the availability or quality of foraging habitat as negligible. Therefore, we do not further address the effects of tree removal on bats via exposure to changes in foraging habitat availability or quality.

The conservation measures that TVA proposes to implement for tree removal activity (see Section 2.2.2) include a general prohibition for tree removal near known Ibat and NLEB hibernacula. Specially, measure TR2 states:

> "Removal of suitable summer roosting habitat within 0.5-mi of Priority 1/Priority 2 Indiana bat hibernacula, or 0.25-mi of Priority 3/Priority 4 Indiana bat hibernacula or any northern long-eared bat hibernacula will be prohibited, regardless of season, with very few exceptions (*e.g.,* vegetation maintenance of TL ROW immediately adjacent to Norris Dam Cave, Campbell County, TN)."

We believe this measure limits the severity of any effects of tree removal on the microclimate of hibernacula, and on any individual bats hibernating within, to insignificant levels. Therefore, we do not further address the direct or indirect effects of tree removal under this Action on bats in hibernacula.

Two of TVA's proposed conservation measures address the removal of trees that are documented as Ibat or NLEB roost trees (TR6) or are within 150 ft of documented roost trees (TR5) (see Section 2.2.2). If documented roosts are present or within 150 ft of a tree-removal project area, these measures commit TVA to a site-specific review and assessment. If pups are present in trees planned for removal, these measures also commit TVA to coordination with the Service in determining how to avoid or minimize impacts to pups to the extent possible (2017 BA). Also, TVA discourages tree removal during pup season through implementation of TR1 and TR9.

The likelihood of the Action removing an occupied NLEB roost during the non-volant season was assessed using TVA Annual Reports from 2018-2020 (TVA 2020) and additional information from TVA (E. Burton Hamrick, pers. comm., 2023). On average, 38.5 ac of suitable summer roosting habitat are removed when pups may not be volant. This would represent only 1% of NLEB occupied habitat if all of it occurred in documented occurrence buffers (38.5 ac/3,578 ac occupied NLEB portion of the 240,103 forested acres in the Action Area). The 3-year average of acres removed in known Ibat and/or NLEB areas is 6% of the total acreage removed. The 3-year average of acres of suitable summer habitat removed during pup season is 13.6% of the total acreage removed. The likelihood of the Action removing acres in known habitat during pup season is estimated as < 1% (0.06-ac known habitats x 0.136-ac suitable habitat in pup season = 0.0082).

We cannot quantitatively estimate how many bats will benefit from these procedural conservation measures at the scale of this programmatic Action. The 2017 and 2023 BA's do not identify or tally the number of documented roost trees that are within the Action Area. Because the Action Area is not specifically delineated by project, we are unable to determine whether the Action may affect any particular documented roosts. Therefore, we acknowledge the potential benefits of these measures in project-level implementation of the Action, but do not attempt to estimate the extent to which they may avoid or minimize adverse effects of tree removal in the following analyses.

Six proposed conservation measures for tree removal (TR1, 3–4, and 7–9) either relate to tracking and reporting tree removal activity or prescribe general conditions that may or may not reduce potential adverse effects (e.g., TR7, which limits tree removal within 100 ft of existing transmission ROWs to hazard trees). The tracking and reporting measures are appropriate components of this programmatic Action, but do not change the effects of the Action. For the remaining measures, we are unable to estimate the degree to which they may change the effects of the Action, and do not further consider them in the following analyses.

5.2.1. Stressors and Responses

The 2017 BA describes three primary stressors associated with the proposed tree removal activity: (1) noise and disturbance during removal operations; (2) loss of shelter (roost trees); and (3) introduction of sediments and contaminants to drinking water sources. We have dismissed #3 from further analysis (see Section 5.2), but we agree that (1) and (2) are environmental changes caused by tree removal that are relevant to the Ibat and NLEB.

5.2.1.1. Noise/Disturbance

The people, chainsaws, and heavy equipment involved in tree removal generate noise and disturbance. During the active season for bats, this disturbance could cause volant bats to temporarily flee or permanently abandon roosts during the day, which is a disruption of normal behavior. Gardner *et al.* (1991b) reported that Ibats continued to roost and forage in an area with noise created by an active timber harvest. Callahan (1993) monitored the location of a primary roost tree, where a bulldozer had cleared brush adjacent to the tree, by conducting evening exit counts. He found that at some point during an 18-day gap between successive counts, Ibats abandoned the roost tree and noted noise and disturbance by the bulldozer was the likely, but not confirmed, cause of the roost abandonment.

Permanent abandonment of a maternity roost with non-volant, nursing pups by the mother would be reasonably certain to cause the death or injury of these pups. Although Ibats are known to carry pups between roosts, such movement increases the likelihood of injury to the point that it would be reasonably certain to occur. Regardless of whether pups are present, flushing and flying from a disturbance during daylight hours can result in injury or death.

Mikula *et al*. (2016) reviewed about 1,500 reports from 109 countries of attacks by 143 species of diurnal birds on 124 species of bats. The review compiled cases involving species from several bat taxonomic families. The family Vespertilionidae, to which the genus *Myotis* belongs, represented 22.8% and 58.8% of the cases of bats taken by raptors of the hawk and falcon families, respectively, and 77% of the bats taken by non-raptors (e.g., gulls, crows). Citing data from other studies, the authors surmised that the diurnal predation rate on bats is likely 100–1,000 times higher than the nocturnal predation rate when standardized relative to the duration of day versus night bat activity. The authors concluded that the reports and studies they reviewed strongly suggest that predation by birds restricts daytime activity in bats and is likely a major factor that contributed to the evolution of their generally nocturnal behavioral patterns.

About half of the forecasted 20-year cumulative tree removal activity under this Action will occur within narrow power line ROWs (see Table 2-1). Noise and disturbance will move with these operations along the length of the ROW, such that the duration of elevated sound and activity levels at any one location would be temporary. The results of Mikula *et al*. (2016) summarized above support a finding that such disruption of diurnal sheltering behavior increases the likelihood of injury through predation by diurnal predators, which is consistent with the definition of incidental take in the form of harassment leading to harm. Despite the lack of evidence of such a response in Gardner *et al*. (1991b) cited above, we conservatively estimated in the 2018 BO that 10% of volant Ibats exposed to daytime tree removal disturbances will fly to alternate roosts located away from the disturbances (Table 5-3). However, an analysis of rangewide effect of noise and/or disturbance on NLEB concluded that the potential for noise disturbance to harm NLEBs is more probable when new sources of noise and disturbance occur within suitable habitat and that any new sources of noise within suitable habitat are likely to be associated with habitat removal (USFWS 2023), which is addressed in the effects analysis for Tree Removal. Therefore, we do not anticipate additional take beyond that estimated for tree removal for NLEB.

5.2.1.2. **Roost Tree Loss – Direct Effects**

Ibats and NLEBs use a network of multiple roost trees within their home range and show fidelity to roosts used in previous years (see Section 3.2.1). However, trees are an ephemeral resource, especially the trees preferred for roosting, which are typically dead or dying, with cavities, crevices, exfoliating bark, and other characteristics of decay or poor health. Despite the observed use of the same roosts between years, both species must seek new roosts as necessary when traditional roost trees inevitably fall. Potential bat responses to roost loss, caused by natural factors or felling by humans, depends on when the loss occurs during the annual life cycle: (a) when non-volant pups (or adults in torpor) are present in the tree; (b) other times during the active season; or (c) during the inactive (winter hibernation) season. Removal of an occupied roost tree during the spring, summer, or fall has direct and immediate effects. Removal of an unoccupied roost tree has indirect (later in time) effects (USFWS 2022), which we discuss in the following sub-section.

Due to their small size, it is extremely unlikely to detect an Ibat or NLEB killed or injured by tree felling in a forested setting. The literature we have reviewed contains no reports of NLEB mortality resulting from roost tree removal. In the BO for the NLEB 4(d) rule (USFWS 2016), the Service summarized three accounts of Ibat injury and mortality resulting from tree removal, which we quote here.

> "Cope *et al.* (1974) reported the first felling of an occupied Indiana bat maternity roost tree in Wayne County, Indiana. The landowner observed bats exiting the tree when it was bulldozed down. The original account stated that eight bats (2 adult females and 6 juveniles) were "captured and identified as Indiana bats," and that about 50 bats flew from the tree. Although the original account did not specify how the eight bats were captured, J. Whitaker (Indiana State University, pers. comm., 2005) recounted that those bats were killed or disabled, retrieved by the landowner, and subsequently identified by a biologist. In another case, Belwood (2002) reported on the felling of a dead maple in a residential lawn in Ohio. One dead adult female and 33 non-volant young were retrieved by the researcher. Three of the young bats were already dead when they were picked up, and two more died subsequently. The rest were apparently retrieved by adult bats that had survived. In a third case, 11 dead adult female Indiana bats were retrieved (by people) when their roost was felled in Knox County, Indiana (J. Whitaker, pers. comm., 2005)."

All three of these accounts document adult bat mortality. Two document juvenile mortality, two document adult survival, and one documents juvenile survival. Of the two documenting adult survival, apparently far more adults survived than were killed, and more juveniles survived than were killed in the Belwood case. The juvenile survival rate in the Belwood case was apparently high (five died out of 33 retrieved, and the rest were apparently carried away by adults). This case from a residential lawn is the only available data on juvenile bat survival/mortality rates following roost tree removal. However, we believe it is not representative of tree felling in forested settings, where the ability to detect, retrieve, and place pups where adult bats may find them and carry them away is likely negligible.

For purposes of this consultation, we conservatively assume that removal of an occupied roost will harm (kill or injure) all non-volant pups present. We also assume that roost removal will either harm or harass all volant bats present. Cutting an occupied roost tree may cause some to fly away before the tree falls and crush some when the tree falls but will cause all volant survivors to seek an alternate roost after the tree falls. Expelled from their roost, survivors are exposed to diurnal predators and other hazards until finding alternate shelter. For simplicity, and to avoid underestimating lethal effects, we treat these two responses to tree removal (immediate death/injury *vs*. displacement that creates the likelihood of injury) as a single effects pathway, to which we attribute a 100% harm response.

5.2.1.3. **Roost Tree Loss – Indirect Effects**

The effects of removing a roost tree while it is unoccupied depend on how individual Ibats and NLEBs use that tree at other times, whether as a maternity roost, an alternate summer roost, or a roost during spring staging or fall swarming. Removal of a primary maternity roost likely has the greatest impact, but the loss of any previously established roost causes bats to spend time and energy seeking a new roost that meets their requirements in that area.

Ibats and NLEBs form summer maternity colonies that exhibit "fission-fusion" behavior (Barclay and Kurta 2007; Garroway and Broders 2007). Members coalesce to form a group (fusion), but the composition of the main unit is dynamic. Individuals exit the main unit for solitary roosting or to form smaller roosting groups (fission), and later return to the main unit, after which they may move to another roost. Ibats and NLEBs switch roosts often, typically every 2–3 days (Foster and Kurta 1999; Kurta *et al.* 2002; Owen et al. 2002; Carter and Feldhamer 2005; Kurta 2005; Timpone *et al.* 2010). Several researchers interpret these behaviors as an adaption to the ephemeral nature of tree roosts, whereby bats proactively seek and test the suitability of new roost trees in preparation for the eventual loss of the primary and secondary roosts they previously and currently use (Kurta *et al.* 2002, Carter and Feldhamer 2005, Timpone *et al.* 2010).

Because Ibats and NLEBs rely on previously established roosts, roost tree loss, regardless of whether it occurs during the active or inactive (winter) seasons, may affect the fission-fusion dynamics of their maternity colonies. Kurta (2005) suggested that loss of a single, alternate roost at any time of year probably has little impact on Ibats, because Ibat colonies use at least 8–25 alternate summer roosts, but that loss of a primary roost could disrupt colony social structure. Sparks *et al.* (2003) found that the natural loss of a single primary maternity roost led to the fragmentation of the colony (bats used more roosts and congregated less) following the roost loss. Because colonial behavior contributes to reproductive success (see Section 3.2.1), colony fragmentation could reduce the colony recruitment rate (survival of offspring to sexual maturity).

Silvis *et al.* (2014a) studied the social dynamics of an Ibat colony located in central Ohio for two years using telemetry methods. These investigators represented the observed roosting networks in a mathematical model and then simulated the effects of roost removal. Results varied between the models of each year's networks. The probability of colony fragmentation exceeded 50% with the simulated removal of only 5% of the roosts using the 2009 network data, but with the simulated removal of 30% of the roosts using the 2010 network data. In both years, simulated removal of the primary roost resulted in fragmentation. The advantages of colonial behavior are reduced or lost when a colony fragments. However, colony fragmentation is probably also a necessary dispersal adaptation to the inevitable loss of ephemeral roosts. The authors of this study concluded: "As the ephemerality of roost trees likely cause Indiana bat maternity colonies to experience frequent roost loss, including that of primary roosts, fission-fusion dynamics may provide a mechanism for the formation of new maternity colonies by presenting opportunities for the colony to split."

At Fort Knox in Kentucky, Silvis *et al.* (2014b) tracked three maternity colonies of NLEB to evaluate their social and resource networks, *i.e.,* roost trees. Roost and social network structure differed between maternity colonies, and roost availability was not strongly related to network characteristics or space use. In model simulations based on the tracking data, removal of more than 20% of roosts initiated social network fragmentation, with greater loss resulting in greater fragmentation. The authors suggested that flexible social dynamics and tolerance of roost loss are adaptive strategies for coping with ephemeral conditions in dynamic forest habitats.

In the same Fort Knox study area with the same three NLEB maternity colonies, Silvis *et al.* (2015) removed (during winter) a primary maternity roost tree from one colony, 24% of the secondary roosts from another colony, and none from the third. Neither removal treatment altered the number of roosts used by individual bats the following active season, but secondary roost removal doubled the distances moved between sequentially used roosts. The overall location and spatial size of colonies was similar pre- and post-treatment. Patterns of roost use before and after removal treatments also were similar. Roost height, DBH, percent canopy openness, and roost species composition were similar pre- and post-treatment. The study did not investigate pre- and post-treatment reproductive success. NLEB use a wide range of tree species and sizes as roosts, and potential roosts were not limited in the treatment areas.

The studies summarized above suggest that colony fragmentation is a natural, later-in-time Ibat response to the loss of a primary roost tree and to the loss of a sufficient percentage of alternate roost trees. Colony fragmentation, or delayed colony formation for bat populations returning from hibernation to an altered colony home range, when they are already compromised by WNS, could reduce recruitment rates. Splitting already declining maternity colonies into smaller populations only further harms their ability to survive and ultimately recover. Such reduction is consistent with the definition of incidental take in the form of harm, but no studies have yet investigated this indirect effect on either Ibats or NLEBs. Experimental results of roost tree removal during winter from two NLEB colonies did not document fragmentation, but loss of secondary roosts doubled the distances individuals travelled between roosts, and effects on reproductive success were not investigated. Therefore, available evidence indicates that, at minimum, the later-in-time Ibat and NELB response to roost tree loss is an increased energy expenditure to establish a new roost network, and that this increase is likely proportional to the fraction of home range roost trees removed. Although studies have focused on summer maternity habitats, it is reasonable to assume that loss of roosts in spring staging and fall swarming habitats also causes an increased energy expenditure. Whether this response to habitat modification actually reduces survival or reproductive success is uncertain.

According to the NLEB SSA (USFWS 2022), if bats are required to search for new roosting or foraging habitat and to find the same habitats as the rest of their colony finds in the spring, it is reasonable to conclude that this effort places additional stress on pregnant females at a time when fat reserves are low or depleted and they are already stressed from the energy demands of migration and pregnancy. In addition, removal of roosting or foraging habitat may result in longer travel distances between sites used for roosting and foraging. The increased energetic cost of longer commuting distances may result in maternity colony disruption and may be particularly important for pregnant and lactating females and therefore, reproductive success. NLEB emerge from hibernation with their lowest annual fat reserves and return to their summer home ranges. Loss or alteration of roosting or foraging habitat puts additional stress on species such as NLEB with strong summer site (i.e., roosting area) fidelity, when returning to summer roosting or foraging areas after hibernation. NLEB exposure to WNS (a disease known to greatly impact the species) is an added stressor to bats, especially female NLEBs returning to summer roosts when they are already energetically taxed from WNS. Reproduction is one of the most energetically demanding periods for temperate-zone bats. Female NLEB produce a maximum of one pup per year; therefore, loss of just one pup results in loss of that entire year's recruitment for females. Limited reproductive potential severely limits the ability of bat populations to respond quickly to perturbations. For this BO, we limit the injury caused by unoccupied roost removal, regardless of season, to adult females, and we use an injury rate of 10% to estimate numbers of bats responding to this stressor in this manner.

5.2.2. Estimation of Exposure and Numbers of Bats Affected

Section 5.2.1 identified noise/disturbance, direct physical trauma, and the loss/reduction of shelter (roost trees) as stressors caused by tree removal that are relevant to Ibat and NLEB individuals. We identified the bat responses to these stressors as: (1) fleeing noise/disturbance; (2) death or injury (removing occupied roost trees); and (3) reduced survival or reproductive success (removing unoccupied roost trees). We identified the response to disturbance as a disruption of diurnal roosting behavior that creates the likelihood of injury thorough predation (harm), with an expected 10% response rate upon exposure (*i.e.*, 10% will flee; 90% will not). We identified the response to unoccupied roost tree removal as a reduction in reproductive success (harm), with expected 10% response rate upon exposure (*i.e.*, 10% will fail to raise a pup to volancy). Although some bat pups and volant bats may survive the felling of an occupied roost tree, we assume a 100% lethal/injurious (harm) response rate to such exposure. Ibat and NLEB exposure to the three stressors depends on the timing and location of tree removal relative to their home ranges within the Action Area.

TVA does not specify the locations for tree removal activity under this programmatic Action. Instead, the BA provides annual and 20-year cumulative acreages for tree removal that will occur in the 1.015-million acre Action Area and specifies the seasonal timing for these acreages (see Table 2-2). Conducting 60% of the 20-year cumulative tree removal during the inactive season limits the direct impacts of noise and physical trauma to 40% of the acreage affected by this activity. Proposed conservation measures that may further limit the extent of exposure to the stressors caused by tree removal include (paraphrased):

- TR2 – With few exceptions, prohibiting the removal of suitable summer roosting habitat within 0.5-mi of P1/P2 Ibat hibernacula, and within 0.25-mi of P3/P4 Ibat hibernacula or any NLEB hibernacula.
- TR5 and TR6 – Requiring a site-specific review and assessment before removing a known Ibat or NLEB maternity roost tree, or any trees within 150 ft of a known Ibat or NLEB maternity roost tree, during the active season. If pups are present in trees planned for removal, TVA will coordinate with the USFWS to determine how to avoid or minimize impacts to pups.

Table 5.3 provides a summary of provides a summary of the original estimates of the numbers of Ibats from the 2018 BO and our current estimates of NLEBs that we expect tree removal activity to affect. For each stressor and corresponding life-stage-specific response, the table provides data for the expected spatial overlap between seasonal tree removal activity and occupied areas, bat densities in occupied areas, and the expected bat response rate, to calculate bat numbers affected, and the corresponding percentage of the Action Area total population affected. For the Ibat, three sets of seasonal tree removal activity are used in these calculations: (1) Annual 2018–2021; (2) Annual 2022–2038; and (3) Cumulative 2018–2038. These sets correspond to the description of the Action, which estimates a higher acreage of tree removal during the first 3 years than in the remaining 17 years, and the 20-year total acreage. For the NLEB, we do not estimate numbers of individuals affected prior to the issuance of this BO (2018-2022) and instead use Annual 2023-2038 and the 15-year cumulative. Where our calculations result in a fraction of an individual, we round up for the annual rate to indicate the maximum expected number of individuals in a single year. For cumulative values, however, the fractional value is not rounded up until after being multiplied by the number of years to estimate the expected rate of take more accurately over time and total amount of expected take.

Table 5-3. Estimated numbers of bats affected by tree removal.

Stressors -->	Noise/ disturbance	Physical trauma		Reduction of shelter resource
Stressor type	Direct	Direct	Direct	Indirect
Exposure period	Entire active season	Pup season	Entire active season	Year round
Life stage affected	Volant bats	Pups	Volant bats	Adult females
Individual Response	Flight to alternate roost (harassment)	Death or injury (harm)	Death or injury (harm)	Reduced reproduction (harm)
A. Response rate (section 5.2.2)	10%	100%	100%	10%
B. Percent of forest cover affected (from Table 5-2)				
Annual 2018-2021	0.75%	0.38%	0.75%	1.57%
Annual 2022-2038	0.31%	0.13%	0.31%	0.84%
Cumulative 2018-2038	7.94%	3.59%	7.94%	19.66%
C. Percent of forest cover occupied (sections 4.1.1 and 4.2.2)				
Ibat		3.30%		
NLEB		1.49%		
D. Total Action Area Forested Acres				
Ibat			153,498	
NLEB			240,103	
E. Expected overlap (acres) (B*C*D)				
Ibat				
Annual 2018-2021	38	19	38	79
Annual 2022-2038	16	7	16	42
Cumulative 2018-2038	402	182	402	996
NLEB				
Annual 2018-2022	N/A	N/A	N/A	N/A
Annual 2023-2038	0	5	11	30
Cumulative 2023-2038	0	70	166	451
F. Bat density in occupied areas (section 5.1)				
# Ibat/acre	0.0706	0.0353	0.0706	0.0353
# NLEB/acre	0.0900	0.0450	0.0900	0.0450
G. Number of bats affected (A*E*F) (rounded up to nearest whole integer)				
Ibat				
Annual 2018-2021	1	1	3	1
Annual 2022-2038	1	1	2	1
Cumulative 2018-2038	3	7	29	4
NLEB				
Annual 2018-2022	N/A	N/A	N/A	N/A
Annual 2023-2038	0	1	1	1
Cumulative 2023-2038	0	4	15	2
H. Percentage of Action Area bats affected (G/H)				
Ibat (H=360 adults, or 180 pups, as applicable)				
Annual 2018-2021	0.28%	0.56%	0.83%	0.28%
Annual 2022-2038	0.28%	0.56%	0.56%	0.28%
Cumulative 2018-2038	0.83%	3.89%	8.06%	1.11%
NLEB (H=264adults, or 132 pups, as applicable)				
Annual 2018-2022	N/A	N/A	N/A	N/A
Annual 2023-2038	0.00%	0.76%	0.38%	0.38%
Cumulative 2023-2038	0.00%	0.17%	0.38%	0.05%

5.3. Prescribed Burning

In Section 5.3, we examine the direct and indirect effects on Ibat and NLEB of the proposed prescribed burning on TVA lands over the next 20 years. Section 5.3.1 reviews best available data about stressors associated with prescribed burning and the responses of bats to these stressors. Section 5.3.2 provides our estimation of the amount or extent of bat exposure to these stressors caused by the Action. In this introduction to Section 5.3, we first dismiss from further analysis potential stressors that are not likely to have measurable or detectable effect on bat numbers, reproduction, or distribution.

TVA determined that prescribed fire under this Action is NLAA listed bats when they are within caves and mines areas documented as hibernacula or as active-season roosts. The TVA burning program prohibits prescribed fire within 0.25-mi of the entrances to such sites and other measures that limit the potential for smoke entering caves and mines that bats occupy (see Section 2.3.2). The Service previously concurred with this determination relative to the gray bat, Virginia big-eared bat, and Ibat critical habitat (see Section 1). We also concur with this determination relative to the Ibat and NLEB. Therefore, in this BO, we do not further address the effects of prescribed burning on bats via exposure to smoke in hibernacula.

Prescribed fire may have both beneficial and adverse effects on the availability of suitable tree roosts and prey resources, which some of the literature we reviewed for the following section describes. However, we believe the scale of the TVA prescribed burning program, which will rarely exceed 1,500 ac annually (see Section 2.3) on 26,247 ac of TVA Reservoir Lands (5.7%), is unlikely to have a measurable or detectable effect on the availability of roost tree or prey resources for the Ibat or NLEB colonies that may occupy these lands. Further, several of the TVA burning objectives listed in Table 2-3 are to maintain an early-successional seral stage, habitat that does not support Ibats and NLEBs.

In this BO, we use occupancy rates in the Action Area of 3.3% and 1.49% for Ibat and NLEB, respectively. Assuming that all 26,247 ac of Reservoir Lands that could use prescribed fire are forested, burning 5.7% of these lands annually yields an expected overlap between burning and bats of 49 and 22 ac (rounded) for Ibat and NLEB, respectively. While we do not discount this overlap, assessing the indirect effects (later in time changes in maternity roost availability) of burning at this small scale in a programmatic context without site-specific data is not feasible. Therefore, we limit our analysis of prescribed burning to its direct effects on bats in forested habitats.

5.3.1. Stressors and Responses

Smoke and heat are stressors that are relevant to all species within or near the path of a fire, including the Ibat and NLEB, whether it is a wildfire or a prescribed burn. Three of the proposed avoidance and minimization measures listed in Section 2.3.2 should limit the severity of smoke and heat as stressors in forested settings that bats occupy. TVA will use fire breaks to burn larger areas in smaller units (SHF1 and SHF3). Burns in April and May will occur when temperatures exceed 55°F to avoid affecting adult bats in torpor, who are unable to rouse quickly and fly to a roost beyond the smoke (SHF4).

Perry (2012) provided a review of fire effects on bats in the eastern oak region of the U.S., and Carter *et al.* (2002) provided a similar review for bats in the southeastern and mid-Atlantic states. Forest-dwelling bats, including the Ibat and NLEB, were presumably adapted to the fire regime that preceded European settlement and subsequent fire suppression in many parts of the eastern U.S. These reviews summarized how fire may affect individual bats directly (negatively) through exposure to heat, smoke, and carbon monoxide, and indirectly (both positively and negatively) through habitat modifications and resulting changes in their food base and tree roosts (Dickinson *et al.* 2009).

5.3.1.1. **Direct Effects in Tree Roosts**

Few studies have examined bat escape behaviors, direct mortality, or potential reductions in survival associated with fire. Dickinson *et al.* (2009) monitored two NLEB (one male and one female) in roosts during a controlled summer burn. Within 10 minutes of ignition near their roosts, both bats flew to areas that were not burning. All four bats they tracked before and after burning switched roosts during the fire, with no observed mortality. Rodrigue *et al.* (2001) reported flushing a *Myotis* bat from an ignited snag during an April controlled burn in West Virginia. Although these studies did not document injury or mortality resulting from daytime flights away from prescribed fire, this disruption of normal sheltering behavior creates the likelihood of injury by exposure to diurnal avian predators (see discussion in Section 5.2.1 under "Noise/Disturbance").

Carter *et al.* (2002) suggested that the risk of direct injury and mortality to southeastern forest-dwelling bats resulting from summer prescribed fire is generally low. During warm temperatures, bats are able to arouse from short-term torpor quickly. Most adult bats are quick, flying at speeds > 30 km/hour (> 18 mi/hour) (Patterson and Hardin 1969), enabling them to escape to unburned areas. Ibats and NLEBs use multiple roosts, switching roost trees often (see Section 3.2.1), and could likely use alternative roosts in unburned areas, should smoke make the current roost uninhabitable or fire destroy it. Non-volant pups are likely the most vulnerable to death and injury from fire. Although most eastern bat species are able to carry their young for some time after they are born (Davis 1970), the degree to which this behavior will allow females to relocate their young if fire threatens the nursery roost is unknown.

Dickinson *et al.* (2010) used a fire plume model, field measurements, and models of carbon monoxide and heat effects on mammals to explore the risk to the Ibat and other tree- roosting bats during prescribed fires in mixed-oak forests of southeastern Ohio and eastern Kentucky. Carbon monoxide levels did not reach critical thresholds that could harm bats in low- intensity burns at typical roosting heights for the Ibat (8.6 m) (28.2 ft). NLEB roost height selection is more variable, but on average lower (6.9 m) (22.8 ft) than the Ibat (Lacki *et al.* 2009). In this range of heights, direct heat could cause injury to the thin tissue of bat ears. Such injury would occur at roughly the same height as tree foliage and potentially result in necrosis (death) when temperatures reach 60 °C (140 °F). Generally, forest managers plan prescribed fires to avoid significant tree scorch.

5.3.2. Estimation of Exposure and Numbers of Bats Affected

Prescribed burning is proposed for a well-defined portion of the larger Action Area for this consultation. This portion is comprised of 26,247 ac of TVA Reservoir lands on which TVA believes fire is an appropriate habitat management tool over the 20-year duration of the Action (see Section 2.3.1). These lands are entirely within the range of both the Ibat and NLEB; therefore, no partitioning of the proposed prescribed burning activity by species is necessary for this analysis.

Due to funding and staff limitations, TVA has indicated that its burn activity is unlikely to exceed 1,500 ac annually, and that burn frequency on parcels presently treated with fire ranges from one to five years. Burning 1,500 different acres only once every year over 20 years would cover 30,000 ac, slightly more than the 26,247 ac that could benefit from prescribed fire. Maintaining a fire frequency of one to five years on some parcels and burning less than 1,500 ac annually will necessarily fall short of covering all the lands TVA would like to burn.

TVA proposes to conduct 10% of its prescribed burning during the active season outside of the pup season, none during the pup season (June and July), and the remainder (90%) during the inactive (winter) season (see Section 2.3.1). Burning under the proposed Action will have no direct effects on non-volant pups. As we discussed in the introduction to Section 5.3, we have dismissed the direct effects of smoke on bats in hibernacula from further analysis, due to the proposed conservation measures that limit such effects to insignificant levels. We have also dismissed the indirect effects of burning on bats through changes in their forested habitat resources from further analysis, such as roost tree availability and prey abundance. Winter burning has no direct effects on bats in forested habitats (bats are not present on the landscape at that time); therefore, our analysis in this section is limited to the direct effects of active season burning, which would only occur during months that bats are volant.

The 20-year cumulative acreage proposed for burning during the bat active season outside the pup season is 10% of 26,247 ac, or 2,624 ac. Lacking more specific data, we assume that the seasonal breakdown for the 20-year cumulative acreage applies to annual burning activity, which TVA indicates will rarely exceed 1,500 ac. Therefore, 150 ac is the expected annual amount of burning that may directly affect Ibats and NLEBs in their forested habitats, which is 0.571% of the TVA Reservoir Lands that may receive prescribed fire.

In this BO, we use occupancy rates in forested portions of the Action Area of 3.3 and 1.49% for Ibat and NLEB, respectively (see Sections 4.1.1 and 4.1.2). Assuming all 26,247 ac of Reservoir Lands that could use prescribed fire are forested, burning 0.571% of these lands annually yields an expected overlap between burning and occupied areas of 4.9 and 2.2 ac for Ibat and NLEB, respectively ($0.00571 \times 0.033 \times 26{,}247 = 4.9$, and $0.00571 \times 0.0149 \times 26{,}247 = 2.2$).

In this BO, we use a density of 120 adult bats per 1,700 ac for Ibat ($120 \div 1{,}700 = 0.0706$), and 66 adults per 1,000 ac for NLEB ($66 \div 1{,}000 = 0.066$). On 4.9 and 2.2 occupied acres burned annually, the expected number of Ibats and NLEBs affected is one for each species is arrived at by multiplying $4.9 \times 0.0706 = 0.35$ for Ibat and $2.2 \times 0.066 = 0.15$ for NLEB. Burning 0.571% of the eligible Reservoir Lands annually for 20 years with constant bat occupancy rates and densities, we would expect fire to affect about 7 Ibats and 3 NLEBs over the full duration of the Action (20×0.35 and 15×0.15).

Based on our literature review of the effects of fire on bats in Section 5.3.1, we expect that all adult Ibats and NLEBs exposed to smoke or heat from prescribed fire would fly to alternate roosts, and that most would do so without injury. However, daytime flight away from such annoyance exposes bats to diurnal avian predators (see discussion in Section 5.2.1 under "Noise/Disturbance"), which is consistent with the definition of incidental take in the form of harassment leading to harm.

5.4. Summary of Effects

In Section 5.2, we identified four unique pathways by which we expect stressors caused by tree removal under this Action to affect bats: 1) noise and disturbance, 2) physical trauma to non-volant pups, 3) physical trauma to volant bats, and 4) loss of shelter indirectly causing reduced reproduction. Bat responses upon exposure to the latter three pathways are consistent with the definition of incidental take in the form of harm, and responses to disturbance are consistent with the definition of take in the form of harassment leading to harm.

However, the scale of this harassment leading to harm is small relative to the size of the Action Area and the numbers of bats we estimate it supports. We estimate that noise from tree removal will cause one Ibat and zero NLEB (see Section G. in Table 5.3) to flee their roosts each year, exposing them to diurnal predators. These numbers are low because approximately 90% of Ibats and NLEBs are likely to remain in roosts of unremoved trees during tree removal activities (see response rate under Section A. in Table 5.3).

For the NLEB, the scale of harm caused by tree removal is also small relative to the Action Area population. The range of the NLEB encompasses the entire Action Area, whereas the range of the Ibat covers only 64%. Again, we use an occupancy rate of 1.49% for the NLEB, and 3.3% for the Ibat.

For the Ibat, we expect the three pathways leading to harm (see Section G. in Table 5.3) to affect up to five individuals annually (one pup, three volant bats, and one adult female). The 20-year cumulative estimates of harm are seven pups and 29 volant bats killed or injured by felling an occupied tree, and four adult females injured (reproductive failure) by removal of unoccupied roost trees from the individual's roost network. Harming up to four volant bats annually represents 1.11% of the Ibat adult population that we believe the Action Area is likely to support (three maternity colonies support 360 adults).

NLEB is also affected by the same three pathways that leads to Ibat harm (again, refer to Section G. in Table 5.3). We expect tree removal to annually harm up to one NLEB pup, one volant bat, and one adult female. The remaining 15-year cumulative estimates of harm are four pups, 15 volant bats, and two adult females. Harming up to two volant bats annually represents 0.76% of the NLEB adult population that we believe the Action Area is likely to support (four maternity colonies = 264 adults).

In Section 5.3, we determined that only the direct effects of prescribed burning during the bat volancy period (portion of the active season outside the pup season) are relevant to our analysis. Only 10% of proposed burning will occur in this seasonal period. We expect that up to one Ibat and one NLEB annually (7 Ibat and 3 NLEB cumulatively) will experience heat and smoke in their roosts and fly to an alternate roost, which will expose them to diurnal avian predators. This disruption of normal sheltering behavior, which creates the likelihood of injury, is consistent with the definition of incidental take in the form of harassment.

6. CUMULATIVE EFFECTS

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA. Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities are reasonably certain to occur. These factors include but are not limited to existing plans for the activity and any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

The 2017 BA suggests that many types of non-federal actions may occur within the 1.015-million-acre Action Area during the 20-year Action duration that may affect environmental resources. As examples, TVA lists state highway maintenance and improvement projects, airport operations and expansions, rail development projects, and others. However, the 2017 BA does not provide an assessment of how these actions may affect the Ibat or NLEB.

Most of the lands (about 89%) included in the Action Area are under a large or substantial degree of TVA control:

- 331,000 ac of TVA-retained lands (33%); and
- 569,001 ac of transmission line easements (56%) (source: 2017 BA, Table 2-1).

Although non-federal actions may occur within transmission line easements, we believe it is reasonable to assume that all actions on TVA-retained lands and many on TVA easements will involve managing and maintaining conditions for TVA purposes. Such actions are federal actions that we do not consider under cumulative effects in a consultation. The 2017 BA does not assess the effects of other non-federal actions that are reasonably certain to occur on these lands.

The remaining 11% of the Action Area lands are other non-TVA public lands associated with an anticipated level of TVA economic development support (7%), and an anticipated acreage of private lands identified for distributed solar energy generation (4%). These areas are not identified in the 2017 BA because many of the sites that may support such activity over the 20-year duration of the Action have not yet been determined.

TVA expects that activities under this Action will only affect about 462,000 ac (45%) of the 1.015-million-acre Action Area. Therefore, it is not necessary to consider cumulative effects on about 55% of the Action Area. We lack a spatial delineation of the area that the Action may affect and any data about non-federal actions that are reasonably certain to occur in that area; therefore, the Service is unable to meaningfully assess relevant cumulative effects.

7. CONCLUSION

In this section, we summarize and interpret the findings of the previous sections for the Ibat and NLEB (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

<u>Status</u> – Biennial Ibat population estimates were increasing from 2001 to 2007, suggesting a reversal in a long-term decline. The decline thereafter is largely attributable to WNS, especially in the Northeast RU. The NLEB was common in many areas of its broad range until the onset of WNS in 2006 but has declined rapidly since. We expect further declines in both species as WNS continues to spread. The 2017 Ibat census estimated a total of 530,705 Ibats in 229 hibernacula in 17 states. The Service calculated a rough rangewide population estimate of about 6.5 million NLEB in the intra-Service BO for the species' final 4(d) rule. However, in the more recently completed SSA (USFWS 2022), the Service estimated that WNS has caused estimated NLEB population declines of 97–100% across 79% of the species' range.

<u>Baseline</u> – Based on the 2017 Ibat hibernacula census data, we estimate that the 82-million-acre TVA Region supports about 23,000 adult Ibats. Of this regional population, we estimate that the 1.015-million-acre Action Area supports three Ibat maternity colonies, each comprised of 60 adult females and associated with the same number of sympatric adult males. Estimates of NLEB numbers cannot rely on hibernacula census data. Instead, we make inferences based on an observed occupancy rate of 1.49% in the TVA Region and colony characteristics from the literature. We estimate that the Action Area supports four NLEB maternity colonies, each comprised of 33 adult females and associated with the same number of sympatric adult males. Ibat and NLEB conservation needs and threats in the Action Area are largely the same as the rangewide needs and threats. WNS is detected in all seven states of the TVA Region and is a major threat to the survival and recovery of Ibat in portions of the Action Area (based on over 90% declines in the Appalachian RU) and to the NLEB throughout the extent of the Action Area (the foremost stressor on the species).

<u>Effects</u> – We expect that noise and disturbance caused by tree removal activity under the proposed Action will harass small numbers of bats (up to one Ibat) each year of the 20-year Action by flushing individuals from tree roosts. We expect tree removal to harm relatively small numbers of Ibats and NLEBs each year, particularly regarding the NLEB, that are currently estimated at low numbers. The likelihood of the Action encountering an occupied NLEB maternity roost when pups are non-volent is unlikely (about 1%). TVA's commitment to avoid felling an occupied known roost and conservation measures to minimize the Action during pup season further minimizes potential effects to bats.

For the Ibat, our estimates of harm are up to one pup and three volant bats killed or injured by felling occupied roost trees, and up to one adult female injured (reproductive failure) by removing roost trees from the individual's roost network. Therefore, up to five Ibats a year (about 1% of the Ibat population that we believe the Action Area is likely to support before pups are born [three maternity colonies = 360 adults]) would be harmed.

For the NLEB, our estimates of harm are one pup and one volant bat killed or injured by felling occupied roost trees, and one adult female injured (reproductive failure that year) by removing roost trees from their roost networks. Harming up to three bats a year represents less than 1% of adults in the NLEB population that we believe the Action Area is likely to support before pups are born (four maternity colonies; 264 adults).

The extent of prescribed burning on TVA lands that may affect bats is about 150 ac per year. This burning will not affect bat pups. We expect that up to one volant adult of each species will annually be harassed leading to harm from experiencing heat and smoke in their roosts and flying to alternate roosts, exposing themselves to diurnal predators.

Harming up to five Ibats and harassing up to two Ibats per year of the 2017 rangewide population of about 530,000 Ibats will not appreciably reduce the likelihood of the species' survival and recovery in the wild. Ibat numbers have declined due to WNS by about 10,000–60,000 adults between successive biennial winter census counts in recent years. The effects of this Action will not alter that trend by an amount that is biologically meaningful at either the recovery unit or rangewide scales.

Harming up to three NLEBs and harassing up to one NLEB per year of the rangewide population will not appreciably reduce the likelihood of the species' survival and recovery in the wild. The Service determined previously that an average annual timber harvest rate of about 3.7-million acres throughout the range of the NLEB was not likely to appreciably reduce the likelihood of the species' survival and recovery in the wild (USFWS 2016). Tree removal under this Action, currently up to 2,010 ac per year, is a tiny subset of this rangewide average annual activity. Although NLEB numbers continue to decline due to WNS, the effects of this Action will not alter this trend by an amount that is biologically meaningful at the scale of either regional populations overlapping the Action Area or the species' range.

Cumulative Effects – TVA expects that various activities under the Action will affect about 462,000 ac (45%) of the 1.015-million-acre Action Area. Therefore, it is not necessary to consider cumulative effects on about 55% of the Action Area. We lack a spatial delineation of the 462,000 ac that the Action may affect and any data about non-federal actions that are reasonably certain to occur in that area; therefore, the Service is unable to meaningfully assess the cumulative effects that may be relevant to this consultation.

Conclusion – After reviewing the species' current status, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the Ibat or the NLEB.

8. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) regulations prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term "take" in the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA §3). In regulations at 50 CFR §17.3, the Service further defines:

- "harass" as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering;"
- "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;" and
- "incidental take" as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited, provided that such taking is in compliance with the terms and conditions (T&Cs) of an incidental take statement (ITS). For the exemption in ESA §7(o)(2) to apply to the Action considered in a BO, the TVA must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. The TVA has a continuing duty to regulate the activities covered by this ITS.

The programmatic Action evaluated in this BO does not authorize, fund, or carry out any of the project-level activities that it describes, and these Federal activities are subject to the requirements in ESA §7(a)(2). The TVA must determine on a project-level basis whether a proposed activity is consistent with the description of activities included in the programmatic Action and addressed in this BO, and if so, may rely upon the findings of this BO to document its compliance with §7(a)(2) with respect to the Ibat and NLEB. Such compliance does not relieve TVA of the requirements in §7(a)(2) for activities that may affect designated critical habitat or endangered and threatened species other than the Ibat and NLEB.

8.1. Amount or Extent of Take

This section specifies the amount or extent of take of Ibats and NLEBs that the Action is reasonably certain to cause, which we estimated in the "Effects of the Action" (Section 5) of this BO. We reference, but do not repeat, those analyses here.

The Service anticipates that the Action is reasonably certain to cause incidental take of individual Ibats and NLEBs consistent with the definitions of harm and harassment resulting from tree removal activities (see Section 5.2) and harassment leading to harm from prescribed burning (see Section 5.3). We expect that the amount of harm and harassment caused by tree removal will not exceed six Ibat and three NLEB per year and will not exceed 43 Ibats and 21 NLEBs over the 20-year and 15-year duration of the 2018 & 2023 BO's, respectively (see Table 5-3). We expect that the amount of harassment leading to harm caused by prescribed burning will not exceed one Ibat and one NLEB per year and will not exceed seven Ibats and three NLEBs over the 20-year and 15-year duration of the 2018 & 2023 BO's, respectively (see Section 5.3.2).

The Service expects that incidental take of Ibats and NLEBs caused by the Action will be difficult to detect for the following reasons:

- Ibats and NLEBS are cryptic – individuals are small, mostly nocturnal, and when not hibernating, occupy forested habitats where they are difficult to observe;
- Ibats and NLEBs roosting habitat is also cryptic - both species form maternity colonies under loose bark or in the cavities of trees, and males and non-reproductive females may roost individually, which makes finding roost trees difficult;
- Finding dead or injured individuals during or following tree removal is unlikely;
- Observing individuals flying away from trees that are not known to contain a bat roost during tree removal operations or prescribed burning is unlikely; and
- Some of the anticipated incidental take is in the form of reproductive failure that is not directly observable.

Due to the difficulty of detecting take of Ibats and NLEBs, TVA will monitor the extent of taking using the annual and cumulative acreages of tree removal and prescribed burning under the programmatic Action as a surrogate measure because these activities will cause the taking. The amount of anticipated taking depends upon the seasonal timing of these activities. Therefore, TVA will monitor the annual and cumulative acreages according to the three seasonal periods defined for these activities in the description of the proposed Action. Taking of Ibats and NLEBs are expected in forested acreage of the Action Area; Ibats will be taken in their 3.3% occupied habitat within 153,498 ac (63.93% of the full Action Area). Based on the very low NLEB occupancy, NLEBs will be taken within their post-WNS documented occurrence buffers as delineated and maintained by the Service's Information for Planning and Consultation (IPaC) system. Taking of Ibats and NLEBs will not exceed the levels we estimate in this BO resulting from tree removal and prescribed burning on an acreage within the above-defined areas of reasonable certainty of Ibat and NLEB presence. For Ibat, take will be less than or equal to the amounts in Table 8-1 within the 153,498 acres of forested habitat where the Ibat range and TVA action area overlap. For NLEB, take will be less than or equal to the amounts in Table 8-2. Where these acreages overlap, they will count for both species.

Table 8-1. Tree Removal and Prescribed Burning Acreages Monitored within Ibat range of the Action Area.

Years	Tree Removal Acreage			
	Inactive Season; Hibernating;	Active Season; Volant Bats;	Active Season; Pups Non-Volant;	Total
	November 15 –March 15	March 16 – April 30, and August 1 – November 14	June 1 – July 30	
Annual 2018-2021	1,258	557	589	2,403
Annual 2022-2038	810	277	198	1,285
Cumulative 2018-2038	17,990	6,667	5,516	30,172
	Prescribed Burning Acreage			
Annual	1,350	150	0	1,500
Cumulative 2018-2038	23,622	2,625	0	26,247

Table 8-2. Tree Removal and Prescribed Burning Acreages Monitored for NLEB within IPaC documented post-WNS occurrence buffers in the Action Area.

Years	Tree Removal Acreage			
	Inactive Season; Hibernating;	Active Season; Volant Bats;	Active Season; Pups Non-Volant;	Total
	November 15 –March 15	March 16 – April 30, and August 1 – November 14	June 1 – July 30	
Annual 2018-2022	N/A	N/A	N/A	N/A
Annual 2023-2038	1267	434	309	2,010
Cumulative 2023-2038	19,005	6,510	4,635	30,150
	Prescribed Burning Acreage			
Annual	1,350	150	0	1,500
Cumulative 2023-2038	23,622	2,625	0	26,247

8.2. Reasonable and Prudent Measures

When providing an ITS, the Service is required to give non-discretionary reasonable and prudent measures (RPMs) it considers necessary or appropriate to minimize the take along with T&Cs that must be complied with, to implement the RPMs. The proposed programmatic Action includes conservation measures to avoid and minimize impacts to Ibat and NLEB (see sections 2.2.2 and 2.3.2) and to promote their recovery (see Section 2.4). The analysis of effects of the Action in this BO considers that TVA will authorize, fund, or carry out all activities under the

Action in a manner that is consistent with the description of activities in the 2023 BA, including all applicable conservation measures.

TVA also proposes procedures to document and report the alignment of TVA activities with the proposed programmatic Action (see Section 2.5). These procedures include advance notification to the appropriate Service Field Office regarding project-specific effects determinations, alignment with the programmatic Action, bat survey results (if conducted), and coordination with Service Field Offices in the event that tree removal activity may adversely affect Ibat or NLEB non-volant pups.

Based on our review of the proposed Action, its conservation measures, and its project-level review and notification procedures, the Service believes that no additional RPMs are necessary to minimize the impacts of incidental take on the NLEB caused by the Action.

8.3. Terms and Conditions

No RPMs to minimize the impacts of incidental take caused by the Action are provided. However, we have provided the following term and condition in order to appropriately track take of NLEB.

1. TVA will include in its project-level process a means to identify projects that occur within post-WNS documented occurrence buffers as delineated and maintained by IPaC. This can be accomplished by mapping the project in the IPaC system and working through the NLEB determination key, and/or TVA can establish a data sharing agreement/memorandum of understanding (MOU) with the Service's IPaC managers. IPaC managers are expected to have the ability to establish an MOU for data sharing in year 2024 or shortly thereafter.

8.4. Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, the TVA "must report the progress of the Action and its impact on the species to the Service as specified in the incidental take statement" (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting (M&R). As necessary and appropriate to fulfill this responsibility, the TVA must require any permittee, contractor, or grantee to accomplish the monitoring and reporting through enforceable terms that are added to the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify the TVA and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

M&R1. Federal Fiscal Year (October 1–September 30) Reporting. Each year, TVA shall file a report by no later than March 31 from March 31, 2019-March 31, 2039. The reports will cover activities completed in the preceding fiscal year (2018-2038). The first report will only cover activities that were completed April 13, 2018-September 30, 2018, due to the BO being finalized in April 2018. The final report will only cover activities completed October 1, 2037–April 30, 2038.

The report will:

(a) identify all tree-removal and prescribed burning projects, and report the seasonal timing and total acreage for each project;
(b) provide the results of any bat surveys associated with such projects;
(c) provide the effects determination for each project according to the procedures specified under Chapter 6 of the 2023 BA;
(d) summarize the outcome of any coordination with Service Field Offices as specified under tree removal conservation measures TR5 and TR6 in Chapter 5.2.4 of the 2023 BA; and
(e) provide the results of any TVA-sponsored bat monitoring and research in the TVA Region.

TVA will provide these annual reports to the U.S. Fish and Wildlife Service, Tennessee Field Office, at 446 Neal Street, Cookeville, Tennessee 38501.

M&R2. Annual Coordination. TVA will convene a meeting with the TNFO at least once each calendar year on a mutually agreeable date between May 1 and December 31 to:
(a) discuss the annual report under M&R1;
(b) review the progress of the Action; and
(c) review any new information relevant to the Action and its effects on the bat species considered in this consultation.

M&R3. Handling and Reporting Dead or Injured Listed Species. All personnel involved in activities under this TVA programmatic Action must take care when handling dead or injured Ibats, NLEBs, and any other endangered or threatened species that are found in a project area to preserve biological material in the best possible state, and to protect the handler from exposure to diseases, such as rabies. Project personnel are responsible for ensuring that evidence for determining the cause of death or injury is not unnecessarily disturbed. Reporting the discovery of dead or injured listed species is required to enable the Service to determine whether the level of incidental take exempted by this ITS is exceeded. Personnel finding a dead, injured, or sick specimen of any endangered or threatened species, must promptly notify the Service's Division of Law Enforcement at 1875 Century Blvd., Suite 380, Atlanta, Georgia 30345 (Telephone: 404/679-7057), and then the Service's Ecological Services Field Office of applicable jurisdiction.

9. CONSERVATION RECOMMENDATIONS

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species. The Service offers the following recommendations that are relevant to the listed species addressed in this BO and that we believe are consistent with the authorities of the TVA. In general, our recommendations encourage TVA to continue and expand various programs it currently undertakes contributing to bat conservation.

1. Continue collaboration with partners to survey bridges and culverts that may support maternity colonies.
2. Continue collaboration with partners to learn more about how bats are using habitats within the TVA region (*e.g.,* spring migration radio tagging and tracking, and locating and assessing of roost trees).
3. Conduct bat monitoring following bat habitat enhancement and artificial roost projects on TVA-managed lands to assess project benefits.
4. Monitor and maintain gates and signage at caves that listed bats use and determine the need for new gates, fences, or signage at other caves on TVA lands used by listed bats.
5. Continue to serve as a member of state WNS planning committees.
6. Continue to update and maintain a database of listed bat occurrence records (*i.e.,* mist net captures, cave, bridge, and tree roosts, *etc.*), and use this database to inform project-specific environmental reviews and BAs.
7. Continue to offer workshops to TVA staff interested in assisting with conducting bat habitat assessments.

10. REINITIATION NOTICE

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the TVA retains discretionary involvement or control over the Action (or is authorized by law) when:

a. the amount or extent of incidental take is exceeded;
b. new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
c. the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
d. a new species is listed or critical habitat designated that the Action may affect.

In instances where the amount or extent of incidental take is exceeded, the TVA is required to immediately request a reinitiation of formal consultation.

LITERATURE CITED

Adams, R.A. 2010. Bat reproduction declines when conditions mimic climate change projections for western North America. Ecology 91(8):2437–2445.

Adams, R.A., and M.A. Hayes. 2008. Water availability and successful lactation by bats as related to climate change in arid regions of western North America. J. Animal Ecology **77**:1115-1121.

Amelon, S., and D. Burhans. 2006. Conservation assessment: *Myotis septentrionalis* (northern long-eared bat) in the eastern United States. Pages 69-82 *in* Conservation assessments for five forest bat species in the eastern United States, Thompson, F. R., III, editor. U.S. Department of Agriculture, Forest Service, North Central Research Station, General Technical Report NC-260. St. Paul, Minnesota. 82pp.

Barbour, R.W. and W.H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington. 286 pp.

Barclay, R.M.R., and A. Kurta. 2007. Ecology and Behavior of Bats Roosting in Tree Cavities and Under Bark. Chapter 2: pp. 17-60 in Bats in Forests: Conservation and Management, M.J. Lacki, J.P. Hayes, and A. Kurta, editors. The Johns Hopkins University Press, Baltimore, Maryland, 352pp.

Brack, V. Jr. 2006. Autumn activities of *Myotis sodalis* (Indiana bat) in Bland County, Virginia. Northeastern Naturalist 13(3):421-434.

Brack, V., Jr., and J.O. Whitaker, Jr. 2001. Foods of the northern myotis, *Myotis septentrionalis*, from Missouri and Indiana with notes on foraging. Acta Chiropterologica 3(2):203-210.

Broders, H.G., G.J. Forbes, S. Woodley, and I.D. Thompson. 2006. Range extent and stand selection for roosting and foraging in forest-dwelling northern long-eared bats and little brown bats in the Greater Fundy ecosystem, New Brunswick. J. Wildlife Management 70(5):1174-1184.

Burles, D.W., R.M Brigham, R.A. Ring, and T.E. Reimchen. 2009. Influence of weather on two insectivorous bats in a temperate Pacific Northwest rainforest. Canadian Journal of Zoology 87:132–138.

Caceres, M. C., and M. J. Pybus. 1997. Status of the northern long-eared bat (*Myotis septentrionalis*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 3, Edmonton, AB.

Callahan, E.V., III. 1993. Indiana bat summer habitat requirements. M.S. Thesis, University of Missouri, Columbia, Missouri.

Callahan, E.V., R.D. Drobney, and R.L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. J. Mamnmalogy. 78:818-825.

Carter, T. C., W.M. Ford, and M.A. Menzel. 2002. Fire and bats in the Southeast and Mid-Atlantic: more questions than answers? *In*: W.M. Ford, K.R. Russell, C.E. Moorman, eds., Proceedings: the role of fire for nongame wildlife management and community restoration: traditional uses and new directions. General Technical Report GTR-NE-288.

Newtown Square, PA: USDA Forest Service, Northeastern Research Station. pp. 139-143.

Carter, T.C., and G. Feldhamer. 2005. Roost tree use by maternity colonies of Indiana bats and northern long-eared bats in southern Illinois. Forest Ecology and Management 219:259-268.

Cheng, T.L., J.D. Reichard, J.T.H. Coleman, T.J. Weller, W.E. Thogmartin, B.E. Reichert, A.B. Bennett, H.G. Broders, J. Campbell, K. Etchison, D.J. Feller, R. Geboy, T. Hemberger, C. Herzog, A.C. Hicks, S. Houghton, J. Humber, J.A. Kath, R.A. King, S.C. Loeb, A. Massé, K.M. Morris, H. Niederriter, G. Nordquist, R.W. Perry, R.J. Reynolds, D.B. Sasse, M.R. Scafini, R.C. Stark, C.W. Stihler, S.C. Thomas, S.C. Thomas, G.G. Turner, S. Webb, B. Westrich, and W.F. Frick. 2021. The scope and severity of white-nose syndrome on hibernating bats in North America. Conservation Biology 2021:1–12.

Clawson, R.L. 2002. Trends in population size and current status. Pp. 2-8 in A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Davis, R. 1970. Carrying young by flying female North American bats. American Midland Naturalist, 83: 186- 196.

Deeley, S.M., and W.M. Ford. 2022. Summary Assessment of USFWS Capture Data for Little Brown, Northern Long-eared, and Tricolored Bat Species Status Assessment. Chapter A in Straw, B.R, J. A. Martin, J.D. Reichard, and B.E. Reichert, editors. Analytical Assessments in Support of the U.S. Fish and Wildlife Service 3-Bat Species Status Assessment. Cooperator Report prepared in cooperation with the U.S. Geological Survey, United States Fish and Wildlife Service and Bat Conservation International. Available at: https://doi.org/10.7944/P9B4RWEU (Accessed July 25, 2022).

Dickinson, M.B., M.J. Lacki, and D.R. Cox. 2009. Fire and the endangered Indiana bat. Proceedings of the 3rd Fire in Eastern Oak Forests Conference GTR-NRS-P-46. Pp. 51-75.

Dickinson, M.B., J.C. Norris, A.S. Bova, R.L. Kremens, V. Young, and M.J. Lacki. 2010. Effects of wildland fire smoke on a tree-roosting bat: integrating a plume model, field measurements, and mammalian dose-response relationships. Canadian J. Forest Research 40:2187-2203.

Foster, R.W., and A. Kurta. 1999. Roosting ecology of the northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). J. Mammalogy 80(2):659-672.

Frick, W.F., D.S. Reynolds, and T.H. Kunz. 2010. Influence of climate and reproductive timing on demography of little brown myotis *Myotis lucifugus*. Journal of Animal Ecology, 79:128–136.

Gardner, J.E. and E.A. Cook. 2002. Seasonal and geographic distribution and quantification of potential summer habitat. Pp. 9-20 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991a. Summary of *Myotis sodalis* summer habitat studies in Illinois: with recommendations for impact assessment. Report prepared for Indiana/Gray bat Recovery Team Meeting, Columbia, MO 28 pp.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1991b. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Unpublished report to Region-3 U.S.

Garroway, C.J., and H.G. Broders. 2007. Nonrandom association patterns at northern long-eared bat maternity roosts. Canadian J. Zoology 85:956-964.

Geipel, I., M. J. Smeekes, W. Halfwerk, and R.A. Page. 2019. Noise as an informational cue for decision-making: the sound of rain delays bat emergence. Journal of Experimental Biology:222, jeb192005. doi:10.1242/jeb.192005.

Girder, J.F., A.L. Larson, J.A. Homyack, and M.C. Kalcounis-Rueppell. 2016. Winter activity of coastal plain populations of bat species affected by White-Nose Syndrome and wind energy facilities. PLoS ONE 11(11): e0166512. doi:10.1371/journal.pone.0166512. Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0166512 (Accessed July 27, 2022).

Grindal, S.D., T.S. Collard, B.M. Brigham, and R.M.R Barclay. 1992. The Influence of Precipitation on Reproduction by Myotis Bats in British Columbia. The American Midland Naturalist, 128(2):339–344. doi:10.2307/2426468.

Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Publ. Mus. Art., Gallery Publ. 12:1-68.

Hall, J.S., R.J. Cloutier, and D.R. Griffin. 1957. Longevity Records and Notes on Tooth Wear of Bats. J. Mammalogy 38(3):407-409.

Hein, C., and B. Straw. 2021. Proceedings from the State of the Science and Technology for Minimizing Impacts to Bats from Wind Energy. 80 pp. Available at: https://tethys.pnnl.gov/publications/proceedings-state-science-technology-minimizing-impacts-bats-wind-energy (Accessed July 28, 2022).

Henderson, L.E., and H.G. Broders. 2008. Movements and resource selection of the northern long-eared myotis (*Myotis septentrionalis*) in a forest-agriculture landscape. J. Mammalogy 89(4):952-963.

Humphrey, S.R., A.S. Richter and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. J. Mammalogy 58(3):334-346.

Humphrey, S.R., and J.B. Cope. 1977. Survival rates of the endangered Indiana bat, *Myotis sodalis*. J. Mammalogy 58:32-36.

Jachowski, D.S., J.B. Johnson, C.A. Dobony, J.W. Edwards, W.M. Ford. 2014. Space use and resource selection by foraging Indiana bats at the northern edge of their distribution. Endangered Species Research 24(2):149.

Jackson, J.L. 2004. Effects of wildlife stand improvements and prescribed burning on bat and insect on bat and insect communities: Buffalo Ranger District, Ozark-St. Francis National Forest, Arkansas. MSc Thesis, Arkansas State University, Jonesboro, Arkansas, 152pp.

Johnson, J.B, J.W. Edwards, W.M. Ford, and J.E. Gates. 2009. Roost tree selection by northern myotis *(Myotis septentrionalis)* maternity colonies following prescribed fire in a Central Appalachian Mountains hardwood forest. Forest Ecology and Management 258:233- 242.

Jordan, G.W. 2020. Status of an Anomalous Population of Northern Long-Eared Bats in Coastal North Carolina. Journal of Fish and Wildlife Management 11(2): 665-678. Available at: https://meridian.allenpress.com/jfwm/article/11/2/665/441001/Status-of-an-Anomalous-Population-of-Northern-Long (Accessed July 26, 2022).

Kiser, J.D. and C.L. Elliott. 1996. Foraging habitat, food habits, and roost tree characteristics of the Indiana bat (*Myotis sodalis*) during autumn in Jackson County, Kentucky. Report prepared for Kentucky Department of Fish and Wildlife Resources, Nongame Program, Frankfort, KY. 65 pp.

Kniowski, A.B., and S.D. Gehrt. 2014. Home range and habitat selection of the Indiana bat in an agricultural landscape. J. Wildlife Management 78(3):503-512.

Kurta, A. 2005. Roosting ecology and behavior of Indiana bats (*Myotis sodalis*) in summer. Pp. 29-42 *in* K.C. Vories and A. Harrington (eds.), Proceedings of the Indiana bat and coal mining: a technical interactive forum. Office of Surface Mining, U.S. Department of the Interior, Alton, IL. Available at: http://www.mcrcc.osmre.gov/PDF/Forums/Bat%20Indiana/TOC.pdf.

Kurta, A., S.W. Murray, and D.H. Miller. 2002. Roost selection and movements across the summer landscape. Pp. 118-129 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Lacki, M.J., D.R. Cox, and M.B. Dickinson. 2009. Meta-analysis of summer roosting characteristics of two species of *Myotis* bats. American Midland Naturalist. 162: 318-26.

LaVal, R.K., R.L. Clawson, M.L. LaVal and W. Caire. 1977. Foraging Behavior and Nocturnal Activity Patterns of Missouri Bats, with Emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis*. J. Mammalogy 58(4):592-599

LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Department of Conservation, Terrestrial Series 8:1-52.

Menzel, J.M., W.M. Ford, M.A. Menzel, T.C. Carter, J.E. Gardner, J.D. Garner, and J.E. Hofmann. 2005. Summer habitat use and home-range analysis of the endangered Indiana bat. J. Wildlife Management 69(1):430-436.

Mikula, P., F. Morelli, R.K. Lucan, D.N. Jones, and P. Tryjanowski. 2016. Bats as prey of diurnal birds: a global perspective. Mammal Review. 46: 160-174.

Myers, R.F. 1964. Ecology of three species of myotine bats in the Ozark Plateau. Ph.D. Dissertation. University of Missouri, Columbia, MO. 210 pp.

NatureServe Explorer. 2022. Myotis septentrionalis, Northern Long-eared Bat. E. Britzke, pers. comm., 2015, citation. Available at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.102615/Myotis_septentrionalis (Accessed July 26, 2022).

Owen, S.F., M.A. Menzel, W.M. Ford, B.R. Chapman, K.V. Miller, J.W. Edwards, and P.B. Wood. 2003. Home-range size and habitat used by the Northern Myotis (*Myotis septentrionalis*). American Midland Naturalist 150(2):352-359.

Owen, S.F., M.A. Menzel, W.M. Ford, J.W. Edwards, B.R. Chapman, K.V. Miller, and P.B. Wood. 2002. Roost tree selection by maternal colonies of northern long-eared myotis in an intensively managed forest. USDA Forest Service. Newtown Square, Pennsylvania.

Patriquin, K.J. and R.M. Barclay. 2003. Foraging by bats in cleared, thinned, and unharvested boreal forest. J. Applied Ecology, 40:646-657.

Patterson, A.P. and J.W. Hardin. 1969. Flight Speeds of Five Species of Vespertilionid Bats. J. Mammalogy 50(1):152–153. Available at: https://doi.org/10.2307/1378653.

Perry, R.W. 2011. Fidelity of Bats to Forest Sites Revealed From Mist-Netting Recaptures. J. Fish and Wildlife Management 2(1):112-116.

Perry, R.W. 2012. A Review of Fire Effects on Bats and Bat Habitat in the Eastern Oak Region. Proceedings of the 4th Fire in Eastern Oak Forests Conference. GTR-NRS-P-102.

Rodrigue, J.L., T.M. Schuler, and M.A. Menzel. 2001. Observations of bat activity during prescribed burning in West Virginia. Bat Research News 42:48-49.

Rommé, R.C., A.B. Henry, R.A. King, T. Glueck, and K. Tyrell. 2002. Home range near hibernacula in spring and autumn. Pp. 153-158 in A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species Bat Conservation International, Austin, TX.

Sasse, D.B., and P.J. Pekins. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. Bats and Forests Symposium October 1995, Victoria, British Columbia, Canada, pp. 91-101.

Sherwin, H.A., W.I. Montgomery, and M.G. Lundy. 2013. The impact and implications of climate change for bats. Mammal Review 43(3):171-182.

Silvis, A., W.M. Ford, and E.R. Britzke. 2015. Effects of Hierarchical Roost Removal on Northern Long-Eared Bat (Myotis septentrionalis) Maternity Colonies. PLoS ONE, 10(1):1-17.

Silvis, A., A.B. Kniowski, S.D. Gehrt, and W.M. Ford. 2014a. Roosting and Foraging Social Structure of the Endangered Indiana Bat (Myotis sodalis). PloS one 9:e96937.

Silvis, A., W.M. Ford, and E.R. Britzke, and J.B. Johnson. 2014b. Association, roost use and simulated disruption of Myotis septentrionalis maternity colonies. Behavioral processes, 103:283-290.

Smallwood, K.S., and D.A. Bell. 2020. Relating Bat Passage Rates to Wind Turbine Fatalities. Diversity 2020, 12(2), 84. Available at: https://www.mdpi.com/1424-2818/12/2/84/htm (Accessed July 11, 2022).

Sparks D.W., M.T. Simmons, C.L. Gummer, and J.E. Duchamp. 2003. Disturbance of roosting bats by woodpeckers and raccoons. Northeastern Naturalist 10:105-8.

Sparks, D.W., C.M. Ritzi, J.E. Duchamp, and J.O. Whitaker, Jr. 2005. Foraging habitat of the Indiana bat *(Myotis sodalis)* at an urban-rural interface. J. Mammalogy 86:713-718.

Stratton, C., and K.M. Irvine. 2022. Summertime Analysis Statistical Report for Little Brown, Northern Long-eared, and Tricolored Bat Species Status Assessment. Chapter B in Straw, B.R, J. A. Martin, J.D. Reichard, and B.E. Reichert, editors. Analytical Assessments in Support of the U.S. Fish and Wildlife Service 3-Bat Species Status Assessment. Cooperator Report prepared in cooperation with the U.S. Geological Survey, United States Fish and Wildlife Service and Bat Conservation International. Available at: https://doi.org/10.7944/P9B4RWEU (Accessed July 25, 2022).

Tennessee Valley Authority (TVA). 2017. Programmatic Biological Assessment for Evaluation of the Impacts of Tennessee Valley Authority's Routine Actions on Federally Listed Bats. Project Number: 2017-21. Knoxville TN. 184 pp. with appendices.

Tennessee Valley Authority (TVA). 2020. Annual Report, Fiscal Year 2020, Programmatic Consultation in Accordance with Section 7 of the Endangered Species Act, Evaluation of the Impacts of Tennessee Valley Authority's Routine Actions on Federally Listed Bats. Knoxville, TN. 12 pp. with appendices.

Tennessee Valley Authority (TVA). 2023. Reinitiation of the Programmatic Biological Assessment for Evaluation of the Impacts of Tennessee Valley Authority's Routine Actions on Federally Listed Bats. Project Number: 2017-21. Knoxville, TN. 195 pp. with appendices.

Tennessee Wildlife Resources Agency (TWRA). 2022. Tennessee Bat Population and White-nose Syndrome Monitoring Report for 2020-2021. Prepared by Josh Campbell, Tennessee Wildlife Technical Report 20-6. 18 pp. and appendices.

Timpone, J.C., J.G. Boyles, K.L. Murray, D.P. Aubrey, and L.W. Robbins. 2010. Overlap in roosting habits of Indiana Bats (*Myotis sodalis*) and northern bats (*Myotis septentrionalis*). American Midland Naturalist 163:115-123.

U.S. Department of Agriculture, Forest Service (USFS). 2014. U.S. Forest Resource Facts and Historical Trends. Forest Service, FS-1035, 64pp.

U.S. Fish and Wildlife Service (USFWS). 1983. Recovery Plan for the Indiana Bat. Twin Cities, MN.

U.S. Fish and Wildlife Service (USFWS). 1999. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. Fort Snelling, MN. 53 pp.

U.S. Fish and Wildlife Service (USFWS). 2007. Indiana bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. Fort Snelling, MN.

U.S. Fish and Wildlife Service (USFWS). 2009. Indiana Bat (*Myotis sodalis*) 5-Year Review: Summary and Evaluation. Bloomington Ecological Services Field Office, Bloomington, Indiana. 45 pp.

U.S. Fish and Wildlife Service (USFWS). 2012. Biological Opinion on Effects of Golden-Winged Warbler Habitat Creation by the Natural Resources Conservation Service on the Indiana Bat (Myotis sodalis), Somerset County, Pennsylvania. Prepared by: U.S. Fish and Wildlife Service, Pennsylvania Field Office. Submitted to: Natural Resources Conservation Service, Harrisburg, Pennsylvania. 47 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. Northern Long-eared Bat Interim Conference and Planning Guidance. USFWS Regions 2, 3, 4, 5, & 6. 67 pages, including appendices.

U.S. Fish and Wildlife Service (USFWS). 2016. Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities from Take Prohibitions. Midwest Region. 103 pp.

U.S. Fish and Wildlife Service (USFWS). 2017. 2017 Indiana bat (*Myotis sodalis*) population status update. Indiana Ecological Services Field Office. 9 pp.

U.S. Fish and Wildlife Service (USFWS). 2022. Status Assessment Report for the Northern Long-eared Bat (*Myotis septentrionalis*), Version 1.1. Great Lakes Region, Bloomington, Minnesota. 96 pp and appendices.

U.S. Fish and Wildlife Service (USFWS). 2023 Standing Analysis and Implementation Plan – Northern Long-Eared Bat Assisted Determination Key. Version 1.1. Midwest Region, Bloomington, Minnesota. 36 pp.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. Endangered Species Consultation Handbook. Available at: https://www.fws.gov/endangered/esa-library/pdf/esa_section7_handbook.pdf.

Voigt, C.C., K. Schneeberger, S. L. Voigt-Heucke, and D. Lewanzik. 2011. Rain increases the energy cost of bat flight. Biological Letters 7:793–795.

Watrous, K.S., T.M. Donovan, R.M. Mickey, S.R. Darling, A.C. Hicks, and S.L. Von Oettingen. 2006. Predicting minimum habitat characteristics for the Indiana bat in the Champlain Valley. J. Wildlife Management 70:1128-1237.

Webb, D.R., and J.R. King. 1984. Effects of wetting on insulation of bird and mammal coats. Journal of Thermal Biology 9(3)189–191.

Whitaker, J.O., Jr. and V. Brack, Jr. 2002. Distribution and summer ecology in Indiana. Pp. 48-54 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Whitaker, J.O., and W.J. Hamilton. 1998. Order Chiroptera: Bats. Chapter 3: pp.89-102 in Mammals of the eastern United States, Third Edition, Comstock Publishing Associates, a Division of Cornell University Press, Ithaca, New York, 608pp.

Whitby, M., B.J. Udell, A.M. Wiens, T. Cheng, W. Frick, B.E. Reichert, and J.D. Reichard. 2022. Summer Mobile Acoustic Transect Analysis for Little Brown, Northern Long-eared, and Tricolored Bat Species Status Assessment. Chapter C in Straw, B.R, J. A. Martin, J.D. Reichard, and B.E. Reichert, editors. Analytical Assessments in Support of the U.S. Fish and Wildlife Service 3-Bat Species Status Assessment. Cooperator Report prepared in cooperation with the U.S. Geological Survey, United States Fish and Wildlife Service and Bat Conservation International. Available at: https://doi.org/10.7944/P9B4RWEU (Accessed July 25, 2022).

White-Nose Syndrome Response Team. 2022. Available at: https://whitenosesyndrome.org/where-is-wns (Accessed July 26, 2022).

Wiens, A.M., J. Szymanski, B.J. Udell, and W. E. Thogmartin. 2022. Winter Colony Count Data Assessment and Future Scenarios for the Little Brown, Northern Long-eared, and

Tricolored Bat Species Status Assessment. Chapter E in Straw, B.R, J. A. Martin, J.D. Reichard, and B.E. Reichert, editors. Analytical Assessments in Support of the U.S. Fish and Wildlife Service 3-Bat Species Status Assessment. Cooperator Report prepared in cooperation with the U.S. Geological Survey, United States Fish and Wildlife Service and Bat Conservation International. Available at: https://doi.org/10.7944/P9B4RWEU (Accessed July 27, 2022).

Yates, M.D., and R.M. Muzika. 2006. Effect of forest structure and fragmentation on site occupancy of bat species in Missouri Ozark Forests. J. Wildlife Management 70(5):1238-1248.

Personal Communications:

Hamrick, Elizabeth Burton. 2023. Tennessee Valley Authority. Email dated April 20, 2023, to Nicole Sikula and Todd Shaw, U.S. Fish and Wildlife Service, Tennessee Ecological Services Office.

LeGrand, Holly. 2017. Tennessee Valley Authority. Email dated December 17, 2017, to Todd Shaw, U.S. Fish and Wildlife Service, Tennessee Ecological Services Office.

LeGrand, Holly. 2018a. Tennessee Valley Authority. Email dated January 9, 2018, to Todd Shaw, U.S. Fish and Wildlife Service, Tennessee Ecological Services Office.

LeGrand, Holly. 2018b. Tennessee Valley Authority. Email dated March 28, 2018, to Jerry Ziewitz, U.S. Fish and Wildlife Service, Southeast Regional Office.

Lott, Keith. 2023. U.S. Fish and Wildlife Service, Ohio Ecological Services Field Office. Email dated March 7, 2023, to Mike Armstrong, U.S. Fish and Wildlife Service, Kentucky Ecological Services Field Office