United States Department of the Interior

FISH AND WILDLIFE SERVICE
Tennessee Ecological Services Field Office
446 Neal Street
Cookeville, Tennessee 38501
(931) 528-6481

July 11, 2025

Mr. William Douglas White
Senior Manager, Biological Compliance
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902

Subject/Re: FWS 2025-0079091, Final Biological Opinion for TVA Clinch River Nuclear Site in Roane County, Tennessee

Dear Mr. White:

This letter transmits our second and final version of the enclosed biological opinion (BO) and conference opinion (CO) for the Clinch River Nuclear Site Advanced Nuclear Technology Park, Unit 1 (CRN-1) project on the Oak Ridge Reservation (the Action) in Roane County, Tennessee. On February 21, 2025, we agreed that the Biological Assessment (BA) was sufficient and that formal consultation for the Action was appropriate. You determined that the Action is likely to adversely affect the federally endangered Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), and gray bat (*Myotis grisescens*), and the proposed endangered tricolored bat (*Perimyotis subflavus*).

In response to your request for formal consultation, we concur with your determination that the proposed activity is likely to adversely affect these species. We have addressed effects to the species in the enclosed BO/CO, which concludes that the Action is not likely to jeopardize the continued existence of the species. This finding fulfills the requirements applicable to the Action for completing consultation under §7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended.

The BO/CO includes an Incidental Take Statement that requires implementation of reasonable and prudent measures that we consider necessary or appropriate to minimize the impacts of anticipated taking of listed species. Incidental taking of listed species that are in compliance with the terms and conditions of this statement are exempted from the prohibitions against taking under the Endangered Species Act.

This letter completes consultation requirements for the Action relative to the Indiana bat, northern long-eared bat, gray bat, and tricolored bat. Reinitiating consultation relative to these species is required when:

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

We sincerely appreciate the significant bat conservation work that your staff and TVA undertake to advance the recovery of endangered bats in Tennessee. Your remarkable contributions under this consultation will greatly benefit the local populations in the Oak Ridge area, and we wholeheartedly recognize and appreciate your dedicated efforts. A complete administrative record of this consultation is on file at our Cookeville, TN office. If you have any questions about the BO/CO, please contact Steve Alexander by phone at 931/525-4980 or via email at steven_alexander@fws.gov.

Sincerely,

DANIEL ELBERT

Digitally signed by DANIEL ELBERT
Date: 2025.07.11 15:28:00 -05'00'

Field Supervisor

Biological Opinion/Conference Opinion

CLINCH RIVER NUCLEAR SITE ADVANCED NUCLEAR REACTOR TECHNOLOGY PARK
Tennessee Valley Authority

FWS ECOSphere Project Code: 2025-0079091

Prepared by:

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

DANIEL ELBERT

Digitally signed by DANIEL ELBERT
Date: 2025.07.11 15:18:14 -05'00'

Daniel Elbert, Field Supervisor

Date

ACKNOWLEDGEMENTS

With sincere gratitude, we would like to acknowledge the following for their significant contributions to this Opinion:

Elizabeth Hamrick (TVA), Steve Alexander (FWS), and Nicole Sikula (FWS).

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CONSULTATION HISTORY

This section lists CRN -1 key events and correspondence 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
07/03/2025	Email	TVA	Summary of final BO comments
06/30/2025	Phone	TVA, FWS	Discussion of concerns with final BO and review of RPMs and T&Cs
06/27/2025	Email	FWS	Transmittal of final draft BO
05/09/2025	E-mail	TVA, FWS	Transmittal of additional proposed conservation measures.
04/23/2025	Teams Meeting	Hamrick, Alexander, Sikula, Sykes, Amacker, White	Current status of construction and mitigation plans. Update on NRC licensing.
04/21/2025	Email	TVA	Information needs related to TVA CRN-1 BA
03/05/2025	Email	TVA, FWS	Link to NEPA Documents for CRN SMR
02/21/2025	Email	TVA, FWS	Link to the CRN Draft SEIS January 2025 Received
02/20/2025	Email	FWS	Signed TVA CRN-1 BA Sufficiency Review Acknowledgement Transmitted to TVA.
01/21/2025	Email	TVA	TVA CRN-1 BA Received.
02/24/2022	Email	TVA	IPaC Activity Received for review of the Draft EIS
03/10/2022	Email	FWS	TNFO no substantive comments submitted to FWS Regional Office
2017	Email	TVA/FWS	TAILS Activity Received, Initial Review.

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:

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.

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).

Similarly, a conference opinion (CO) is required for a proposed species when a federal action agency determines that a project may jeopardize its continued existence or result in the destruction or adverse modification of proposed designated critical habitat. A CO addresses only species or critical habitat "proposed" for listing and includes the same analyses as a BO. While the prohibitions of the ESA do not yet apply under a CO, a CO follows the same regulations (50 CFR §402.14) and must meet the same standards as a BO, so that the former may be adopted as the latter after the Service issues a final decision listing a species or designating a critical habitat. For simplicity, this document will collectively be referred to as "BO" throughout this document. Any distinctions between formal consultation and conference procedures will be specifically addressed as necessary. Considerations of the proposed tricolored bat in this BO should not be construed as an indication that they will or will not be proposed for listing at some point in the future.

The federal action agency for this consultation/conference is the Tennessee Valley Authority (TVA), and the Federal Action addressed in this document in Roane County, Tennessee. This combined BO/CO addresses effects to the endangered gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), and northern long-eared bat (*Myotis septentrionalis*), and the proposed endangered tricolored bat (*Perimyotis subflavus*) resulting from construction and operation of the Clinch River Small Modular Reactor (CRN SMR) project in Roane County, Tennessee. The proposed project within the CRN site boundary is hereafter referred to as the CRN-1 because there is potential for additional SMR's to be installed adjacent the current proposed project. The CRN-1 site is adjacent to the Clinch River and the Department of Energy (DOE) Oak Ridge Reservation (ORR).

Critical habitat is the specific areas within the geographic area, occupied by the species at the time it was listed, that contain the physical or biological features that are essential to the conservation of threatened and endangered species and that may need special management or protection. Critical habitat may also include areas that were not occupied by the species at the time of listing but are essential to its conservation. The prohibition against destruction and adverse modification of critical habitat protects such areas in the interest of conservation. While critical habitat for the Indiana bat has been designated, none exist in the vicinity of the proposed Action. Critical habitat for the other species has not been designated. Therefore, designated critical habitat will not be considered as part of this consultation or discussed further in this BO.

Section 9 of the ESA and regulations issued under section 4(d) of the ESA prohibit the taking of endangered and threatened species, respectively, without special exemption. Federal agencies may obtain such exemption through the "Incidental Take Statement" (ITS) of a BO that supports a non-jeopardy finding for their proposed actions. Incidental take is take that results from a federal action but is not the purpose of the action. It may be allowed when the Service approves it through an ITS. The ITS includes the amount or extent of anticipated take due to the federal action, reasonable and prudent measures (RPMs) to minimize the take, and terms and conditions (T&Cs) that must be observed when implementing those RPMs.

The Service has given appropriate consideration of the proposed mitigation to offset the permanent loss of this habitat by including the beneficial action in the effects analysis, in the jeopardy analysis, and in the ITS.

In this BO, the Service has determined that the proposed Action may result in incidental take of the gray bat, Indiana bat, and tricolored bat. For this BO, **the Service believes that no more 4,094 ac of gray, Indiana and tricolored bat habitat, and no more than an additional 50 gray bats and 5 tricolored bats will be incidentally taken.**

2. PROPOSED ACTION

Details about the location, purpose and need, scope, and potential impacts of this project and the other alternatives considered can be found in TVA's Clinch River Nuclear (CRN) Site Advanced Nuclear Technology Park Unit 1 Supplemental Environmental Impact Statement (CRN SEIS) and Final Programmatic Environmental Impact Statement (CRN PEIS), available online at: https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/clinch-river-nuclear-site-advanced-nuclear-reactor-technology-park. The Advanced Nuclear Reactor Technology Park Unit 1 Draft SEIS addresses the potential environmental effects associated with site preparation, construction, operation, and decommissioning of one SMR, the GE Hitachi BWRX-300, at TVA's 935-acre CRN Site in Oak Ridge, Roane County, Tennessee.

The SEIS tiers from the previous CRN PEIS. The SEIS updates the PEIS with new information about potential impacts related to the BWRX-300 and environmental resources in the areas to be disturbed and the surrounding vicinity. Site preparation and construction activities in Phase 1 include clearing, grading, foundation excavation, construction of cooling towers, laydown areas,

facility buildings, roads (both onsite and in the immediate vicinity), parking lots, a new switch yard, installation of municipal water and sewer lines, barge landing upgrades, transmission line upgrades onsite and immediately adjacent to the site, cooling water intake and discharge structures, quarry (optional), or transport of borrow material to the site (Figure 2.1).

The CRN Site consists of approximately 935 acres of TVA-managed land bounded on the east, south, and west by the Clinch River arm of Watts Bar Reservoir and on the north by the U.S. Department of Energy's (DOE) Oak Ridge Reservation (ORR) and the TVA Grassy Creek Habitat Protection Area (HPA) (Figure 2.1). Other components of the project include improvements to an existing offsite barge loading area, road improvements to Tennessee Highway 58 and the ramp to Bear Creek Road, and a new 161-kV transmission line constructed within a new 120-foot-wide, 0.56-mile-long right-of-way (ROW). These areas are often referred to in combination as the Barge and Traffic Area (BTA). The proposed project is expected to impact three tricolored bat hibernacula to the north and one gray bat colony and potential tricolored bat hibernacula to the northwest (Figure 2.1) in addition to summer habitat for the gray, Indiana, northern long-eared, and tricolored bats.

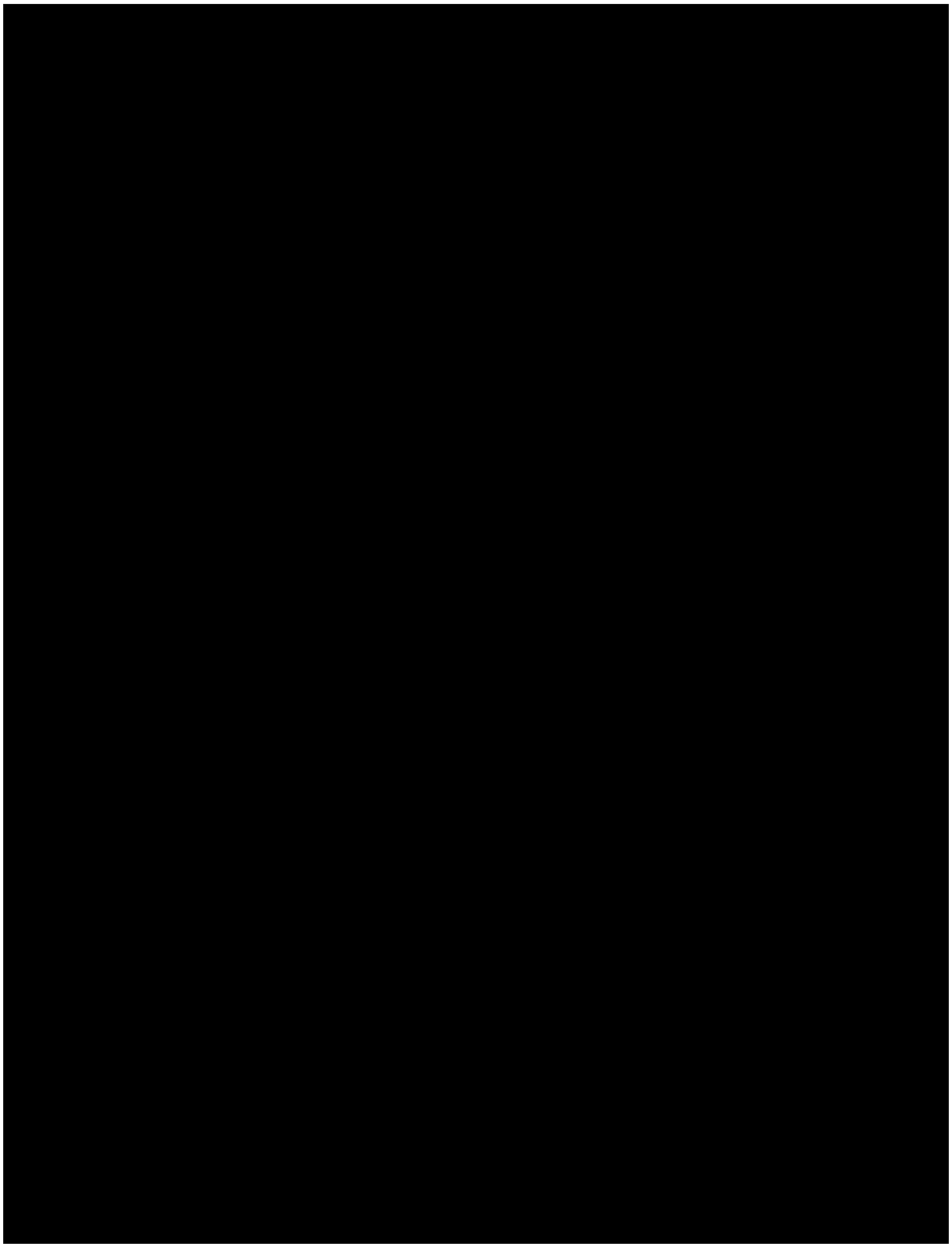

Figure 2-1. Proposed CRN-1 Site and layout, Roane County.

Operational activities in Phase 1 include full plant operations including full reactor operations, use of the cooling system including intaking water from the reservoir and discharging water to the environment through the cooling towers, use of the blowdown holding pond, discharging water to the reservoir, and ongoing plant maintenance activities. Temperatures and chemical concentrations for all discharges would be in compliance with the National Pollutant Discharge Elimination System (NPDES).

Phase 2 of the project will determine whether the analyses developed are bounding and whether there is new information not previously evaluated. Any new information would be evaluated in Phase 2. Upgrades of existing offsite transmission lines are an example of a deferred action that could be evaluated in Phase 2 if applicable.

The primary purpose of the proposed action is to demonstrate the feasibility to license, construct, and operate one or more SMRs at the CRN Site. The proposed action is needed to support the recommendations outlined in TVA's 2019 Integrated Resource Plan (IRP) to evaluate emerging nuclear technologies, including SMRs. This supports TVA's technology innovation efforts aimed at developing future electricity generation capabilities and will enable TVA's Board of Directors to consider next steps in TVA's efforts to explore advanced reactor options that could, in part, be used to help TVA achieve net-zero carbon emissions by 2050 while maintaining a firm, fixed, reliable power supply.

2.1. CRN Site Construction

Analysis of the CRN -1 construction project area and preferred access road option indicate that approximately 536 acres of the project footprint contains 250 acres of potential roost trees for federal listed bat species. A final access road plan has not been selected. The review area under consideration here is located in close proximity to forested natural areas of the ORR with minor development in the form of power-line rights-of-way and secondary roads. The CRN -1 construction project will include the removal of existing forest, which contains many suitable roost trees for Federal and State listed bat species and fill of 0.65 ac of ponds (Table 2-1).

Despite this loss of forested habitat, 446 acres of forested habitat is expected to remain onsite following proposed activities. Adjacent to the CRN-1 site is TVA's Grassy Creek Habitat Protection Area (HPA), which encompasses three tricolored bat hibernacula and 271 acres of suitable forested habitat. The HPA will be expanded by 14 acres to include habitat where two additional state-listed plants are located. While tree removal would occur over 33 acres of the HPA for the proposed 161 transmission line, the newly created ROW would be revegetated with native and/or non-invasive species and still provide quality foraging edges and fields along which to forage (Table 2-1).

Proposed tree removal would occur in winter, November 16 - March 31, to avoid summer roosting Indiana bats, northern long-eared bats, and little brown bats, and to avoid impacts to tricolored bats during spring staging, summer roosting, and fall swarming. Due to the extent of the proposed actions and areas of potential impact across the site, as well as the required

permitting process by the Nuclear Regulatory Commission, tree removal required for construction of the CRN-site could take approximately 4.5 years to complete.

Table 2-1. Description of project area habitats.

Description	Acres
Entire CRN area	935
Entire Forested acreage	696
CRN-1 Construction footprint	536
Proposed Tree removal	250
Proposed Wetland removal	0.65
Grassy Creek HPA	271
HPA expansion	14

Construction activities will include drilling and excavation associated with removal of large amounts of soil and rock for construction of the facilities. Excavation will extend deep below the surface and there is a likely use of loud drilling and jackhammering equipment.

While site optimization plans are likely to eliminate the need for any additional borrow material, TVA is evaluating two alternatives for obtaining borrow material should it be determined later that additional borrow material is needed for building CRN-1. Both alternatives are evaluated as part of a bounding analysis for the SEIS environmental review to provide flexibility for final selection during detailed design.

The first alternative is to obtain borrow material from an existing, commercial, offsite quarry. Approximately 400,000 cubic yards of fill material from the offsite quarry would be brought to CRN-1 by truck during an approximately two-year period using existing roads and haul roads developed onsite. If constructed, the onsite quarry would be expected to operate for two years. Drilling operations would be conducted continuously. Initial blasting frequency would be up to two times per week to establish the quarry pit. Once routine quarry operations are established, blasting operations would be anticipated weekly. TVA would stabilize but not restore the quarry pit area following quarry activities. Material excavated during quarry operations that cannot be used as fill would be disposed of onsite within the identified area of disturbance. The quarry design would include equipment and/or holding ponds within the disturbed area for managing run-off and wastewater generated by the quarry. Stormwater BMPs would be instituted and maintained during the entire period of building and quarry operations. If the quarry is built, haul roads to access the quarry site would be required, along with utilities to support operations such as temporary power, water and sewer services, parking area, stockpile areas for crushed material, and work trailers.

TVA anticipates making improvements to the existing DOE former K-25 Barge Loading Area, on Bear Creek Road between TN 58 and the CRN Site entrance, for deliveries of equipment and materials. Intermittent streams, emergent, forested, and open water wetlands, as well as

deciduous, evergreen and mixed forests occur in this area. Refurbishment of the K-25 barge facility may include improvements such as reducing the height of the sheet pile wall; vegetation clearing; grubbing, grading, upgrades to and limited placement of fill for the haul path; replacement of a culvert along the haul path; addition of tie-off points for the barge; and temporary support of overhead lines. Tree removal may be required. No in-water work is anticipated. As a result of increased traffic during construction, TVA determined congestion may occur at both roadway intersections at Tennessee Highway 58 and the ramp to Bear Creek Road, and at the CRN Site entrance from Bear Creek Road. Roadway improvements such as construction of additional lanes on the impacted roadways, widening of the road, addition of a traffic signal, and reconfiguration of Bear Creek Road at the CRN Site entrance and at the Tennessee Highway 58 ramp may be necessary to avoid congestion impacts. TVA is conducting additional review and is engaged in discussions with the City of Oak Ridge, Tennessee Department of Transportation, and DOE regarding these potential changes. This area contains primarily mature deciduous forest but also ephemeral streams and an intermittent stream.

TVA plans to loop in the existing Kingston Fossil Plant (FP)-Fort Loudoun Hydroelectric Plant (HP) #1 161-kV transmission line and the Kingston-Bethel Valley #2 161-kV transmission line within the CRN Site boundary. TVA also plans to construct a new 161-kV transmission line that interconnects with the Kingston-Bethel Valley #2 transmission line north of Bear Creek Road. North of Bear Creek Road, the proposed new 161-kV transmission line would be constructed within a new 120-foot-wide, 0.08-mile-long right-of-way (ROW) easement on land managed by ORR. South of Bear Creek Road, the new 161-kV line would be in a new 120-foot-wide, 0.48-mile-long corridor within TVA's Grassy Creek HPA. The new 161-kV transmission line would then continue an additional 0.48 miles through the CRN Site to the existing 500-kV corridor. The 161-kV transmission line will run parallel to the existing 500-kV transmission line for approximately 1.41 miles, then down the east side of the site to the switchyard for approximately 0.75 miles, and out of the switchyard to join the existing Kingston FP-Fort Loudoun HP #1 161-kV transmission line, approximately 0.49 miles. Project design has not yet determined which side of the existing 500-kV transmission line the new 161-kV transmission line will occur. Maps reflect the potential for it to occur on either side, though only one side would be needed. In addition, a portion of the existing Kingston FP-Fort Loudoun HP #1 161-kV transmission line within the CRN Site will be removed to accommodate the new transmission line.

The new transmission line corridors are forested and contain deciduous, evergreen, and mixed forests as well as wetlands and streams. Wetlands with sensitive plant communities occur in the path of the proposed new 161-kV corridor in the Grassy Creek HPA and just outside of it.

Tree removal may occur approximately 1,000 feet (~0.2 miles) or more from these caves to widen the existing entry road to the site. Should utility poles need to be relocated along this road, drilling or localized blasting may also need to occur in discrete locations where poles would be installed. Once construction begins, road traffic along this road would also increase due to workers, construction equipment, and potentially from rock being hauled in (should an external quarry site be needed). A temporary construction facility would also be built greater than 0.25 mi, but less than 0.5 mi from these hibernacula. Blasting may need to occur to construct this facility.

[redacted] (where gray bat roost year-round, and tricolored roost during winter) is located across the Clinch River from the CRN Site. Tree removal could occur as close as [redacted] miles from the hibernacula but across the Clinch River. The entry road slated for widening (including tree removal, potential utility pole drilling/blasting, and increased noise traffic) is approximately [redacted] miles away. Blasting and/or drilling may need to occur to construct facility buildings, laydown areas, and other construction/operational support areas. The closest of these areas is approximately [redacted] miles away. Finally, although unlikely to be needed, the optional onsite quarry may be located approximately [redacted] from [redacted]. Other facilities and construction/operational support areas could require drilling or blasting for construction greater than 0.5 miles from the cave. This includes drilling and blasting to dig the reactor shaft, approximately [redacted] miles from [redacted]. Drilling and blasting for the reactor shaft would occur 24 hours a day over approximately 18 months.

2.2. CRN Operations

The condenser cooling system for CRN-1 is a (closed-cycle) mechanical draft cooling water system with makeup water supplied by the Clinch River arm of Watts Bar Reservoir (Reservoir). Makeup water would be withdrawn from the Reservoir through a new intake structure that would be located at approximately Clinch River Mile (CRM) 17.9. Two options are being considered for the intake structure, one in stream and one on shore. A new discharge structure located downstream of the intake structure, near approximately CRM 15.45, will convey cooling tower blowdown pond water to the Reservoir. The CRN-1 NPDES permit would include discharge limits established to protect receiving waters and monitoring requirements to ensure compliance with those limits. Temperatures and chemical concentrations for all discharges would be in compliance with the terms and conditions of the NPDES permit.

During operation of the plant, cooling towers are projected to create less than 70 dBAs as measured 1,000 feet from the source. A threshold of 75 dBAs was established in TVA's Programmatic Consultation with the USFWS for federally listed bats in 2018 and again in updates to this document in 2023. Based on current site layout plans, only a relatively small amount of suitable forested summer roosting habitat (approximately 26 acres) is expected to remain within 1,000 feet of the cooling towers. This section of forest would occur along the Clinch River between 300 and1,000 feet from cooling towers. Noise would be expected to be 70 dBAs or more along this 1,700-foot section of riparian habitat. All caves are greater than 0.5 miles from cooling towers. Noise created by operations of this proposed project are expected to fall below the 75dBA threshold at all caves and across the vast majority of the remaining forested suitable summer roosting habitat.

2.3. 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 TVA CRN site is located in East Tennessee within the Ridge and Valley Physiographic Province of the Eastern Unites States. The climate in East Tennessee runs Humid Sub-tropical to Humid Continental.

The CRN-1 Site consists of approximately 935 acres of TVA-managed land bounded on the east, south, and west by the Clinch River arm of Watts Bar Reservoir and on the north by the U.S. Department of Energy's (DOE) Oak Ridge Reservation (ORR) and the TVA Grassy Creek Habitat Protection Area (HPA) (Figure 1). HPAs are TVA Natural Areas managed to protect populations of species identified as threatened or endangered by the USFWS, state-listed species and any unusual or exemplary biological communities/geological features. Other components include a 120-ft. wide, mile long utility ROW, improvements to an existing barge unloading facility, and access road, often referred to in combination as the Barge and Traffic Area (BTA).

The maximum area of potential onsite disturbance across the CRN-1 project area is approximately 536 acres. Site optimization plans currently underway would reduce the project footprint such that actual disturbance is expected to be less than the maximum acres listed above. The CRN Site as a whole contains a total of 696 acres of forest including deciduous, evergreen, and mixed deciduous-evergreen. Of this, up to approximately 250 acres of forested habitat could be removed (deciduous, evergreen, and mixed). The CRN-1 Sitealso contains open herbaceous habitats, ponds, wetlands and streams. Major cut and fill activities are expected with the grading of the plant area in preparation for construction during Phase 1.

The proposed potential quarry would be located near the center of the CRN Site, just south of the existing 500-kV line (Figure 2-1). It is adjacent to the Clinch River on the southeastern portion of the action area.

TVA also plans to construct a new 161-kV transmission line that interconnects with the Kingston-Bethel Valley #2 transmission line north of Bear Creek Road. North of Bear Creek Road, the proposed new 161-kV transmission line would be constructed within a new 120-foot-wide, 0.08-mile-long right-of-way (ROW) easement on land managed by ORR. South of Bear Creek Road, the new 161-kV line would be in a new 120-foot-wide, 0.48-mile-long corridor within TVA's Grassy Creek HPA. The new 161-kV transmission line would then continue an additional 0.48 miles through the CRN Site to the existing 500-kV corridor. The 161-kV transmission line will run parallel to the existing 500-kV transmission line for approximately 1.41 miles, then down the east side of the site to the switchyard for approximately 0.75 miles, and out of the switchyard to join the existing Kingston FP-Fort Loudoun HP #1 161-kV transmission line, approximately 0.49 miles. Project design has not yet determined which side of the existing 500-kV transmission line the new 161-kV transmission line will occur.

The new transmission line corridors are forested and contain deciduous, evergreen, and mixed forests as well as wetlands and streams. Wetlands with sensitive plant communities occur in the path of the proposed new 161-kV corridor in the Grassy Creek HPA and just outside of it.

The project footprint would result in permanent impacts to:

- 0.65 acres of three ponds
- 3,586 lineal feet of 11 perennial/intermittent streams
- 2,694 lineal feet of eight wet weather conveyances (WWCs)

The proposed action also would result in temporary impacts to:

- 101 lineal feet of three perennial/intermittent streams
- 64 lineal feet of three WWCs

Permanent impacts to streams on the CRN-1 Site are related to building the 161-kV transmission corridor and these streams will be avoided where possible. Impacts to the perennial stream in the BTA are limited to the potential need to expand an existing culvert under the access road to the barge facility. Actual linear footage/acreage of impact is dependent on final site design. Treatment pond(s) for holding and treating process water and stormwater flow would also be constructed; discharges from the operation of the proposed CRN-1 Site would require compliance with a site-specific NPDES permit and compliance with all applicable regulations and conditions.

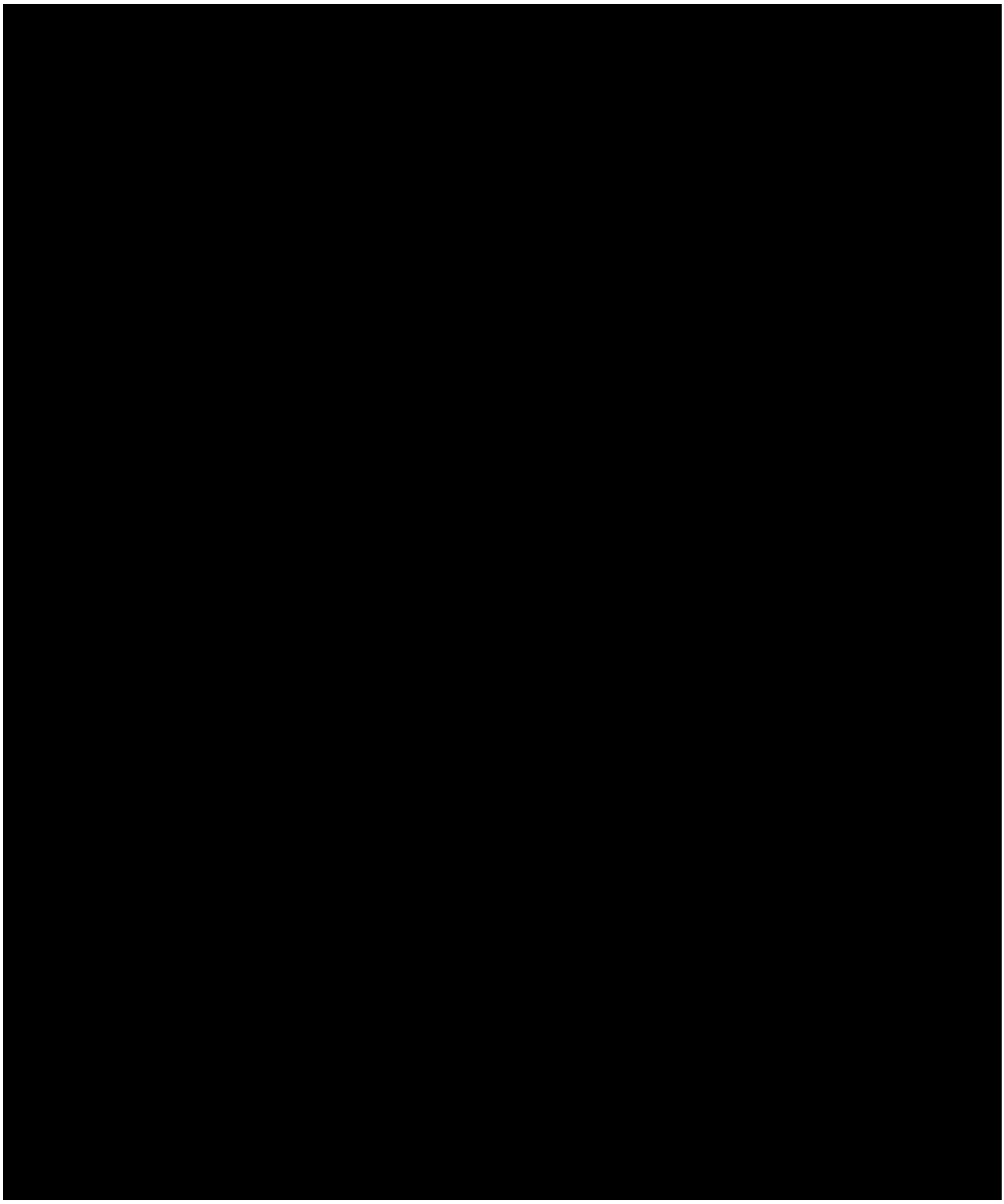

Figure 2-2. CRN-1 action area with 120 dBA noise limit delineated (see Section 5.2).

2.4. Conservation Measures

TVA would implement the following best management practices (BMPs) in accordance with regulations:

Standard Construction BMPs

- Ensure proper disposal of waste, ex: used rags, used oil, empty containers, general trash.
- Maintain every site with well-equipped spill response kits, included in some heavy equipment.
- Conduct Quarterly Internal Environmental Field Assessments.
- Every project must have an approved work package that contains an environmental checklist that is approved by site Environmental Health and Safety consultant.
- When refueling, vehicle is positioned as close to pump as possible to prevent overfilling of tank. Hose and nozzle are held in a vertical position to prevent spillage.

Construction Site Protection Methods

- Sediment basin for runoff - used to trap sediments and temporarily detain runoff on larger construction sites.
- Storm drain protection device.
- Check dam to help slow down silt flow.
- Silt fencing to reduce sediment movement.
- Storm Water Pollution Prevention (SWPP) Pollution Control Strategies
- Minimize storm water contact with disturbed soils at construction site.
- Protect disturbed soil areas from erosion.
- Minimize sediment in storm water before discharge.
- Prevent storm water contact with other pollutants.
- A construction general permit will be obtained prior to construction, and a National Pollutant Discharge Elimination System (NPDES) permit will be obtained once the site begins power generating activities.

A Spill Prevention and Control Countermeasures (SPCC) Plan is created for every generating site. Hundreds of pieces of equipment are often managed at the same time on power generation properties with the goal of minimizing fuel and chemical use.

Operations involving chemical/fuel storage or resupply and vehicle servicing will be handled outside of riparian zones (streamside management zones) in a manner to prevent these items from reaching a watercourse. Earthen berms or other effective means are installed to protect stream channels from direct surface runoff. Servicing will be done with care to avoid leakage, spillage, and subsequent stream, wetland, or ground water contamination. Oil waste, filters, and

other litter will be collected and disposed of properly. Equipment servicing and chemical/fuel storage will be limited to locations greater than 300-ft from sinkholes, fissures, or areas draining into known sinkholes, fissures, or other karst features.

TVA would also implement sustainability measures during building of CRN-1 to include development of pollinator habitat, artificial roosting structures for tree roosting bats, and other sustainable development and land management actions (or activities) in association with a site biodiversity plan in accordance with TVA's Biodiversity Policy. TVA's Grassy Creek HPA encompasses three small tricolored bat hibernacula. While tree removal would occur over 33 acres of the HPA for the proposed 161 transmission line, the newly created ROW would be revegetated with native and/or non-invasive species and still provide quality foraging edges and fields along which to forage.

Main direct impacts to tree roosting bats would be avoided by TVA's winter tree removal restrictions. Additional impacts would be minimized due to the large quantity of suitable roosting habitat remaining onsite and on immediately adjacent lands where bats may find alternative roosting sites. Artificial bat roosting structures would be installed at the CRN Site to provide permanent habitat for imperiled tree roosting bats that otherwise may rely on ephemeral habitat for summer roosting. Structure design and placement would be selected to attract federally protected bats. These structures would also provide opportunities for conservation research activities by TVA Biological Compliance and their partners. Annual monitoring would occur at this location in conjunction with annual surveys of the 50 additional artificial bat roosting structures TVA has installed at nine other locations throughout the Tennessee Valley to support Section 7(a)(1) ESA efforts.

Additional Section 7(a)(1) activities by TVA include cave monitoring at TVA-managed bat caves across the TVA Region in conjunction with state, federal, and NGO partners as a part of WNS response efforts to monitor bat populations. As a part of these efforts, TVA will continue to monitor [redacted] and the caves on the HPA (via internal surveys or exit emergence counts, as appropriate) to document seasonal use and monitor local bat populations. If needed in the future due to high levels of disturbance from humans, TVA would evaluate the potential to install bat friendly cave gates on these caves as it has done at other caves across the region.

Vegetation removal in streamside management zones (SMZs) and wetlands would be restricted to trees tall enough, or with the potential to soon grow tall enough, to interfere with conductors. Clearing in SMZs would be accomplished using hand-held equipment or remote-handling equipment, such as a feller buncher, to limit ground disturbance.

Following clearing and construction, vegetative cover on the ROW would be restored to its prior condition prior to construction, to the extent practicable. TVA would utilize appropriate seed mixtures as described in TVA's BMP guide (TVA 2022a). Erosion controls would remain in place until the plant communities become fully established. Streamside areas would be revegetated as described in TVA's BMP guide. Failure to maintain adequate clearance can result in dangerous situations, including ground faults. As such, native vegetation and plants with favorable growth patterns (slow growth and low mature heights) would be maintained within the ROW following construction.

Drilling and blasting within 0.5 miles of the [redacted] tricolored bat caves in the HPA would be avoided while bats are in winter torpor (Nov 15-March 31).

To minimize and attempt to avoid impacts to gray bats and tricolored bats while in [redacted], the following plan would be implemented by TVA and its partners:

- Once construction methods are determined, pre-blast survey of the project area is conducted, and a preliminary schedule is developed for drilling and blasting activities within 0.5 miles of [redacted], TVA, in coordination with USFWS, would develop a phased approach to determining allowable thresholds for intensity and frequency of drilling and blasting activities within 0.5 miles of this cave.
- At least one week of seismic data would be collected at [redacted] prior to any proposed drilling or blasting activities to determine baseline conditions within the cave. We anticipate this would establish if activities such as boat traffic and recreation along the Clinch River, firing range activities, and road traffic are detectable within the cave.
- Titley roost loggers would be placed inside [redacted] where the greatest number of bats typically roost. Seismic and acoustic data would be collected during blasting and drilling activities to quantify whether vibration and noise associated with drilling or blasting can be detected within the cave where the bats have been observed roosting. These data will be reviewed by both project managers, drilling experts, and TVA Terrestrial Zoology Staff and if it is deemed necessary, vibrations associated with blasting will be "dialed down" to lower levels by the design, placement, and timing of blasting. These efforts would occur until it is determined that minimal or no seismic activity can be detected in roosting areas of the cave or that bats present are not reacting to seismic activity detected. Test blasts would occur until acceptable levels are reached. Initially the amount of explosives used would be restricted to prevent operational problems from blast vibrations. Ramp-up test blasts that increase the amount of explosives would occur only after it has been demonstrated that vibrations can be kept within acceptable levels using test phase amounts of explosives.
- Seismic and bat acoustic data would be collected for either the duration of the blasting and drilling at that particular location, or for a maximum of 1 month, whichever is most logical per site, to verify that no impacts are occurring to the bats in this cave due to the proposed activities. If deemed prudent and if USFWS is satisfied with previous data, detectors can be pulled early to avoid entering the cave to change acoustic monitor batteries when the bats are present.

In addition, TVA would also contribute $500,000 to TVA's Bat Conservation Fund towards local and regional research and monitoring efforts such as capture and tracking of federally listed bats to identify previously unknown maternity roosting sites, harp-trapping at caves where research is lacking, cave gating, and/or internal cave surveys. Any remaining funds could support research opportunities at the on-site artificial bat roosting structures mentioned above or other meaningful efforts to contribute to imperiled bat conservation efforts in the region.

3. STATUS OF SPECIES

This section summarizes best available data about the biology and current condition of gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), and tricolored bat (*Perimyotis subflavus*) throughout their ranges that are relevant to formulating an opinion about the Action.

The gray bat was listed under the Endangered Species Preservation Act on October 15, 1966 (80 Stat. 926; 16 U.S.C. 668aa(c)) and as an endangered species under the ESA of 1973 in the Federal Register on April 28, 1976 (41 FR 17736). Critical habitat is not designated for gray bat.

The Indiana bat was 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 superseded the earlier statute. Critical habitat has been designated for Indiana bat but is not relevant to this consultation because the specific caves and mines that have been designated as critical habitat do not occur in the Action Area and therefore, will not be adversely affected by the proposed Action.

The northern long-eared bat was listed as threatened on April 2, 2015 (80 FR 17973–18033) and uplisted as endangered on March 31, 2023 (88 FR 4908-4910). On April 27, 2016, the Service determined that designation of critical habitat for the species is not prudent (81 FR 24707–24714).

The Service proposed a rule to list the tricolored bat (*Perimyotis subflavus*) as endangered under the ESA on September 14, 2022 (87 FR 56381–56393). The tricolored bat has undergone taxonomic revision. Most of the literature is published under the name *Pipistrellus subflavus*. Hoofer et al. (2006) revised the generic status to *Perimyotis*. The common name "tricolored bat" has been used as an alternative to the technically incorrect classification of eastern pipistrelle.

Please access the Service's Environmental Conservation Online System (ECOS) for additional information regarding listing status and availability of recovery plans and other documents pertaining to these species, hereby incorporated by reference at the following link: https://ecos.fws.gov/ecp/.

3.1. Gray Bat (cave-roosting species)

3.1.1. Life History

Gray bats are cave-dwelling bats found throughout karst areas of the southeastern U.S. where they primarily roost in caves, and occasionally in human-made structures such as concrete box culverts, dams, abandoned mines, and bridges (Timmerman and McDaniel 1992; Johnson et al. 2002; Powers et al. 2016; Sasse et al. 2019). Males and females hibernate together in large colonies for approximately 6-7 months in a few caves throughout Alabama, Arkansas, Kentucky, Missouri, and Tennessee.

Gray bats are considered regional migrants with average migrations of 200 kilometers (km) (124 miles [mi]) (Gerdes 2016). However, some bats have been known to migrate as far as 775 km (481 mi). In the spring, gray bats migrate to caves used as separate bachelor and maternity colonies (Decher and Choate 1995). Spring migration typically takes place between mid-March to late-May, which may vary based on latitudinal gradients and annual weather patterns (Tuttle 1976a).

Fall migration usually occurs from early-August to mid-November (Tuttle 1976a; Gerdes 2016). Very few studies have attempted to document spring and fall migratory pathways, and little is known about bat movements between summer and winter caves (LaVal et al. 1977; Thomas and Best 2000; Moore et al. 2017). Gray bats show strong philopatry to both summering and wintering sites (Tuttle 1976b, 1979; Tuttle and Kennedy 2005; Martin 2007). Because of their highly specific roost and habitat requirements, only about 5% of available caves are suitable for occupancy by gray bats (Tuttle 1979, Harvey 1994).

Staging, Spring Migration and Summer Roosting

The annual activity period of gray bats is April-October (Best et al. 1997). Adult females emerge from winter hibernating caves (hibernacula) in late March or early April, followed by juveniles of both sexes and adult males. Ovulation in females occurs soon after their emergence from hibernation (Guthrie and Jeffers 1938). Juveniles and adult males typically emerge between mid-April and mid-May (Tuttle 1976b). This period following hibernation, but prior to spring migration, is typically referred to as "staging."

Most gray bats migrate seasonally between their hibernacula and maternity caves. Spring migration is hazardous because gray bats that do not have sufficient fat reserves have difficulties surviving the stress and energy-intensive migration period. Consequently, adult mortality is highest in late March and April (Tuttle and Stevenson 1978; Service 1982).

The distance traveled by an individual colony during spring and fall migrations varies depending on geographic location (Service 1982). Distances migrated are discussed further below in the "Fall Migration, Swarming, Mating and Hibernation" section. Each summer colony occupies a traditional home range that often contains several roosting caves scattered over up to a 70 square km (km^2) (43.5 square mi [mi^2]) area or 11,266 hectares (ha) (27,840 ac), adjacent to a river or reservoir. Colony members are extremely loyal to their colony home range, with males and non-reproductive females dispersing and congregating in smaller groups in more peripheral caves within that area (Tuttle 1976b). However, surveyors have also noted unusual roosting behavior in the form of colonies moving to different roosting areas than they have used in the past (S. Marquardt, Service, pers. comm., April 29, 2015).

The reproductively active females congregate in a single, traditional maternity cave (usually the warmest one available) within the colony home range (Tuttle 1976b). Gestation in gray bats lasts 60 to 70 days, with birth (parturition) occurring in late May or early June. Females give birth to one offspring per clutch (i.e., one per year). The young clings to the mother for about a week, after which they remain in the maternity colony until they are able to fly (Mitchell and Martin 2002). Reproductive females must maintain high body temperatures at their relatively cool roosts, requiring larger amounts of energy, especially during the period of lactation from late

May-early July. During the period of peak demand, when young are roughly 20-30 days old, females sometimes feed continuously for more than seven hours during a single night (Service 1982).

Growth rates of non-volant young are positively correlated with colony size (Tuttle 1975), because increasing numbers of bats clustering together reduce the thermoregulatory cost per individual (Herreid 1963, 1967). Growth rates are also affected positively by higher ambient cave temperatures (Service 1982).

Most young are volant (possess the ability to fly) by late June to mid-July at approximately four weeks of age (at 20-25 days old) (Service 1982; Mitchell and Martin 2002). Where colonies have been reduced in size as a result of roost disturbance, days to volancy (flight) in young are sometimes increased up to 35 days following birth, and in severely reduced colonies, the young sometimes die before learning to fly (Service 1982). For newly volant young, growth rates and survival are inversely proportional to the distance from their roost to the nearest aquatic (river or reservoir) foraging habitat (Tuttle 1976a). Although females continue to nurse their young for a brief period after they learn to fly, juveniles must learn how and where to hunt independently (Tuttle and Stevenson 1982).

Fall Migration, Swarming, Mating and Hibernation
Gray bats often migrate in large groups (Whitaker and Hamilton 1998a). Fall migration for gray bats occurs in approximately the same order as spring emergence, with females departing first (early September) and juveniles leaving last (mid-October). Gray bats have been documented to regularly migrate from 17 to 437 km (10.6 to 271.6 mi) between summer maternity sites and winter hibernacula (Hall and Wilson 1966; Tuttle 1976b), with some individuals moving as much as 689 to775 km (428.1to 481.6 mi) (Tuttle 1976b; Tuttle and Kennedy 2005). They typically reach their hibernacula between August and October, with the females arriving first.

3.1.2. Habitat Characteristics and Use

Gray bats are cave obligate (cave dependent) bats, meaning that with very few exceptions, gray bats live in caves. Gray bat populations disperse during spring to establish sexually segregated colonies (Sherman and Martin 2006). Females form maternity colonies, while males aggregate in bachelor colonies. These bachelor colonies also house yearlings of both sexes (Sasse et al. 2007). Gray bats also utilize a third type of cave, the dispersal cave, which they inhabit only during migration (Brack and LaVal 2006).

Summer Roosting Habitat
Gray bat summer caves are usually located along water bodies and have temperatures ranging from 57 to 77° F (Mitchell and Martin 2002). Summer caves typically contain structural heat traps (including domed ceilings, small chambers, and porous rock surfaces) that capture metabolic heat from clustered gray bats, allowing the nursery populations to succeed. Preferred summer colony caves are within 1 km (approximately 0.6-mi) of a body of water and are rarely more than 4 km (2.5 mi) from a lake or major river (Mitchell and Martin 2002). The average

roosting density of gray bats is 1828 bats/square meter (m^2) (10.8 square feet [ft^2]) (Sherman and Martin 2006).

Categorization of Winter Caves (Hibernacula)
The species' recovery plan (Service 1982) assigned gray bat cave priority levels based on biological significance, location, vulnerability, and consensus of opinion of respondents to a cave survey. Priority levels are defined below:

Priority 1 (P1) Caves – Major hibernacula and the most important maternity colonies.
Priority 2 (P2) Caves – Contain fewer bats but are important for geographic or other reasons.
Priority 3 (P3) Caves – Those that require further investigation.
Priority 4 (P4) Caves – All remaining known caves, most of which are of marginal consequences and require no action.

Foraging Habitat
Gray bats feed in slowly traveling groups in early evening hours during peak insect abundance. However, when insect numbers begin to drop 1.5 to 2 hours after sunset, gray bats become territorial. Depending upon prey abundance, foraging territories may be occupied by one to as many as 15, or more, gray bats. Territories seem to be controlled by reproductive females and are located in the same places and used by the same individuals, year to year (Tuttle and Stevenson 1978; Service 1982).

Gray bats forage over extensive ranges, averaging 12.5 km (7.8 mi) (LaVal et al. 1977). Foraging occurs over streams and reservoirs and in riparian forests adjacent to those waters, where they mostly consume night-flying insects with aquatic larval stages (Best et al. 1997; Brack and LaVal 2006). They typically forage below treetop height, concentrate more over slow-moving water or quiet pools than over fast-moving water, and tend to fly downstream more often than upstream, suggesting a potential preference to forage over wider aquatic areas (more typical of lower stream reaches) (LaVal et al. 1977).

3.1.3. Population Dynamics/Status and Distribution

The gray bat is a monotypic species that is known to occur within limestone karst area in 13 southeastern states in the U.S., including Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, North Carolina, Missouri, Oklahoma, Tennessee, and Virginia. The species' range has expanded in some of these states (e.g., Georgia, Indiana, Kansas, and North Carolina), and they have been documented using many caves where they were not previously found prior to completion of the 1982 Recovery Plan (Service 1982, 2009). Alabama, Arkansas, Kentucky, Missouri, and Tennessee are considered to be the states within the primary range of the gray bat and where approximately 95% of the species hibernates in 17 caves, with smaller populations found in adjacent states (Brack et al. 1984; Harvey 1994; Harvey et al. 2005; Mitchell 1998; Martin 2007).

Overall, gray bat numbers have increased significantly in many areas (Service 2009). Rangewide, gray bats have been documented in a few hundred caves (Service 1982). Martin (2007) reported nearly 500,000 gray bats at eight hibernacula, where there had only been about

25,000 recorded historically. In other areas (e.g., Florida) the species has declined significantly at both hibernacula and maternity sites (Service 2009). There is one record of a gray bat hibernating in Pendleton County, West Virginia.

In 2022, Tennessee Wildlife Resources Agency (TWRA) estimated 1,390,861 gray bats in four P1 hibernacula; between 2013 and 2022, the populations have increased by 66% (TWRA 2022).

Maternity Colonies
While wide population fluctuations of gray bat numbers have been documented at many maternity sites across the species' range, there have been significant population increases in some of the major hibernacula (Service 2009). The total number of maternity colonies that exist rangewide is unknown. The *Gray Bat Recovery Plan* (Service 1982) identified a total of 29 P1 maternity colonies in Alabama (6), Arkansas (2), Florida (3), Kentucky (3), Illinois (1), Missouri (7), Oklahoma (1) and Tennessee (6). Past surveys, conducted at the caves inhabited by these 29 maternity colonies, indicate 48% of the bats (in 14 of the maternity caves) are increasing or stable (Service 2009).

3.1.4. Conservation Needs and Threats to Gray Bat

The conservation needs and threats to gray bat are discussed in detail in the recovery plan (Service 1982) and most recent 5-year review (Service 2009). Tuttle (1979), Service (1982), Mitchell (1998), Shapiro and Hohmann (2005), and Martin (2007) listed multiple factors that contributed to the initial decline of gray bats, including human disturbance, natural flooding, impoundment of waterways, and contamination from pesticides.

Human Disturbance, Natural and Man-made Flooding
Although human disturbance remains the number one reason for the continued decline of gray bat populations at some sites (Tuttle 1977, 1979; Rabinowitz and Tuttle 1982; Service 1982; Mitchell 1998; Martin et al. 2000; Shapiro and Hohmann 2005; Martin 2007; Elliott 2008), natural and man-made flooding remains a secondary threat to populations at other sites. Cave flooding is a particular concern, as gray bats retreat further back into caves and roost over water to avoid disruption from humans. Flash flooding in caves can also adversely affect gray bats by damaging gates at cave entrances that were constructed to protect roosting bats (Elliott 2008).

Contamination
Although pesticide contamination has been well-documented in some populations of gray bats, Clark et al. (1978, 1980), Clawson and Clark (1989), Clawson (1991), and Elliott (2008) suggested that increased numbers of gray bats in Missouri coincided with reduced use of pesticides. Sasse (2005) noted that while gray bats at four maternity caves in Arkansas remained exposed to pesticide residues, they were at lower levels than previously reported by others (Clark et al. 1988; Clawson and Clark 1989; Clawson 1991). Nonetheless, he recommended that there should be continued periodic monitoring of pesticide residues in guano and carcasses of dead bats.

Insecticide use historically had a detrimental impact on gray bats (Clark et al. 1978, 1988), though many of the toxic substances are now banned from the market. The longevity, high

metabolic rate, and insectivorous diet of bats increases their likelihood of exposure to bioaccumulating chemicals in the environment. While modern pesticides (e.g., organophosphates, neonicotinoids, pyrethroids, carbonates) aren't expected to bioaccumulate in tissues, they remain a concern, are highly toxic, and may kill bats from direct exposure (Shapiro and Hohmann 2005). The presence of other contaminants of concern that can bioaccumulate (e.g., pharmaceuticals, flame retardants) has also been documented in bats (Secord et al. 2015), although additional research is needed to understand impacts.

Siltation and nutrient loading of waterways where bats forage and drink may negatively affect the species. The adult aquatic insects (mayflies [Ephemeroptera], stoneflies [Plecoptera], and caddisflies [Trichoptera]), which largely comprise the gray bat's diet, are especially susceptible to degraded water quality. Any substantial declines in the populations of these insects may have a detrimental effect on gray bat populations as well (Service 1982). Tuttle (1979) presented a correlation between a decline in gray bat numbers and an increase in sedimentation in several Alabama and Tennessee waterways.

Climate Change

Climate change could have a significant impact on gray bats. Bogan (2003) predicted that climate changes could impact bats by adversely affecting their food supply or the internal roosting temperature of caves. In Australia, Hughes (2003) demonstrated that the ranges of different species of flying foxes (*Pteroptus spp*.) had shifted due to recent rises in ambient temperature on that continent. Humphries et al. (2002) investigated the hibernation energetics of little brown bat (*Myotis lucifugus*) and predicted that global warming would cause climate-mediated energetic constraints on the distribution of it and other hibernating bats. It is projected that a rise in ambient temperature could make traditional and currently occupied hibernacula and maternity sites unsuitable for roosting gray bats and cause a shift in the species' range northward. This could adversely affect the species' food supply or affect the ability of bats to adequately deposit important fat reserves which are critical for gray bats to survive the hibernation season.

White-nose Syndrome

In 2012, the Service confirmed the first instance of white-nose syndrome (WNS) in gray bats (Service 2012). The full impact of WNS on the overall gray bat population has not been determined. While it seems plausible that WNS would pose a serious threat to the gray bat, a species where individuals overwinter in a few high-density hibernacula, to date it appears that the disease TVAs not spread through gray bat colonies as would seem logical, nor be as substantial a threat to the species as initially suspected (TWRA 2014). As of spring 2017, the species had yet to experience any WNS-related declines and their populations appeared to have remained stable within Tennessee (Bernard et al. 2017) and Virginia (Powers et al. 2016). Several behavioral traits, such as preferred microclimates within hibernacula and sustained activity and foraging throughout winter (Bernard and McCracken 2017) may enable this species to prevent or minimize the colonization of *Pseudogymnoascus destructans* (Pd) during torpor.

3.2. Tree-roosting Bats

Indiana, northern long-eared, and tricolored bats are all tree-roosting, insectivorous bats that exhibit biological similarities (see table in Appendix A summarizing and comparing species-specific foraging and roosting requirements during the non-hibernation period). This section provides general biological information about these bat species that is applicable to all three. This information, in combination with the species-specific information that follows, provides the background for analyses in later sections of this BO.

Life Histories and Habitat

The three tree-roosting bats addressed in this consultation have very similar life histories. These bats are migratory and hibernate in caves and mines in the winter and spend summers in forested areas. Their key annual life cycle stages and timing of these stages are listed in Table 3.

Table 3. Key Life Cycle Stages of Tree-Roosting Bats Covered Under this Opinion.

Hibernation	Staging and Migration	Summer Occupancy	Pup Season	Fall Migration and Swarming
Nov 16-Mar 31	Apr 1–May 14	Apr 1-Sept 30	May 15-July 31	Aug 16-Nov 15

Special Notes on Summer Home Ranges and Numbers of Tree-roosting Bats

Summer forest habitats are used to give birth and rear pups, and each species forms maternity colonies of varying sizes; although, tricolored bats may use buildings and other structures for maternity colonies to some degree. Males may or may not be sympatric with female maternity colonies depending upon the species. Both sexes roost primarily in trees and will migrate to their same summer areas (with the exception of Indiana bat males) with high site fidelity to establish seasonal residency within a distinct home range.

Summer home ranges include roosting, foraging and drinking areas, and travel pathways between those habitats for a duration of several months. There is a very high degree of variability in home range estimates. Home ranges do not have an exact definition and may be estimated using various distance measurements. Even the minimum roosting and foraging areas or areas with relatively more concentrated movements (identified via studies) vary greatly among studies. Home range size also varies by time of year. For example, lactating females with non-volant pups have a much smaller home range than at other times of year. Home range size is likely to vary by landscape availability of essential habitats and many other environmental factors.

3.2.1. Indiana Bat

The Indiana bat is a tree-roosting, insectivorous, migratory species that hibernates in caves and mines during winter and forages in wooded areas, particularly riparian areas (LaVal et al. 1977), during summer. Foraging activity and travel are mostly nocturnal.

The species' average life span is five–ten years, but recapture of banded individuals has documented Indiana bats up to 15 years old (Humphrey and Cope 1977). Hall (1962), Myers (1964), and LaVal and LaVal (1980) report sex ratios of 1:1 for the Indiana bat.

The Indiana bat generally hibernates from mid-fall to mid-spring each year; however, the timing varies with latitude and weather conditions (Service 2007). The area around a winter hibernaculum serves as the location for the spring emergence from hibernation. Upon emerging from hibernation, Indiana bats roost in trees and forage in habitats similar to their summer habitats for a few days or weeks within 5 mi of their hibernaculum (spring staging).

Males and non-reproductive females may remain near hibernacula or migrate immediately to summer habitat some distance from their hibernaculum. Female Indiana bats commonly migrate hundreds of miles from their hibernacula (Service 2007). Long-distance migration is energetically demanding. Spring migration occurs when fat reserves have become depleted from hibernation, prey abundance is low, and females are pregnant; therefore, spring migration is possibly the most stressful period in the Indiana bat's life cycle. 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 (Humphrey et al., 1977). Pups are weaned from nursing shortly after becoming volant in mid- to late-July. Fall migration occurs following months of summer foraging and building fat reserves from mid-August to mid-October. Upon arriving at their winter hibernaculum from summer habitats, the species exhibits swarming behavior in the vicinity of the hibernaculum. Indiana bats roost in trees and forage in habitats that are similar to their summer habitats, typically within five miles of their hibernaculum. Fall 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 Indiana bat's life history that are most relevant to this consultation.

3.2.1.1. Summer Habitat and Ecology

Summer habitats for Indiana 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, pioneer 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. Indiana bats tend to forage over hydric habitats and open water (Bergeson et al. 2013).

Wing morphology of the species suggest that it is adapted to moving in cluttered habitats. Many species of bats, including the Indiana bat, 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 Indiana bats appear to remain at or near their 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. Males may occasionally roost in caves. Males exhibit summer site fidelity and have been recaptured in foraging areas from prior years (Service 2007). Male Indiana bats generally remain near hibernacula and, therefore, are not present in significant numbers in the summer habitats utilized by maternity colonies.

3.2.1.2. Maternity Colonies and Roosts

Following a variable-length period of foraging near hibernacula in the spring, females seek suitable habitat for maternity colonies, which appears essential for reproductive success. Indiana bat maternity colonies are generally large, but most contain fewer than 100 adult females (Service 2007). Whitaker and Brack (2002) found that an Indiana bat maternity colony in Indiana averaged 50 to 80 adult females. The mean maximum emergence count from 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).

A post-WNS analysis of colony size for Indiana bat has not been conducted. Assuming population reduction overall would result in a smaller maternity colony size, we use the lower end of the range of estimated females and predict Indiana bat maternity colony size is 60 females.

The species exhibits a degree of inter-annual fidelity to particular roost trees and/or maternity areas (Humphrey et al. 1977; Gardner et al. 1991a, 1991b; Gardner et al. 1996; Callahan et al. 1997). Maternity colonies use networks of roost trees often centered around one or more primary roost trees. Indiana bat maternity colonies use a minimum of 8–25 roost trees per season (Callahan et al. 1997; Kurta et al. 2002).

Indiana bats are known to use a wide variety of tree species ≥ 5 inches diameter at base height (DBH) that have cracks, crevices, or peeling bark for roost trees. A typical Indiana bat primary roost is located under the exfoliating bark of a dead ash (*Fraxinus spp*.), elm (*Ulmus spp*.), hickory (*Carya spp*.), maple (*Acer spp*.), oak (*Quercus spp*.), or poplar (*Populus spp*.), but any tree that retains large, thick slabs of peeling bark is potentially suitable. Primary roosts are usually located in trees that are in early-to-mid stages of decay.

In a study by O'Keefe and Loeb (2017) documenting southern Appalachian roost trees, including ones on the CNF, Indiana bats usually roosted in small groups and were relatively nomadic. Further, bats primarily used yellow pine snags, which is a departure from what has been observed for Indiana bat maternity colonies in the Midwest and Northeast. Bats likely selected

for pines because pine snags were more available than hardwoods snags and because they provide optimal roosting structure (tall, solar-exposed) for Indiana bats in the southern Appalachian Mountains.

Appalachian Indiana bats also differed from Midwest studies by having lower roost fidelity and smaller colony sizes. However, the low roost fidelity, with individual bats using each tree for only two to three days in total, may also relate to high roost availability or to the fact that bats were using ephemeral roost trees and needed to explore alternative roost options (Timpone et al. 2010). In the southern Appalachians, pine snag roosts only lasted for one, or rarely two, maternity seasons (Britzke et al. 2003; O'Keefe and Loeb 2017) and sometimes, lost all their bark in one season. In contrast, in highly fragmented forests in the Midwest, Indiana bat maternity colonies use only one or a few primary roosts for the bulk of the maternity season (Callahan et al. 1997) and for multiple seasons. However, bats may prefer to switch roosts regularly, as this should diminish parasite loads and reduce the risk of predation (Lewis 1995). Greater availability of trees in the southern Appalachians may facilitate these switches.

Although colony sizes were relatively large (75–126 bats) on occasion, data suggest that usually <25 bats used a particular roost and for only a few days on the CNF (O'Keefe and Loeb 2017). Therefore, for purposes of this programmatic BO, we use 25 adult Indiana bat females per colony as the basis for estimating the number of Indiana bat colonies on the summer landscape. We assume that most adult females successfully raise one pup to volancy. For each colony, we further assume the local Indiana bat population is comprised of 25 adult females, 25 sympatric adult males, and 25 juveniles following parturition.

3.2.1.3. Summer Home Range and Numbers

Indiana bats are migratory species that establish seasonal residency within a distinct home range. Their summer home range includes roosting, foraging, and drinking areas and travel pathways between those habitats for a duration of several months. Murray and Kurta (2004) recorded movements of females at a maternity site in Michigan that ranged from 0.5-4.2 km, with a mean of 2.4 km. It is evident that bats nightly travel covers further distances over more area than their areas of concentration, which can be considered their home range.

Home range size estimates for Indiana bat vary greatly among studies. Males summer home range centers around their hibernacula. MacGregor et al. (1999) found that home range size for males ranged from 10 to 568 ha (25-1,404 ac). Other studies using radio telemetry tagging and various analysis methods (i.e., mean convex polygons, 95% adaptive kernel, 95% fixed kernel) have estimated average individual Indiana bat summer home range sizes of 205–828 ac (Menzel et al. 2005; Sparks et al. 2005; Watrous et al. 2006; Jachowski et al. 2014; Kniowski and Gehrt 2014). Jachowski et al. (2014) found home range size averaged 101 ha (249 ac) for four males and 145 ha (358 ac) for eight females. Menzel et al. (2005) found no significant difference in male and female home range size. Womack et al. (2013) found Missouri home ranges averaged 1,137 ha (2,809 ac) and lactating and pregnant females did not significantly differ in home range. Bergeson et al. (2013) analyzed a mean of 375 ha (927 ac) and 285 ha (704 ac) foraging range for females using two different analysis techniques.

From the literature review, we assume males are not sympatric with females and center their summer home ranges around their hibernacula and that male and female summer home range sizes are not significantly different. We also assume summer home ranges can be as small as 25 ac and as large as 2,809 ac, with an average of 739 ac.

We have some knowledge of how many bats may occur within a maternity colony home range and a male colony home range.

- For Indiana bat males, given a sex ratio of 1:1, we would expect that half (approximately 50%) of the hibernaculum population would occur within an area up to 1,404 ac encompassing the hibernaculum or within a radius of 1,400 m (4,793 ft) during the summer occupancy period of April 1–September 30.
- For females, we would expect 60 females (Section 3.1.5.2) in occupied suitable summer habitat with a home range requirement of up to 2,809 ac but averaging 739 ac from April 1 through September 30.
- For juveniles, we would expect one pup per female within the maternity colony..

3.2.1.4. Population Dynamics/Status and Distribution

Indiana bats are concentrated in relatively few hibernacula during the winter. Biennial winter surveys in 2024 estimated a total of 631,786 Indiana bats rangewide within the ten largest hibernacula (Service 2024a). Four states accounted for 95.8% of the total population estimate: Missouri (37.6%), Indiana (37.1%), Illinois (13.2%), and Kentucky (7.9%).

The 2024 rangewide population estimate of 631,786 Indiana bats is a 7.7% increase from the 2022 estimate of 583,185 bats (Figure 3-1). The biennial population estimates had been increasing from 2001 to 2007, suggesting that the species' long-term decline had been reversed (Service 2024a). The decline since 2007 is likely attributable to WNS (see Section 3.1.8), especially in the Northeast RU.

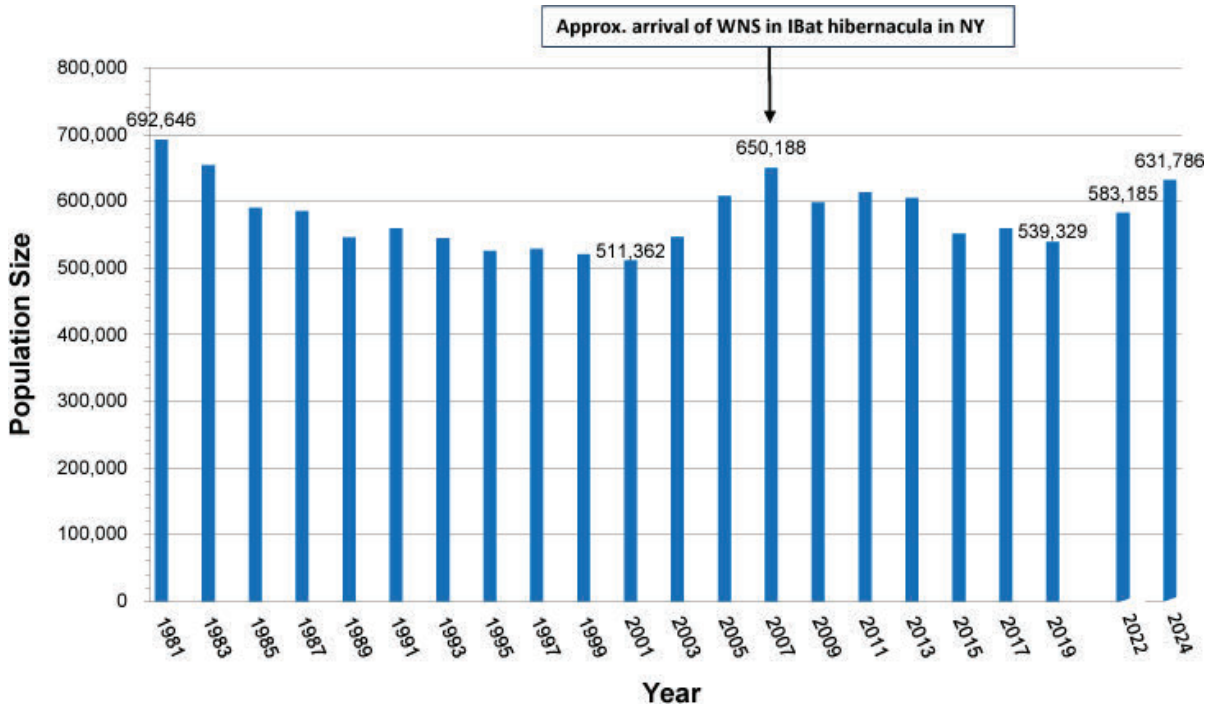

Figure 3-1. Indiana bat range-wide population estimates from 1981–2024 (source: Service 2024b)**.**

3.2.2. Northern Long-Eared Bat

Like the Indiana bat, the northern long-eared bat is an insectivorous migratory species that hibernates in caves and mines during winter and forages at night in wooded areas during summer.

The age of the oldest documented northern long-eared bat is 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 northern long-eared bat to the juvenile stage. Northern long-eared bat sex ratios at the population level are not reported in the literature, but as a species similar to the Indiana bat in many other respects, we assume a 1:1 ratio is likely.

The northern long-eared bat spring migration period typically spans mid-March to mid-May (Easterla 1968; Caire et al. 1979; Whitaker and Mumford 2009). Females depart shortly after emerging from hibernation and are pregnant when they reach their summer maternity area. Young are born between mid-May and early-June, with nursing continuing until weaning, which is shortly after young become volant in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

Northern long-eared bats are not considered to be a long-distance migrant (typically 64 to 80 km [40 to 50 mi]). Migration is energetically demanding for the northern long-eared bat, particularly in the spring when their fat reserves and food supplies are low, and females are pregnant. Males and non-reproductive females may summer near hibernacula or migrate to summer habitat some

distance from their hibernaculum. Males tend to roost singly and females form maternity colonies in cavities of trees (Foster and Kurta 1999; Broders and Forbes 2004).

Young are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts three to five weeks, with pups becoming volant between early July and early August.

3.2.2.1. Summer Habitat and Ecology

Suitable summer habitat for the northern long-eared bat consist of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

While some studies have found the northern long-eared bat associated with upland forests and mature upland forests (Caceres and Pybus 1997), a study on the Cherokee National Forest (CNF) in eastern Tennessee (Rojas et al. 2018) suggest the species is more likely to occupy less rugged sites at lower elevations. The CNF study found sites with a high probability of occupancy (> 0.90) were in forests ranging from 26–120 years in age (mean = 80 years) with the highest occupancy rates occurring in stands with a mix of hardwoods and pines (*Pinus spp*.), primarily oaks, hickory, yellow poplar (*Liriodendron tulipifera*), and white pine (*Pinus strobus*).

Male and non-reproductive female summer roost sites may also include cooler locations, including caves and mines (Barbour and Davis 1969; Amelon and Burhans 2006). It is uncertain if the sex ratio of females to sympatric males in summer habitat is equal; however, an overlap of 90.4% in northern long-eared bat adult male home range and maternity colony home range was observed in Kentucky (Service 2018).

3.2.2.2. Maternity Colonies and Roosts

Following a variable-length period of foraging near hibernacula in spring, females seek suitable habitat for maternity colonies, which appears essential for reproductive success. Males are also occasionally found with females in northern long-eared bat maternity colonies (Service 2022). Based on an analysis of the post-WNS summer adult population size of northern long-eared bat in 30 states, the size of northern long-eared bat maternity colonies varies from 20-45 females (Service 2016). Because the Action Area lies entirely within Tennessee, for purposes of this programmatic BO, we use 20 adult northern long-eared bat females per maternity colony, the number identified for Tennessee included in this analysis. We further assume that the local population is comprised of 20 adult females, 20 sympatric adult males, and 20 juveniles following parturition.

Female northern long-eared bats show inter-annual fidelity to roost trees and/or maternity areas. They use networks of roost trees often centered around one or more central-node roost trees (Johnson et al. 2012) with members of a colony exhibiting fission-fusion behavior (Garroway

and Broders 2007), where members frequently coalesce to form a group (fusion), but composition of the group is in flux, with individuals frequently departing to be solitary or to form smaller groups (fission) before returning to the main unit (Barclay and Kurta 2007). As part of this behavior, northern long-eared bats switch tree roosts often, typically every two to three days (Sasse and Pekins 1996; Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). These bat roost networks also include multiple, alternate roost trees. The minimum summer roost area (area encompassing all known roost locations) for individual female northern long-eared bats ranges between 13 and 65 ac, with most studies finding the summer roost area to be leaning toward the smaller acreage of that range (Owen et al. 2003; Broders et al. 2006; Badin 2014). Bats using familiar foraging and roosting areas are thought to benefit from decreased susceptibility to predators, increased foraging efficiency, and the ability to switch rooCRN -1 in case of emergencies or alterations surrounding the original roost (Gumbert et al. 2002).

Northern long-eared bats roost in cavities, underneath bark, crevices, or hollows of both live and dead trees or snags (typically ≥ 3 in DBH). They are known to use a wider variety of roost types than Indiana bats, using tree species based on presence of cavities, crevices, or peeling bark. Northern long-eared bats have also been found roosting in structures like barns and sheds and under bridges (Krochmal and Sparks 2007; Benedict and Howell 2008; Krochmal and Sparks 2007; Timpone et al. 2010).

3.2.2.3. Summer Home Range and Numbers

Studies of northern long-eared bat home range are highly variable, and it is uncertain if male northern long-eared bat summer home range size is larger or smaller than females. Foster and Kurta (1999) studied Indiana bats at a site also occupied by northern long-eared bats and found that northern long-eared bats moved greater distances (anywhere from 6 to 2,000 m) between roosts. Timpone et al. (2010) reported the mean distance between capture sites and rooCRN -1 was 1,700 m. Fill et al. (2021) recorded a male traveled 2,700 m and a female traveled 300 m between capture site and roost. Another study found foraging areas can be larger for females than males (Broders et al. 2006) with males traveling approximately 500 m for foraging and roosting and females traveling 2000 m; these distances were centered around roosting and foraging areas.

From data reported by Broders et al. (2006), we estimate home ranges for males as approximately 14 ha (35 ac) and 54 ha (134 ac) for females. Henderson and Broders (2008) estimated the distance moved for foraging females was 1,100 m, whereas the total roost area covered was 31 ha (77 ac). Owen et al. (2003) determined a mean maternity home range size of 65 ha (161 ac), and Gorman et al. (2022) estimated a minimum roosting area for a maternity colony at 88.4 ha (218 ac). The *Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities from Take Prohibitions* (Service 2016) indicates 1,000 ac as the area a northern long-eared bat colony utilizes. The Service assumed a 131 ha (325 ac) home range size for northern long-eared bat based on the average from reported studies (Service 2024b); however, the Service did not provide sources for its information.

From a literature review, we assume males are mostly sympatric with females and that male and female summer home range sizes are not significantly different. We also assume summer home

ranges can be as small as 35 ac and as large as 5,659 ac (2,700 m radius), with an average of 279 ac.

While the literature suggests differences in summer home range size between male and female northern long-eared bats, they may share a large fraction of their foraging habitat within the occupied forested landscape. We have found no information about the degree of spatial overlap between northern long-eared bat maternity colonies. However, an analysis of mist net survey data in Kentucky indicates that there is substantial overlap in the summer home range of reproductive females and that of males and non-reproductive females (Service 2016). Of 909 capture locations for male and non-reproductive female bats of the species, only 87 (9.57%) did not have reproductively active females and were more than 3 mi from captures of reproductive females (Service 2018). This data suggests a 90.43% (100 - 9.57) overlap between the home range of individuals belonging to maternity colonies and other individuals (as previously mentioned under Summer Habitat and Ecology), which we adopt for use in this BO.

We have some knowledge of how many bats may occur within a maternity colony home range, with 90.4% of males co-located with maternity colonies and 9.6% of males and non-reproductive females roosting singly.

- For males, we expect a sex ratio of 1 male:1 reproductive female in 90.4% of occupied suitable summer habitat and a sex ratio of 1 male:1 non-reproductive female in 9.6% of occupied suitable summer habitat. Both areas require a home range of up to 5,659 ac, but 279 ac on average from April 1-September 30.
- For females, we would expect 20 females (Section 3.2.2.2) per maternity colony from April 1 through September 30.
- For juveniles, we would expect 1 pup per female within the maternity colony.

3.2.2.4. Population Dynamics/Status and Distribution

The range of the northern long-eared bat extends across much of the eastern and north central U.S. (37 states), and eight Canadian provinces, as far west as the southern Yukon Territory and eastern British Columbia (Figure 3.2). Most historical records of northern long-eared bats 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 1998b). Prior to the introduction of WNS, the northern long-eared bat was considered common in the northern portion of its range, uncommon in the South, and rare in the West (Amelon and Burhans 2006). The northern long-eared bat 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).

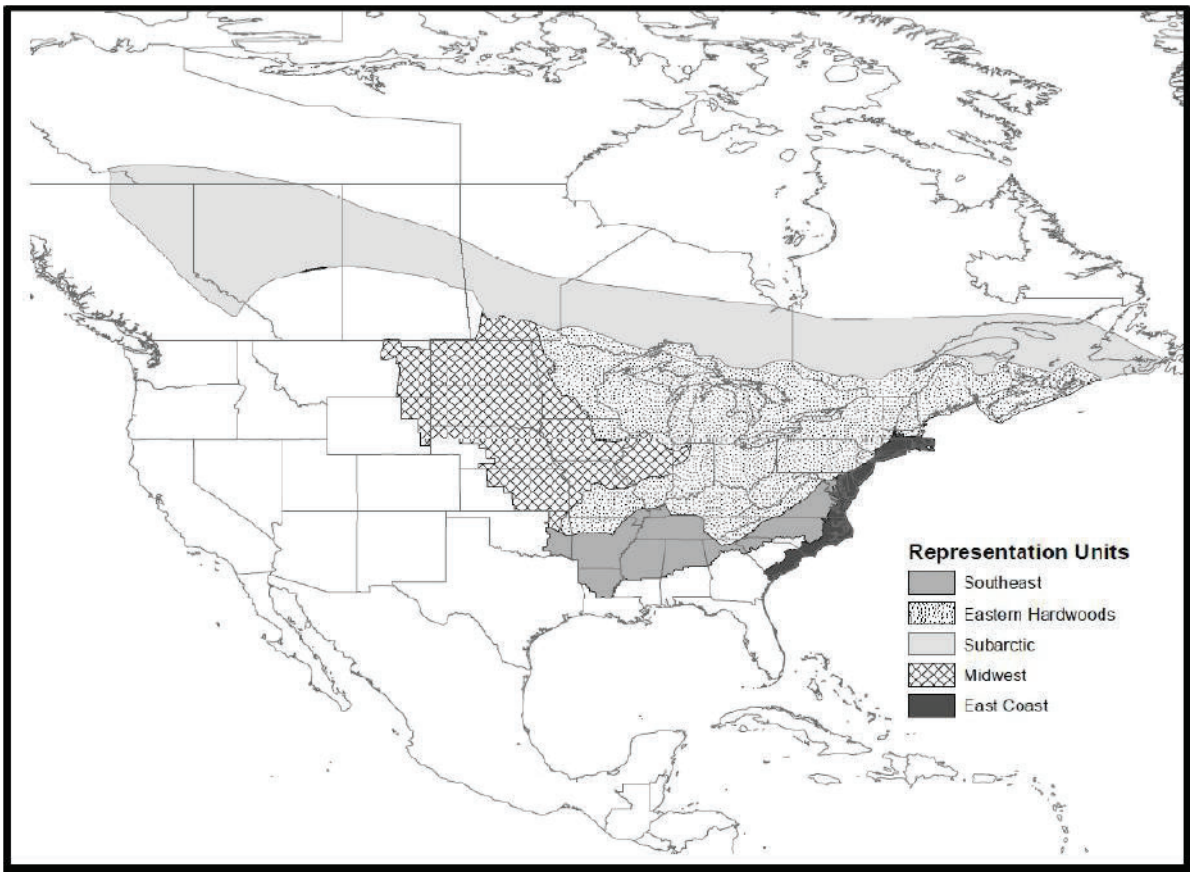

Figure 3-1. Range of the Northern Long-eared Bat.

According to the recently completed species status assessment (SSA) for the species (Service 2022), available evidence indicates northern long-eared bat 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 the northern long-eared bat 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 were also 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 northern long-eared bat summer range (Service 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 RU (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 (Service 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 WNS. Collectively, these data indicate the northern long-eared bat has declined and given the declining trajectories, will continue to decline (Service 2022).

Given the dramatic declines across its range and current low numbers, we do not have reasonable certainty that northern long-eared bat is currently present within suitable habitat or pre-WNS, historically documented occurrence areas. Therefore, the Service has established post-WNS years ranging from 2013 to 2022 for individual states, depending upon when population bottlenecks occurred as a result of WNS in each state. These post-WNS years represent the year after the population bottleneck in areas with historically documented occurrences that have reasonable certainty of continued northern long-eared bat presence from the date of the bottleneck to present. The Service has determined 2015 to be the post-WNS year for Tennessee based on state-wide winter survey data (TWRA 2022).

3.2.3. Tricolored Bat

The tricolored bat is an insectivorous, migratory species that hibernates in caves and mines during winter and forages at night during summer. It is one of the smallest bats in eastern North summer America and is distinguished by its unique tricolored fur that appears dark at the base, lighter in the middle, and dark at the tip (Barbour and Davis 1969).

The typical lifespan of a tricolored bat is thought to be four to eight years in the wild (Fujita and Kunz 1984; Nowak 1991), with higher probability of survival for males and relatively high juvenile mortality (Davis 1966). A male holds the maximum reported longevity record of at least 14.8 years (recaptured after it was originally banded) (Walley and Jarvis 1971).

Between mid-August and mid-October, tricolored bats migrate to hibernation sites from summer roosting areas where they converge at cave and mine entrances to swarm and mate (Service 2021). However, mating has also been observed in late winter and in spring (Vincent and Whitaker 2007; Dodd and Johnson 2012). Adult females store sperm in their uterus during the winter and fertilization occurs soon after spring emergence from hibernation (Guthrie 1933).

Tricolored bat hibernate from November to mid-March in more caves and abandoned mines than any other cave-hibernating bat species in eastern North America (Service 2021). Tricolored bat disperse from winter hibernacula and migrate to summer roosting habitat from mid-March to mid-May. Reported migration distances to summer habitats vary from 44 km (27 mi) to a maximum straight-line distance of 243 km (151 mi) for a female that migrated from her winter hibernaculum in southern Tennessee to a summer roost in Georgia (Samoray et al. 2019).

Little is known about the natural mortalities of this species. Most predation is presumably by chance. The chief cause of natural mortality is probably young falling from the maternity roost (Service 2017b). There are two records of tricolored bats being attacked by hoary bats (*Lasiurus cinereus*) (Whitaker and Hamilton 1998b).

3.2.3.1. Summer Habitat and Ecology

Tricolored bats prefer landscapes with greater forest area, forest aggregation, and tree corridors and are less abundant among urban development (Duchamp and Swihart 2009; Farrow and Broders 2011). They typically forage within a 5-mi radius of their roosting site (Kath 2022) at treetop level or higher and often over waterbodies (Davis and Mumford 1962; Barbour and Davis 1969; Schmidly 1991), on small, flying insects (Service 2021).

Roosts are often located in mature forests within riparian corridors (Perry and Thill 2007a; O'Keefe 2009), far from roads (Perry et al. 2008). The species prefers to roost among clusters of live and dead leaves on live or recently dead deciduous hardwood trees (Veilleux et al. 2003; Perry and Thill 2007a; Thames 2020), among pine needles (Perry and Thill 2007a), and in eastern red cedar (*Juniperus virginiana*) (Thames 2020). They also roost in Spanish moss (*Tillandsia usneoides*) and bony beard lichen (*Usnea trichodea*) in the southern and northern portions of their range, respectively (Davis and Mumford 1962; Poissant 2009; Poissant et al. 2010) and in buildings, under bridges and use other man-made structures, but rarely roost within caves (Fujita and Kunz 1984; Veilleux et al. 2003; Service 2021).

Limited research suggeCRN -1 the minimum summer roost area (not including foraging area) for individual adult female tricolored bat ranges between 0.1 and 2.2 ha (0.25 and 5.4 ac) (Veilleux and Veilleux 2004). A study conducted by Schaefer (2017) in western Kentucky and Tennessee found that tricolored bats used roost trees within relatively small geographic areas, with 482 meters (m) (1,581 ft) being the maximum distance moved between successive rooCRN -1 and 86 m (282 ft) being the average distance moved; bats remained within 2.5 km (1.6 mi) of their original capture site.

Female tricolored bats exhibit high site fidelity, returning every year to the same summer roosting locations (Allen 1921; Veilleux and Veilleux 2004), and switch roost trees regularly (e.g., between 1.2 days and 7 days) (Veilleux and Veilleux 2004; Quinn and Broders 2007; Poissant et al. 2010), while males roost singly (Perry and Thill 2007a; Poissant et al. 2010).

3.2.3.2. Maternity Colonies and Roosts

Tricolored bat maternity colonies are generally small, with groupings sometimes consisting of only a single female and her two pups. In Indiana, maternity colonies averaged 4.4 ± 2.4 bats (range: 1–8) (Veilluex and Veilluex 2004). In Arkansas, maternity colonies (adults and pups) averaged 6.9 ±1.5 (range: 3–13). In Wisconsin, maternity colonies averaged 7.25 bats (range: 1–15 bats) (Wisconsin Department of Natural Resources [DNR] 2022). In Nova Scotia, maternity colonies averaged 10 bats (range: 1–18) (Poissant 2009). In South Carolina, 3–4 tricolored bats emerged from several rooCRN -1 where pregnant or lactating females were roosting (Leput 2004). As the maternity season progresses, colony sizes begin to fluctuate, females begin to

disband soon after young became volant, and post-lactating females roost singly for the remainder of the summer (Veilluex and Veilluex 2004). In this BO, we used the average of the above averages and estimate maternity colony size as three females and six pups because females typically give birth to two pups between May and July (Allen 1921; Barbour and Davis 1969; Cope and Humphrey 1972).

Males are solitary and do not form colonies (Hofmann 2008; Fraser et al. 2012). Young begin to fly at three weeks of age and achieve flight and foraging ability at four weeks (Lane 1946; Whitaker 1998). Adults often abandon maternity rooCRN -1 soon after weaning, but young remain longer (Whitaker 1998).

3.2.3.3. Summer Home Range and Numbers

While little is known about tricolored bat home range and daily movement, and more research is needed (Wisconsin DNR 2022), a few studies have been carried out to identify home range sizes for the species that included primary foraging locations. A summer foraging range and diurnal roost selection study of tricolored bats in Franklin County, Tennessee (Thames 2020) found the mean foraging area for seven adult male tricolored bats was 2,350 ha (5,807 ac), ranging from 234 to 9,655 ha (578 to 23,858 ac) and 364 ha (900 ac) for a single, non-reproductive female (Thames 2020). The home range (roosting and foraging area) for a single male tricolored bat in central Indiana was 546 ha (1,349 acres) (Helms 2010). The average male home range size of these studies is 3,578 ac.

Home range size of females can be much smaller than males. In Wisconsin, home ranges for two lactating female tricolored bats roosting in trees were 420 ac (170 ha) and 642 ac (260 ha) (Wisconsin DNR 2018). The mean home range for pregnant (n=4), lactating (n=5), or post-lactating (n=1) female tricolored bats in a significantly forest fragmented landscape in central Indiana was 765 ac (range: 168–1,515 ac) (309 ha; range: 68–613 ha) (Helms 2010). Compared to females roosting in tree roosts on CRN -1, home ranges for four pregnant or lactating female tricolored bats roosting in structures (i.e., barn, bridge) in Wisconsin were smaller (mean: 103 ac; range: 40–163 ac [42 ha; 16–66 ha]) (Wisconsin DNR 2017). The average of these studies is 483 ac for reproductive females.

During summer, male tricolored bats typically roost alone but utilize similar summer roosting habitat as females. A literature review found evidence of highly skewed sex ratios, indicating that males and females separate during pup-rearing season (McCoshum et al. 2023). For the purposes of this BO, we use assume males and females use similar summer habitat but are not sympatric.

We have some knowledge of how many bats may occur within a maternity colony home range. Males are not sympatric with females but occupy similar summer roosting habitats.

- For males, we expect a sex ratio of 1 male:0 females in 50% of occupied suitable summer habitat, requiring 3,578 ac of home range, and 0 males to 1 female in the other 50%, requiring 483 ac of home range, from April 1-September 30.
- For females, we expect three females (Section 3.2.3.2) per tree-roosting maternity colony from April 1-September 30 in 50% of occupied suitable summer habitat.

- For juveniles, we expect two pups per female within the maternity colony..

3.2.3.4. Population Dynamics/Status and Distribution

The range of the tricolored bat encompasses 39 states in the eastern U.S. and in recent decades has expanded westward and into the Great Lakes basin, four Canadian provinces, Guatemala, Honduras, Belize, Nicaragua, and Mexico (Service 2021). The species recent U.S. westward expansion (Geluso et al. 2005; Adams et al. 2018; Hanttula and Valdez 2021) and expansion into the Great Lakes basin (Kurta et al. 2007; Slider and Kurta 2011) is due to increases in suitable summer habitat (e.g., forested areas) and suitable winter roosting sites (e.g., abandoned mines and other human-made structures) (Benedict et al. 2000; Geluso et al. 2005; Slider and Kurta 2011). A detailed description of the current range, including the species' three RPUs (Northern, Eastern, and Southern), and population dynamics is available in the SSA (Service 2021) and is hereby incorporated by reference.

Prior to 2006 (i.e., before WNS was first documented), tricolored bat was highly abundant and widespread, with over 140,000 bats observed in 1,951 known hibernacula during winter surveys across >405 million ha (one billion acres) in 34 states and one Canadian province (Service 2021). Cheng et al. (2022) and Wiens et al. (2022) found that historically tricolored bat numbers varied temporally and spatially, but abundance and occurrence on the landscape generally had been stable.

More recently, available evidence indicates tricolored bat abundance has and will continue to decline substantially over the next ten years under current conditions (Service 2021). Rangewide winter abundance has declined by 52%, and the number of extant winter colonies is down 29% since 2000, with a noticeable shift towards smaller colony sizes. The magnitude of winter declines, although widespread, varies spatially. Abundance has declined 89%, 57%, and 24% in the Eastern RPU, Northern RPU, and Southern RPU, respectively. Whereas the number of winter colonies (i.e., occupied hibernacula) have also decreased 46% in the Eastern, 24% in the Northern, and 34% in the Southern RPUs. Lastly, across all RPUs, the potential for population growth is currently undetectable (Service 2021). Refer to Figures 5.2, 5.3, and 5.4 and Tables A-3B1 and A-3B2 in the SSA to further view these trends which are hereby incorporated by reference.

Declining trends in tricolored bat occurrence and abundance is also evident from summer data (Service 2021). Based on derived rangewide summaries from Stratton and Irvine (2022), summer rangewide occupancy declined by 28% from 2010–2019. Similarly, Whitby et al. (2022) using data collected from mobile acoustic transects found a 53% decline in rangewide relative abundance from 2009–2019; they found measurable declines in the Northern RPU (86%), Southern RPU (65%), and Eastern RPU (38%). Deeley and Ford (2022) observed a significant decline in mean capture rates from 1999 to 2019 across the range; estimates derived from their results correspond to a 12% decline in rangewide mist net capture rates compared to pre-WNS capture rates. They found capture rates decreased 19%, 16%, and 12%, in the Eastern RPU, Northern RPU, and Southern RPU, respectively. Refer to Table A-3B4 in the SSA, hereby incorporated by reference, to view these declines.

3.2.4. Threats for Tree-Roosting Bats

The conservation needs and threats to Indiana bat and northern long-eared bat are discussed in detail in the species' respective recovery plans, most recent 5-year reviews, and SSAs. Conservation needs and threats to tricolored bat are discussed in its listing notice and SSA.

Due to similarities in biology and geography, the tree-roosting bat species addressed in this BO face similar threats to their survival. Common threats are addressed and summarized below.

White-nose Syndrome
In recent years, no other threat is more severe and immediate for the Indiana bat, northern long-eared bat, and tricolored bat than WNS. Since first observed in New York in 2006 (Meteyer et al. 2009), WNS has spread rapidly in bat populations from the Northeast to the Midwest and to the Southeast and Interior West, and more recently to the Pacific Northwest. As of February 2024, WNS has been confirmed in 40 states and eight Canadian provinces, and there is evidence that the causative fungus of WNS, *Pseudogymnoascus destructans* (Pd), is present in three additional states and two additional Canadian provinces; currently, 12 bat species in North America have been confirmed with WNS (White-Nose Syndrome Response Team 2024).

The rangewide Indiana bat population has decreased by 19.2% since arrival of WNS in New York State (from 2007 to 2019) (Service 2019a). While this decrease has contributed to downturns in Indiana bat numbers in some RUs, it has not afflicted them rangewide in the manner that WNS has affected northern long-eared bat and tricolored bat. It is unlikely that northern long-eared bat populations would be declining so dramatically without the impact of WNS. Cheng et al. (2021) concluded that WNS caused 97–99% population declines in northern long-eared bat populations in the eastern United States (across 79% of the species range) and that 59% of the tricolored bat's range is threatened by the presence of WNS. It appears that WNS will continue to spread throughout the ranges of the Indiana, northern long-eared, and tricolored bat, therefore, addressing the threat of WNS is the first and foremost conservation need for these three species.

Studies have found that there are additional energetic demands for Indiana bats in areas where WNS is present. For example, WNS-affected bats have fewer fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2012) and have wing damage (Meteyer et al. 2009; Reichard and Kunz 2009) that makes migration and foraging more challenging. Females that survive migration to their summer habitat must partition energy resources between foraging, keeping warm, and maintaining enough energy to heal, while successfully enduring pregnancies and rearing pups.

Other stressors that had no discernable population-level impacts previously, combined with the impact of the disease, could become factors influencing northern long-eared, Indiana, and tricolored bat 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. For example, a single bat maternity colony reduced in size by WNS-related

mortality and with the remaining individuals weakened by the disease, would be 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.

White-nose Syndrome in Tennessee

WNS is greatly impacting winter bats in Tennessee, including the northern long-eared bat and tricolored bat. Some bat researchers and biologiCRN -1 believe WNS has caused and is leading to extirpation of species from sites (TWRA 2022). WNS and Pd, were first documented in Tennessee during the winter of 2009-2010 (Lamb and Wyckoff 2010), when the fungus was found on the three species indicated above in six caves within six different counties. Currently, WNS and Pd are found in 57 of the 77 counties containing caves in Tennessee (74%), and the disease is considered widespread in the state (TWRA 2022).

According to TWRA (2022), since 2013, winter populations of northern long-eared bat in Tennessee have declined precipitously. Although, historically, observations of northern long-eared bats in hibernacula in Tennessee have been low, since 2015, there have only been 36 northern long-eared bats observed in Tennessee during annual winter colony counts (Figure 3-3) (TWRA 2022). No observations were made during the 2020-2021 cave survey period. This 100% decline in total observations may not indicate complete extirpation, as many of the sites surveyed had not been previously surveyed and not all caves in the state were surveyed. However, such a drastic decline in the number of observations across multiple winters indicates WNS is having detrimental impacts to northern long-eared bats, and therefore, is a high cause of concern for the species in Tennessee.

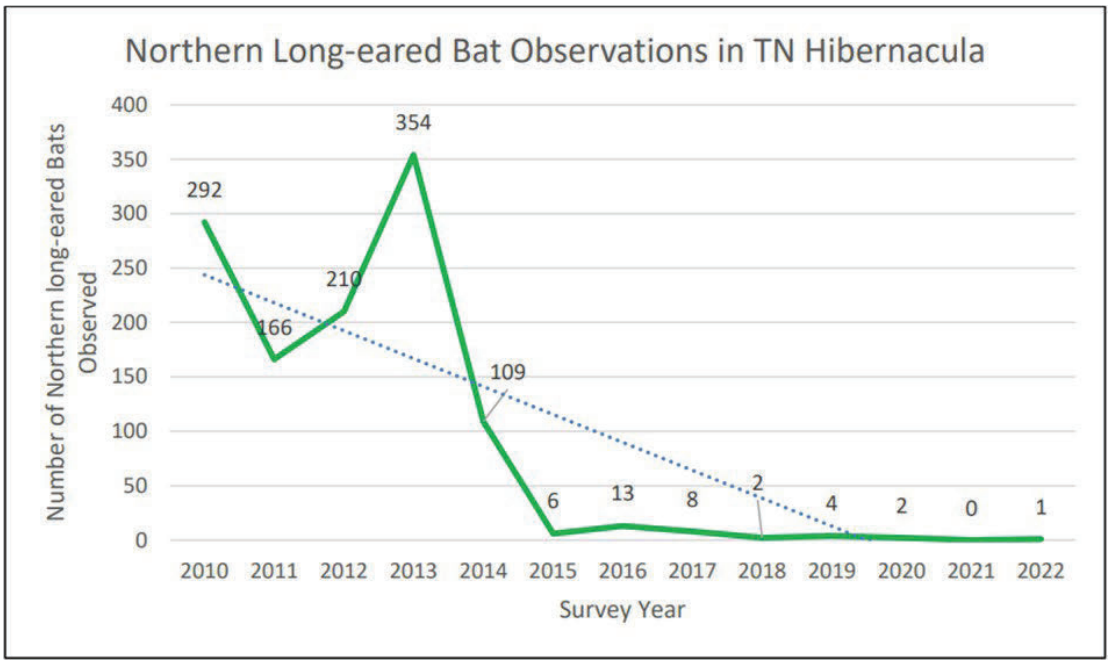

Figure 3-2. Northern long-eared bat observations from winter colony counts in Tennessee since the introduction of white-nose syndrome (TWRA 2022).

Summer declines in northern long-eared bats appear to have followed the same trends as winter populations in Tennessee (TWRA 2022). Once commonly captured throughout much of the state, captures for this species during the summer have declined significantly. To demonstrate these declines, the following capture summary has been provided in the *Tennessee Bat Population and White-nose Syndrome Monitoring Report for 2020-2021* (TWRA 2022). Pre-WNS, northern long-eared bats were captured every 4.56 mist net hours or every 2.21 mist net nights, and 100 net hours would produce approximately 21 captures of the species. Post-WNS, captures have significantly declined for the northern long-eared bat. They are now captured every 76.92 mist net hours or every 13.89 mist net nights, and 100 net hours now produce approximately 1.3 captures of the species. Therefore, based on net hours necessary to capture the species, captures during the summer have declined 93.8%, post-WNS, similar to declines observed in winter populations.

The following summaries of winter observations and summer captures for tricolored bat are included from the *Tennessee Bat Population and White-nose Syndrome Monitoring Report for 2020-2021* (TWRA 2022). Tricolored bat constituted over 48% of the 2020-2021 observations, and the species was observed in 64.5% of all caves surveyed. Despite being commonly observed, the species continues to decline throughout the state. As with other species, its documented numbers peaked in 2013, but have since declined at an alarming rate. Winter observations continued to decrease 5.51% between the 2019-2020 (1,161 individuals) and 2020-2021 (1,097 individuals) winter field seasons and as of 2020-2021, have declined 49.19% since the 2009-2010 winter survey period. Along with the decrease in total observations, the number of tricolored bats observed per cave survey has declined significantly since 2009-2010. During 2009-2010, the average number of tricolored bats observed per cave was 59.97; however, the average number of individuals observed per cave during 2020-2021 was 9.97.

A similar pattern has emerged for tricolored bat in Tennessee when assessing summer captures. Pre-WNS summer surveys (2005–2009) resulted in 100 mist net hours producing approximately 14 tricolored bat captures. Post-WNS captures (2009-2020) of tricolored bats have declined significantly, with 100 mist net hours now producing approximately two tricolored bat captures. Tricolored bat captures during the summer have declined 85.7% when comparing captures per net hour (7.09 pre-WNS mist net hours versus 43.48 post-WNS mist net hours) and are almost twice that of declines observed during winter surveys.

WNS was first reported in Tennessee by TWRA in 2010 when the agency began monitoring winter observations of bats. The annual survey data presents clear evidence that populations of bat species susceptible to WNS bottlenecked by 2015 (TWRA 2022). Therefore, the Service's TNFO categorizes data up to the year 2014 as "pre-WNS" and data from 2015 to present as "post-WNS."

Forest Fragmentation and Habitat Modifications

Forests used by foraging and roosting bats during spring, summer, and fall have changed dramatically from pre-settlement conditions, and loss of deciduous forest landcover has decreased bat habitats which influence survival and reproduction of bat colonies across their

ranges (Service 1999, 2021). The U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS) summary of forest trends (USDA, USFS 2014) reported a decline in forest acreage from 1850 to the early 5360s, when forests were converted to other land cover types or native plant communities were altered. Over the next century, other land cover types (mostly cropland) were converted to forest 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 forests (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 that forest fragmentation has caused to bat habitats, especially summer habitats, it is suspected in contributing to the decline in numbers of tree-roosting bat species (Service 1999, 2022). These changes in landcover may be associated with losses of suitable roosting or foraging habitats, longer flights between suitable roosting and foraging habitats due to habitat fragmentation, fragmentation of maternity colony networks, and direct injury or mortality (Service 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 Indiana and northern long-eared bats' 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 Indiana bats and northern long-eared bats 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 forest, as there is a higher probability of removing roosts or causing loss of connectivity between roosting and foraging habitats (Service 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 (Service 2012).

According to the SSA for the Tricolored Bat (Service 2021), while temporary or permanent habitat loss may occur throughout the species' range, impacts to the tricolored bat and its habitat typically occur at a more local-scale (i.e., individuals and potentially colonies), with impacts from loss of habitat varying dependent upon the timing, location, and extent of the removal and may range from minor (e.g., removal of a small portion of foraging habitat in largely forested landscapes with robust tricolored bat populations) to significant (e.g., removal of roosting habitat in highly fragmented landscapes with small, disconnected populations). Adverse impacts are more likely in areas with less forest or highly fragmented forests (e.g., western U.S. and central Midwestern states), where there is a higher probability of removing roosts or causing loss of connectivity between roosting and foraging habitat.

Wind Turbines

Mortality by wind turbine collision has been recorded for 24 of North America's 47 bat species (American Wind Wildlife Institute 2018). Bats are vulnerable to mortality and injury associated with the rotating turbine blades, either by collision or barotrauma (pressure-change injury). Compared to many passerine birds, wind turbines may have a more pronounced negative impact

on migratory tree-roosting bats. At the majority of U.S. wind facilities that have been examined, bat mortality has been estimated to be higher than bird mortality (Schuster et al. 2015; Allison, et al. 2019) with estimates of annual bat fatalities in North America totaling between 600,000 to 949,000.

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. 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 bats, are limited. Bats are sensitive to changes in temperature, humidity, and precipitation (Adams and Hayes 2008). For example, during winter only a small proportion of caves provide the right conditions for hibernating Indiana bats 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. Therefore, climate change may shift bats from southern to northern hibernacula (Clawson 2002).

Observed climate-related impacts for some species of insectivorous bats (such as 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 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 bats' 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 bats. The rapid spread of WNS across their ranges likely masks any effects of climate change on their status.

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 northern long-eared bat hibernacula. Although variation exiCRN -1 among sites, an overwhelming majority of hibernating northern long-eared bat colonies have developed WNS and experienced serious impacts within two to three years after the arrival of Pd (Cheng et al. 2021; Wiens et al. 2022). The vast majority of northern long-eared bat 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 northern long-eared bat. The species has been found to be active year round on the southern coastal plain, where there are no known traditional hibernacula (i.e., caves or mines) and no symptoms of WNS (Grider et al. 2016; Jordan 2020). Torpor for northern long-eared bats 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 estimated to be impacting 85–100% of tricolored bat hibernacula (Wiens et al. 2022) and has resulted in most winter colonies experiencing dramatic declines in abundance compared to historical conditions (Cheng et al. 2021); it is predicted to reach 100% of the tricolored bat's range in the U.S. by 2025 (Wiens et al. 2022).

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 gray bay, Indiana bat, northern long-eared bat, and tricolored bat, 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/conference and TVAs do not include the effects of the Action under review.

The CRN Site is located on the site of the former Clinch River Breeder Reactor Project (CRBRP). Approximately 240 acres within the CRN Site were disturbed in 1982-1983 during CRBRP site preparation activities which included leveling a ridge from 880 feet above mean sea level (AMSL) to 780 AMSL, excavation of the reactor area, and installation of various structures. The excavation totaled approximately 24 acres with a depth of up to 100 feet. After CRBRP termination of CRBRP in 1983, site redress plans were implemented. The excavated area was partially backfilled in a manner that was intended to sustain site drainage. Level areas of the CRBRP site were graded and compacted. Much of the vegetation on site remains heavily disturbed due to this major earth moving effort.

The CRN Project Area as a whole contains a total of 696 acres of forest including deciduous, evergreen, and mixed deciduous-evergreen. Of this, up to approximately 250 acres of forested habitat could be removed (deciduous, evergreen, and mixed). The CRN Project Area also contains open herbaceous habitats, ponds, wetlands and streams. Major cut and fill activities are expected with the grading of the plant area in preparation for nuclear foundation construction. National Land Cover Data from 2023 indicates 32.5% of the project area is forested and another 8.7% is wooded wetland area.

Nine caves are known within 3 miles of the CRN Site. A former northern long-eared bat hibernacula is within 5 miles of the CRN Site; however, this cave is believed to be unoccupied post-WNS. Two caves to the west of the CRN Site within the 120 dBA limit (Figure 2-2) are on private land and are not known to host listed bat species.

Wetland and stream surveys were performed by TVA in 2021. Aquatic resources include five perennial streams, seven intermittent streams, 16 wet weather conveyances (WWC; such as ditches and swales), three ponds, and 25 wetlands totaling approximately 30.9 acres.

Ambient noise within and adjacent to the CRN Site was evaluated in an Ambient Noise Assessment (AECOM 2014). Noise heard from within the CRN Site was observed to come from vehicles, general wildlife, birds, insects, humans, wind through foliage, rain, and construction/industrial equipment. Day-night average sound levels (over a 24-hour period with a 10-decible penalty applied to nighttime levels) ranged from 49.7-55.2 dBA within the CRN Site. DOE property abuts the CRN Site on the north side. Several training facilities exist on DOE properties with the two closest being along Bear Creek Rd. One is immediately adjacent to the Grassy Creek HPA and the other is approximately 0.75 miles down. the road. Both contain outdoor firing ranges whose activity can be heard on the CRN Site and in the surrounding community.

4.1. Gray Bat

[redacted], a transitional roosting cave for gray bat, was identified in 2021 across the Clinch River arm of Watts Bar Reservoir from the project area. Winter cave surveys documented one gray bat and five tricolored bats roosting inside the cave in March 2021 (TVA 2022b). A small pile of guano was also documented in the cave at that time, suggesting a small number of gray bats use the cave outside of winter. Summer emergence counts, using infrared and visual methods, performed at this cave in June 2021 did not observe any bats emerging. Subsequent acoustic monitoring at the cave from June 2023 through June 2024, resulted in documentation of a small number of gray bats roosting in the cave throughout the spring, summer, and fall. TVA made additional bat observations when they entered the cave to replace batteries in the acoustic monitors. Visual bat counts during battery replacements are approximate because entry and exit were made in less than 5 minutes total to minimize disturbance. Approximately 40 gray bats were observed in May 2023 but only two in June of 2023. Approximately 17 gray bats were present in September of 2023 and none in mid- November of 2023. Acoustic results during that same timeframe indicated a large enough quantity of bats was present to capture chatter sporadically from early June through early November 2023. Acoustic detectors were removed for the winter (December 2023 - March 2024). Approximately 20 gray bats were present in the cave in March 2024 when acoustic monitoring resumed and only one gray bat in June 2024 when the monitoring was completed. Larger quantities of guano were noted in the cave in March and June 2024 than had previously been observed. Acoustic monitoring from March-June 2024 captured sporadic bat chatter in March, April, and May 2024, with the most chatter May 9 through 12 and May 27, 2024.

Mist net and acoustic surveys have documented gray bats at the CRN Site numerous times over the last 13 years. Four gray bats, three of which were pregnant, were captured during mist net surveys at CRN Site and on adjacent DOE property in 2021. An additional gray bat was captured in a mist net on the CRN Site during summer 2011. Gray bats were also acoustically detected at the CRN Site in 2011, 2013 and 2021. Acoustic surveys in 2014 and 2015 also detected gray bat at the BTA.

Outside of the project area, gray bats have been detected on the ORR foraging along a pond approximately 2 miles north of the Site and a large gray bat maternity cave (approximately 10,000 bats) was recently documented approximately 3.32 miles from the CRN Site.

Three caves are known from the Grassy Creek HPA. Internal surveys were performed in 2021 by TVA Terrestrial Zoologists and ORNL staff. Surveys determined none of these caves are being used by gray bats and none of them offer suitable habitat for gray bats given their small size and shape.

Given these data, we have reasonable certainty that gray bats are present in the action area spring, summer, and fall and that there is potential for gray bats to be present during the hibernation season at [redacted].

4.2. Indiana Bat

Internal surveys of [redacted] as well as the three caves within the Grassy Creek HPA in 2021 determined none of these caves are being used by Indiana bats. The closest summer record of Indiana bat to the Clinch River Property was a pre-White-nose Syndrome (WNS) mist net capture of an adult male on ORR in 2013 approximately 9.9 mi away from the proposed CRN Site. The Service has a record of a non-maternity Indiana bat capture within 2.5 mi of the CRN Site from August 2005. ORR summer acoustic records from 2013 – 2023 demonstrate Indiana bat acoustic detections from as near as 1.5 mi of the CRN Site and estimate Indiana bat occupancy during these years to be 31.4% (unpublished data). However, winter counts across Tennessee indication that Indiana bat populations have declined by 84% since its peak in 2013 and by 75% on average from pre-WNS years to post-WNS years. The closest known winter record of Indiana bat to the CRN Site is a hibernaculum approximately 27 miles to the northeast in Campbell County, Tennessee.

Potentially suitable summer roosting habitat for Indiana bat occurs in mature forests throughout the CRN Site, BTA, and associated Offsite 161-kV Transmission Corridor. Suitable foraging habitat occurs over streams, wetlands, and ponds across the site as well as the Reservoir. Mist net and acoustic surveys were performed at the CRN Site (2011, 2013, 2021) and acoustic surveys were performed at the Barge/Traffic Area (2015). No Indiana bats were captured or detected in 2011 or 2021, but they were detected acoustically in 2013 (pre-WNS). Acoustic surveys at the Barge/Traffic Area in 2015 and on ORR property near Jones Island Rd in 2021 resulted in calls identified as Indiana bat by bat acoustic software.

Given these data, we are not certain Indiana bat are present in the CRN Site action area, but it is likely this species occurs in the area in very low numbers.

4.3. Northern Long-eared Bat

A former northern long-eared bat hibernacula is within 5 miles of the CRN Site; however, this cave is believed to be unoccupied post-WNS. ORR summer acoustic records from 2013 – 2023 demonstrate northern long-eared bat acoustic detections from as near as 1 mi of the CRN Site and estimate northern long-eared bat occupancy during these years to be 41.3% (unpublished data). However, northern long-eared bat populations have been decimated by WNS: winter counts across Tennessee indicate a decline of 98-99% and northern long-eared bats have very rarely been captured in summer mist net surveys since 2015.

Northern long-eared bat was captured on the CRN Site during 2011 mist net surveys, captured on ORR property approximately 9.9 mi away in 2013, and detected during 2011, 2013, and 2015 acoustic surveys on the CRN Site and the BTA. TVA biologists identified a hibernaculum for this species in Roane County approximately 9 miles away in January 2014. As mentioned above, nine caves are known within 3 miles of the CRN Site. Internal surveys of that cave as well as the three caves within the Grassy Creek HPA in 2021 determined none of these caves are being used by northern long-eared bats. Suitable summer roosting habitat occurs in forested areas across the CRN Site, the BTA, and the associated Offsite 161-kV Transmission Corridor. Suitable foraging habitat for northern long-eared bat is present over and along streams, wetlands and the Clinch River arm of Watts Bar Reservoir.

Given these data, the Service is not reasonably certain northern long-eared bats are present post-WNS in the CRN Site action area at any time of year.

4.4. Tricolored Bat

[redacted] small tricolored bat hibernacula (between 1 and 3 tricolored bats observed in each) exist in the Grassy Creek HPA. [redacted] where tricolored roost during winter is located across the Clinch River from the CRN Site. Three tricolored bats also were captured during 2011 mist net surveys on the CRN Site. No tricolored bats were captured during 2021 mist net surveys on the CRN Site. However, one post-lactating female tricolored bat was captured on ORR property approximately 1.7 miles from the CRN Site during that same survey effort. ORR summer acoustic records from 2013 – 2023 demonstrate tricolored bat acoustic detections from as near as 1 mi of the CRN Site and estimate tricolored bat occupancy during these years to be 71.6% (unpublished data). However, tricolored bat populations have also declined due to WNS: winter counts across Tennessee indicate a decline of 87% from its peak in 2013 and by 77% on average from pre-WNS to post-WNS years. TVA field reviews of the CRN Site determined all forested habitat could be used by tricolored bat. Tricolored bats are also known to forage in open areas and are less restricted to interior forests than Indiana and northern long-eared bats.

Given these data, we are reasonably certain several tricolored bats occupy the action area in each season of its life cycle.

4.5. Action Area Conservation Needs and Threats

Threats to the three bat species within the Action Area are the same as the rangewide threats described in Section 3.2.4.

5. EFFECTS OF THE ACTION

This section analyzes the effects of the proposed federal Action on the gray bat and the tree-roosting bat species, Indiana, northern long-eared, and tricolored bats, including all consequences to these species that would be 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).

Effects of the action include loss of habitat, noise, vibration, alteration of existing wetlands and waterways, increased water temperature from cooling tower discharges, and potential collisions. Other effects on the environment are discussed in the EIS.

Based on the information presented in the Environmental Baseline (Section 4), we have reasonable certainty that gray bats are present in the Action Area spring, summer, and fall and that there is potential for gray bats to be present during the hibernation season at [redacted]. We are reasonably certain tricolored bats species may be present in the Action Area throughout the year. We have evidence Indiana bat could utilize the Action Area in very low numbers in its summer season. We are not reasonably certain that northern long-eared bats are still present in the Action Area.

5.1. Stressor: Tree Removal

Tree-roosting bats use networks of multiple roost trees within their home ranges and show fidelity to roosts used in previous years (see Section 3.2). 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, these 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 (Service 2022).

Silvis et al. (2014) modeled the effects of roost-loss on northern long-eared bats, and Silvis et al. (2015) actually removed known roosts during the winter to investigate the effects. 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. However, once removals exceeded 20–30% of documented roosts (with 70-80% of similar roosts remaining), a single maternity colony network started showing patterns of break-up. Sociality is believed to increase reproductive success (Silvis et al. 2014), and smaller colonies could experience reduced reproductive success, providing less thermoregulatory benefits for adults in cool spring temperatures and/or for non-volant pups. Fitness benefits of colonial roosting include minimizing the physiological stress of lactation, creation of more favorable thermal conditions, and cooperative rearing of young (Olivera-Hyde et al. 2019).

Effects Pathway 1

Activity – tree clearing; removal of up to 250 ac of forested habitat greater than 0.25 mile from caves

Stressor – Removing trees that provide habitat for foraging, roosting, and maternity colony bats

Exposure (time) – Removal over 4.5 years equating to permanent loss of habitat and indirect harm from winter clearing.

Exposure (space) – 250-ac of forested habitat

Resource Affected – Insect prey, forest cover that supports bat activity, potential, unknown maternity colonies, pregnant females, swarming/mating and staging bats.

Individual Response – Potential reduced fitness of returning pregnant females; temporary energy expenditure due to relocating from traditional use areas to alternative habitat, reduced summer foraging habitat and swarming/staging habitat for tricolored bats. Potential abandonment of hibernacula and gray bat colony cave from land use change.

Conservation and Minimization Measures –

- The 250 ac of tree removal will occur in winter Nov 15 – Mar 31 and could take approximately 4.5 years to complete.
- Vegetation removal in streamside management zones (SMZs) and wetlands would be restricted to trees tall enough, or with the potential to soon grow tall enough, to interfere with conductors. Clearing in SMZs would be accomplished using hand-held equipment or remote-handling equipment, such as a feller buncher, to limit ground disturbance.
- Following clearing and construction, vegetative cover on the ROW would be restored to its prior condition prior to construction, to the extent practicable. TVA would utilize appropriate seed mixtures as described in TVA's BMP guide (TVA 2022a). Erosion controls would remain in place until the plant communities become fully established. Streamside areas would be revegetated as described in TVA's BMP guide. Failure to maintain adequate clearance can result in dangerous situations, including ground faults. As such, native vegetation and plants with favorable growth patterns (slow growth and low mature heights) would be maintained within the ROW following construction.

- TVA would install artificial bat roosting structures at the CRN Site to provide permanent habitat for imperiled tree roosting bats that otherwise may rely on ephemeral habitat for summer roosting. Structure design and placement would be selected to attract federally protected bats. These structures would also provide opportunities for conservation research activities by TVA Biological Compliance and their partners. Annual monitoring would occur at this location in conjunction with annual surveys of the 50 additional artificial bat roosting structures TVA has installed at nine other locations throughout the Tennessee Valley to support Section 7(a)(1) ESA efforts.
- TVA would expand the 271-ac Grassy Creek HPA that is primarily forested by an additional 14 ac.
- TVA would also contribute $500,000 to TVA's Bat Conservation Fund towards local and regional research and monitoring efforts such as capture and tracking of federally listed bats to identify previously unknown maternity roosting sites and any remaining funds could support research opportunities at the on-site artificial bat roosting structures mentioned above or other meaningful efforts to contribute to imperiled bat conservation efforts in the region.

Interpretation – Loss of forest habitat decreases opportunities for growth and successful reproduction. Depending on location and size of the harvest, forest cover removal in the summer home range may cause a shift in home range or relocation. Loss of habitat in staging/swarming areas near hibernacula may cause a similar shift in habitat use and may reduce fall mating success and/or reduced fitness in preparation for spring migration. Removal of suitable roosting trees and foraging habitat could indirectly harm tree-roosting bats; however significant acres of adjacent contiguous forest remains for bats to easily locate alternative roosts. Additionally, tree removal will be gradual rather than all at once giving bats substantial time to adjust and seek alternative roosts. The conservation measure to install artificial roosts will give Indiana bats suitable roosting opportunity while attempts to identify and locate unknown maternity roosting sites in the larger area would contribute to the conservation of the local population. Finally, loss of 250 ac of habitat may be somewhat offset by the HPA expansion and revegetation of ROW's to attract flying insects.

Effects Pathway 2

Activity – tree removal of a portion of the 250 ac of forested habitat within 0.25 mile from caves

Stressor – Removing trees that provide habitat for roosting, hibernating and maternity colony bats

Exposure (time) – Permanent loss of habitat and indirect harm from winter clearing.

Exposure (space) – Tree removal approximately [redacted] miles from the [redacted] tricolored bat hibernacula in the HPA to widen the entry road and tree removal as close as [redacted] mile from the gray bat colony cave at [redacted] for entry road widening, and placement of utility poles.

Resource Affected – Roosting and hibernating tricolored and gray bats, moderation of cave climate, and noise absorption/interruption for the cave environment.

Individual Response – Potential reduced fitness of resting and hibernating bats subject to more exposure to external climate and noise levels. Potential cave abandonment, reducing winter habitat, and potentially reducing gray-bat-maternity colony reproductive success.

Conservation and Minimization Measures –

- TVA would also contribute $500,000 to TVA's Bat Conservation Fund towards local and regional research and monitoring efforts such as harp-trapping at caves where research is lacking, cave gating, and/or internal cave surveys. Any remaining funds could support research opportunities or other meaningful efforts to contribute to imperiled bat conservation efforts in the region.
- Additional Section 7(a)(1) activities by TVA include cave monitoring at TVA-managed bat caves across the TVA Region in conjunction with state, federal, and NGO partners as a part of WNS response efforts to monitor bat populations. As a part of these efforts, TVA will continue to monitor [redacted] and the caves on the HPA (via internal surveys or exit emergence counts, as appropriate) to document seasonal use and monitor local bat populations. If needed in the future due to high levels of disturbance from humans, TVA would evaluate the potential to install bat friendly cave gates on these caves as it has done at other caves across the region.
- Seismic and bat acoustic data would be collected at [redacted] for either the duration of the blasting and drilling at that particular location, or for a maximum of 1 month, whichever is most logical per site, to verify that no impacts are occurring to the bats in this cave due to the proposed activities.

Interpretation – The Service relies on a 0.25 mi buffer as a minimum conservation measure to protect the internal environment of caves and this can include the quality that trees provide in absorbing noise and lighting. It is uncertain if the amount of trees removed within the minimum buffers will cause a measurable change in the internal cave ambient conditions; however TVA's baseline and continued monitoring of these caves will allow TVA and the Service to adaptively manage the area around to caves to restore ambient conditions should they be altered, resulting in lower fitness or reduced use of the caves as winter and summer habitat.

5.2. Stressor: Noise/Vibration and Lighting

Noise and Vibration

Bats have adapted to noise; however, some levels of noise and vibration may still adversely affect bats depending upon on volume, proximity, and duration. Caltrans (2016) reports bats' ear structure has evolved to reduce noise levels and potential hearing damage up to 110 dB for echolocation calls including behavioral avoidance. However, bats may be disturbed by certain activities that cause noise/vibration, which may increase bat arousal during hibernation or reduced fitness during spring emergence. Garner and Gardner (1992) reported that loud noise (e.g., construction equipment, live-fire ranges, aircraft noise) can disturb Indiana bat maternity colonies and suggested that loud activities around or near maternity colonies should be regulated when the species is using the roost. Callahan (1993) noted that an Indiana bat roost tree was

abandoned after a bulldozer cleared brush in an area. If pregnant females are required to search for new roosting habitat due to disturbances, it is assumed such effort would place additional stress on them at a time when fat reserves are low or depleted, and they are already stressed from the energy demands of migration (Service 2007).

There is anecdotal evidence that daytime noise and vibration could cause a bat to flush or abandon a maternity roost. Bennett and Braun (2004) indicated that noise associated with tree cutting on a National Forest, regardless of the felling method used, can cause an Indiana bat to flush, which could result in the bat altering its normal behavior pattern and possibly make it more susceptible to various predators during daylight hours (Mikula et al. 2016). However, Garner and Gardener (1992) indicate that disturbance would have to be severe to cause roost abandonment. However, there is little scientific evidence of such an effect. Additionally, the likelihood of an unknown roost being exposed to intense daytime noise that would cause a bat flushing from a roost is low.

Other studies suggest that bats avoid noisy areas. Noise effects on bat foraging and other behaviors will vary in relation to volume, proximity, and duration of noise. Effects from noise attenuate with distance; for example, two studies found no or insignificant effects of traffic noise to bats when bats were more than 50-150 m (164-492 ft) from the noise source (Schaub *et al*. 2009; Bonsen et al. 2015). Pallid bats' (*Antrozous pallidus*) foraging efficiency was reduced when exposed to "noise playbacks replicating acoustic conditions as far away as 640 m (3,000 ft) from a major road and 320 m (1,050 ft) from a natural gas compressor station bunk" (Bunkley and Barber 2015). Finch (2020) conducted an experiment that exposed free-living bats to recorded traffic noise in England; Myotis species substantially decreased their activity in experimental areas where they were exposed to noise. No evidence of habituation was found across the approximately two to three-month duration of the two study periods in 2017 and 2018 (Finch et al. 2020). Further, the lesser response to ultrasound compared to noise in the sonic spectrum indicated that the noise acted "through general deterrence and avoidance" as opposed to interfering with echolocation.

The Finch et al. (2020) study demonstrated noise effects on bats at least 20 m (65.6 ft) away from the source. Using an online noise attenuator calculator (https://www.calctool.org/waves/distance-attenuation) and assuming normal conditions, terrain, and traffic noise, the study found a peak of 86 decibels (dB) at 3m, would attenuate over 20 m to 69.5 dB.

Siemers and Schaub (2011) exposed captive foraging bats to playbacks of different types of road noise (continuous and transient) and different amplitudes simulating noise levels with increasing distances from a highway (7.5–50 m). They found that foraging efficiency in bats decreased proportionally with increasing proximity to the simulated highway. Search times increased by a factor of five in trials simulating noise conditions closest to the highway. The study authors estimated that effect of the highway noise on foraging efficiency was equivalent to a 25-fold decrease in available foraging area for the bats. This effect levels off with distance from the highway and the authors extrapolated their results to estimate effects up to 60 m from the road. Levels of highway traffic noise typically range from 70-80 dBA (decibels adjusted to human hearing levels) at a distance of 15 m (50 ft) from the source (Federal Highway Administration

[FHWA] 2003). Using the online distance attenuation calculator at 60 m away from an 80 dBA source (at 15 m) the noise would be 68.1 dBA.

Siemers and Schaub (2011) also determined that even close to the highway, bats were still able to detect and localize prey by their rustling movement sounds in about 50% of the trials. These results show that bats may be impeded, but not prevented, from foraging effectively next to highways. The studies suggest that the bats' acute and highly directional sense of hearing allow them to differentiate and localize the high frequency components of click-like sounds of prey from lower frequency road noise.

The U.S. military has documented some evidence that habituation to noise and vibration TVAs occur in bats and may be less impactful than might be assumed. Martin et al. (2004) evaluated acoustic bat call and thermal imaging video data of bat activity on Fort Knox, Kentucky. They found that preliminary data analysis generally indicated somewhat consistent bat activity in the vicinity of firing ranges throughout an evening of large and small caliber weapons firing. However, the data analyzed for Martin et al. (2004) only represented a small sample of the entire data set intended to eventually be processed and statistically compared. 3D/Environmental (1996) monitored the foraging behavior of nine radio-tracked Indiana bats on Fort Leonard Wood, Missouri. Their research indicated that for a small sample size of five Indiana bats, military training activity and noise on specific ranges did not alter their selection of foraging locations on nights with training activities versus nights without training activities. BHE Environmental, Inc. (2002) captured and radio-tracked an adult male Indiana bat on Fort Campbell, Kentucky in June 2002. The Indiana bat was observed foraging and night-roosting in approximately the same location near the impact area on three nights when heavy training activity (frequent, low-altitude helicopter flights and artillery firing) occurred, compared to nights with little or no training activity. Further, Whitaker and Gummer (2002) indicated that bats on Camp Atterbury, Indiana do not avoid active ranges or alter foraging behavior during night-time maneuvers.

Gardner et al. (1991) found evidence that Indiana bats continued to roost and forage in an area with active timber harvest. Hom et al. (2016) exposed big brown bats (*Eptesicus fuscus*) (to 20-100 kilohertz (kHz) at 116 dB for one hour and reported little or no influence on echolocation behavior in individual bats. In Zurcher et.al (2010), the authors conclude noise level and lighting from highways was considered to have no effect on the behavior of the bats.

In conclusion, there is experimental evidence of effects to bat foraging above an estimated 68 dBA, but it is uncertain if these observations are biologically significant. Most construction sounds are in the 80-90 dBA range at 50 ft from the source, while jackhammers and other such loud equipment can generate noise up to 120 dBA (American National Standards Institute 2018). Federal regulations (30 CFR 816.97[b]) require that noise associated with blasting may not exceed 129 to 133 dB. FHWA's 2006 Construction Noise Handbook stated blasting for rock slope production was 126 dB. However, FHWA's current Handbook indicates blasting is 94 dBA at 50 ft (FHWA 2018). Google searches in 2025 still cite blasting can reach levels up to 110-120 dB.

The Service uses the following formula to determine the distance point source construction noise will travel before it attenuates:

$$D = Do * 10^{((\text{Construction Noise} - \text{Ambient Sound Level in dBA})/\alpha)}$$

Where D = the distance from the noise source

Do = the reference measurement distance (50 feet in this case)

α = 25 for soft ground and 20 for hard ground. For point source noise, a spherical spreading loss model is used. These alpha (α) values assume a 7.5 dBA reduction per doubling distance over soft ground and a 6.0 dBA reduction per doubling distance over hard ground. α = 15 for soft ground and 10 for hard ground. For line source noise (e.g., traffic along a highway), a cylindrical spreading loss model is used. These alpha (α) values assume a 4.5 dBA reduction per doubling distance over soft ground and a 3.0 dBA reduction per doubling distance over hard ground.

If we use 68 dB as the ambient threshold level for bat adverse effects, then construction without loud drilling equipment (80-90 dBA) would attenuate to 68 dBA in just 116 m (0.07 mile) over soft ground and in a forest, trees would absorb, scatter, and interfere with sound waves such that noise and vibration would be expected to travel even less distance. In these cases, noise and vibration up to 90 dB would be localized and in the case of construction, temporary. However, if equipment generating noise up to 105 dBA (e.g., pile drivers and sand blasters) are part of the proposed action, then noise would attenuate to 68 dBA around 460 m (0.3 miles) from the source. If blasting is part of the proposed action and sound was kept to under 120 dBA, then noise would attenuate to 68 dBA in 1,832 m (1.1 mi) over soft ground. However, if blasting is unmitigated and occurs at the regulated limit of 133 dB, then it would not attenuate until 6,067 m (3.8 mi) over soft ground. All of these limits are expected to be a conservative maximum because forest trees would reduce such distances significantly.

It is important to note, that the Service is aware of numerous instances where gray, Indiana and northern long-eared bats are found roosting and even forming maternity roosts in extremely loud environments, such as military training ranges and highway structures. However, other evidence suggests individual bats do respond negatively to new, chronic anthropogenic noise/vibration.

A significant new disturbance close to a roost could cause a bat to flush or abandon a maternity colony; however, where there are no known roosts, the chance of this exposure is unlikely for endangered bats that occur in low numbers on the landscape. Reduced foraging efficiency or deterrence over a relatively small area compared to the amount of locally available habitat would not be significant enough to impair essential behaviors. We expect rare forest-dwelling bats to be minimally exposed to or not impacted by this stressor, unless noise and/or vibration is expected to occur adjacent to a known occurrence area and encompass a significant portion of a species home range or occur during hibernation near occupied hibernacula. Therefore, for noise without loud equipment/blasting adjacent to forest areas outside of known bat occurrence buffers, we expect effects from this stressor to be insignificant, especially when vast amounts of forested foraging and roosting areas are available, which is the case in most areas of Tennessee. However, this may not be the case in some parts of Tennessee where forested habitat is more limited or where noise and vibration of 120 dBA or greater would affect a sizable area, reducing foraging

efficiency or potentially causing roost abandonment over a significant portion of a known home range. Certainly, loud noise affecting known hibernacula could startle bats out of hibernation, torpor or rest and could cause them to move and deplete critical energy reserves.

Lighting

Numerous studies suggest that artificial lighting could reduce the suitability of an area for bat foraging and cause them to avoid illuminated areas. In Connecticut, lighting negatively affected bat foraging activity (for the little brown bat) by decreasing their use of an illuminated wetland (Seewagen and Adams 2021). In England, activity of Myotis species declined significantly under orange, white, and green light; red light also negatively impacted the bats but not as significantly (Zeale et al. 2018). In France, lighting had a substantial negative effect on Myotis species activity whether the lighting was on for entire nights or only partial nights (Azam et al. 2015). In Italy, bat activity declined at illuminated sites "mainly due to the response of the most abundant species, *Myotis daubentonii*" (Russo et al. 2019). In France, lighting intensity had mixed effects on bats, but the effect was significantly negative for Myotis species (Lacoeuilhe et al. 2014). The light-negative species included primarily aerial hawking and gleaning bats, the two foraging behaviors used by northern long-eared bat; no gleaning bat species were among the light-tolerant species (Lacoeuilhe et al. 2014). In the Netherlands, feeding of pond bats (*M. dasycneme*) was reduced by 60% on nights when they were exposed to artificial light versus dark nights (Kuijper et al. 2008). In England and Wales, experimental exposure, even to low levels of LED lights, reduced activity of Myotis species (Stone et al. 2012).

In European Myotis species that generally use houses and buildings for rooCRN -1, juveniles from illuminated structures were found to be significantly smaller, and night emergence was significantly delayed for adults (Boldogh et al. 2007). A British study showed that LED streetlights caused a reduction in activity in slower flying bats (including Myotis ssp.) (Stone et al. 2012).

Schroer et al. (2020) stated that "The behavior of light-sensitive bats can be impaired within the radius of up to 50 m (164 ft) distance to the light source, even if the luminance level is as low as 1 lux" (lx). Azam et al. (2018) detected streetlight avoidance at values below 1 lux by Myotis species and Serotine bat (*Eptesicus serotinus*) at 50 m from a streetlight (Azam et al. 2018). At 100 m (329 ft), they did not detect avoidance and recommended "separating streetlights from ecological corridors by at least 50 m and to limit vertical light trespass on vegetation to less than 0.1 lx to allow their effective use by light-sensitive bats" (Azam et al. 2018). Effects of lighting on forest-dwelling bats is localized and can be mitigated using cut-off lighting. Unless lighting effects are unmitigated, expected to occur adjacent to a known roost site, and the 50 m buffer from light sources encompasses a significant portion of the species home range, we expect rare forest-dwelling bats to be minimally exposed to this stressor. For forest areas outside of known occurrence buffers, we expect any effects from this stressor to be insignificant given the vast amount of foraging (forested) area available in most areas of Tennessee. This may not be the case in some parts of Tennessee where forested habitat is more limited.

Effects Pathway 3

Activity – Construction noise, drilling and blasting, and new temporary and permanent lighting

Stressor – New chronic and/or intense anthropogenic noise above 68 dBA and associated vibrations and artificial lighting in known suitable habitat.

Exposure (time & space) – Active season, temporary direct effect during construction and permanent potential effects during facility operations. Initial blasting frequency would be up to two times per week to establish the quarry pit. Once routine quarry operations are established, blasting operations would be anticipated weekly. Proposed drilling and blasting activities could occur at any time of year within 0.5 miles of [redacted] drilling and blasting to dig the reactor shaft, approximately 0.78 miles from [redacted]. Drilling and blasting for the reactor shaft would occur 24 hours a day over approximately 18 months Blasting and/or drilling may need to occur to construct facility buildings, laydown areas, and other construction/operational support areas. The closest of these areas is approximately 0.24 miles away. Finally, although unlikely to be needed, the optional onsite quarry may be located approximately 0.35 from [redacted]. Drilling and blasting would be used to establish the pit, then forty-foot drill and blast benches would be tailored to the conditions and materials to ensure safe and efficient operations

The [redacted] tricolored bat winter hibernacula caves in the Grassy Creek HPA are also within 0.5 miles but greater than 0.25 miles of potential drilling and blasting areas needed to construct a temporary construction facility at the Bear Creek Road site entrance, and utility pole installation along the CRN Site access road. Drilling and blasting within 0.5 miles of these caves would be avoided while bats are in winter torpor (Nov 15-March 31).

Exposure (space) – Within the remaining habitat around construction area out to 116 m (0.07 mi) on average with numerous occasional periods of drilling and blasting out to 1,832 m (1.1 mi) and out to 50 m if lighting design is unmitigated.

Resource Affected – Foraging bats, potential, unknown maternity colonies in remaining contiguous forest, known gray bat colony at [redacted], hibernating bats in the action area.

Individual Response – may flush, avoid exposure areas for roosting, potentially abandon unknown maternity colonies, and/or avoid nighttime foraging areas where lighting impacts foraging.

Conservation and Minimization Measures–

- TVA would continue to monitor [redacted] and the caves on the HPA (via internal surveys or exit emergence counts, as appropriate) to document seasonal use and monitor local bat populations in conjunction with state, federal, and NGO partners as a part of WNS response efforts to monitor bat populations.
- If needed in the future due to high levels of disturbance from humans, TVA would install bat-friendly gates on [redacted] and the [redacted] tricolored bat hibernaculum in the HPA. These are currently somewhat protected from human disturbance as the project site as a whole is behind a gate that is locked on evenings and weekends.

- TVA would expand the 271-acre Grassy Creek Habitat Protection Area (HPA) by an additional 14 acres. This TVA owned and managed HPA is primarily forested and provides a large contiguous area of high quality upland habitat for tree-roosting bats.
- TVA would contribute $500,000 to TVA's Bat Conservation Fund. This internal fund was created to accumulate money within TVA to support bat conservation efforts across the region. Funds are distributed periodically when an ad hoc committee that is comprised of both external stakeholders affiliated with bat conservation and representative TVA business units is assembled to review and approve proposed actions that support bat conservation. In this case, contributions from the Clinch River Project into TVA's Bat Conservation Fund would be ear-marked to support local research and monitoring efforts such as capture and tracking of federally listed bats to identify previously unknown maternity roosting sites, harp-trapping at caves where research is lacking, cave gating, and/or internal cave surveys. Any remaining funds could support research opportunities at the on-site artificial bat roosting structures mentioned above or other meaningful efforts to contribute to imperiled bat conservation efforts in the region.
- Drilling, excavation, and blasting within 0.5 miles of known caves would be avoided while bats are in winter torpor (Nov 15-March 31).
- Once construction methods are determined, pre-blast surveys of the project area will be conducted, and a preliminary schedule developed for drilling and blasting activities within 0.5 miles of [redacted]. TVA, in coordination with USFWS, would develop a phased approach to determining allowable thresholds for intensity and frequency of drilling and blasting activities within 0.5 miles of this cave.
- At least one week of seismic data will be collected at [redacted] prior to any proposed drilling or blasting activities to determine baseline conditions within the cave by the placement of Titley roost loggers. Seismic and acoustic data will be collected during blasting and drilling activities to quantify whether vibration and noise associated with drilling or blasting can be detected within the cave where the bats have been observed roosting. If necessary, vibrations associated with blasting will be to lower levels by the design, placement, and timing of blasting. These efforts would occur until it is determined that minimal or no seismic activity can be detected in roosting areas of the cave or that bats present are not reacting to seismic activity detected. Test blasts would occur until acceptable levels are reached
- Seismic and bat acoustic data would be collected for either the duration of the blasting and drilling at that particular location, or for a maximum of 1 month, whichever is most logical per site, to verify that no impacts are occurring to the bats in this cave due to the proposed activities.

Interpretation –Loud equipment and blasting outside the maternity season would cause bats to flee and be subject to increased predation potential during daylight hours. Such loud equipment use during the maternity season could cause roost abandonment and harm to all offspring. Hibernating bats, bats in torpor, and bats in staging may be particularly at risk of harm given any extra energy expenditure for bats fighting WNS is detrimental. Certain lighting types may attract bats to light sources which increases the risk of predation and/or deters their normal foraging

activities. Unshielded lighting and outdoor noise above 68 dBA during operations will reduce foraging habitat for adults and juvenile bats. Significant lighting alteration of known habitat would cause harm similar to the effects of noise on foraging efficiency.

5.3. Stressor: Degradation of Aquatic Resources

Forest-dwelling bats heavily rely on the productivity of forests to generate suitable levels of insect biomass and wetlands are an essential component of suitable bat habitat. Bats are commonly observed foraging over and drinking from surface waters. Small ponds constitute essential water resources for bats during dry months (Lisóon and Calvo 2014). Bats have a positive association with wetland land cover and presence of bats can be somewhat predicted by wetlands, depending on the connectedness of a wetland network (Lookingbill et al. 2010, Nicholson et al. 2024)). For Rafinesque's big-eared bats in Georgia, highest colony densities for the were predicted by duration and size of wetland flooding, with semi-permanent waters being the best indicator (Clement and Castleberry 2013). Myotis species were also found to have increased acoustic activity after wetland restoration (Vasko et al. 2024). Northern long-eared and tricolored bats were among the species shown to rapidly increase in acoustic activity following a wetland construction in North Carolina (Parker et al. 2019).

Drinking water is essential, especially when bats are actively foraging. Bats will utilize a variety of water sources including streams, ponds, and water filled ruts in upland forest. Numerous foraging habitat studies have found that Indiana bats often forage in closed to semi-open forested habitats and forest edges located in floodplains, riparian areas, lowlands, and uplands; old fields and agricultural fields are also used (USFWS 2007). Northern long-eared bats typically forage under the canopy on forested hillsides and ridges rather than along riparian areas (LaVal et al. 1977; Brack and Whitaker 2001). However, forest-covered streams may also be used by the northern long-eared bats during foraging and travel (USFWS 2015).

Rock quarries can expose and concentrate naturally occurring elements that are toxic to bats, such as selenium. Selenium, in particular, has gained attention due to its narrow range between essential dietary requirements and toxic thresholds in wildlife. During rock mining and processing, selenium can be released in multiple forms and transported via surface runoff and groundwater, eventually making its way into aquatic systems where it bioaccumulates through food webs (Etteieb et al. 2020). However, it is uncertain if selenium may be a concern for the geology of this proposed quarry.

The covered species collectively feed on a variety aquatic and terrestrial insects. Indiana bat diets vary seasonally and among different ages, sexes, and reproductive status. Four orders of insects contribute most to the diet of the species: Coleoptera, Diptera, Lepidoptera, and Trichoptera (Belwood 1979; Lee 1993; Kiser and Elliot 1996; Murray and Kurta 2002). Various reports differ considerably in which of these orders is most important. Consistent use of moths, flies, beetles, and caddisflies throughout the year at various colonies suggests that Indiana bats are selective predators to a certain degree, but incorporation of other insects into the diet also indicate these bats can be opportunistic (Murray and Kurta 2002). Brack and LaVal (1985) and

Murray and Kurta (2002) suggested that the Indiana bat may best be described as a "selective opportunist." The northern long-eared bat has a diverse diet that includes aquatic insects such as caddisflies (Griffith and Gates 1985; Nagorsen and Brigham 1993; Brack and Whitaker 2001).

The negative impacts of sedimentation on aquatic insect larvae are well-documented.In a literature review, Henley et al. (2000) summarized how stream sedimentation impacts aquatic insect communities. Sediment suspended in the water column affects aquatic insect food sources by physically removing periphyton from substrate and reducing light available for primary production of phytoplankton. Sediment that settles out of the water column onto the substrate fills interstitial spaces occupied by certain aquatic insect larvae. Increases in sedimentation can change the composition of the insect community in a stream. In a three-year study measuring sedimentation and macroinvertebrate communities before, after, and during disturbance from a highway construction site, Hendrick (2008) found increased turbidity and total suspended solids downstream from the construction that correlated with a shift in macroinvertebrate communities. The change, however, was not great; the Hilsenhoff Biotic Index decreased from "excellent" before construction to "good" after construction. The use of BMPs likely minimized the effects of the construction on the macroinvertebrate communities.

Roughly 2-3% of Tennessee is wetland based on the state's data from 1988 (TDEC 1988). Potentially, 2.5% of Tennessee's 14 million acres of forest could contain wetlands and a smaller portion would be semi-permanently and permanently flooded wetlands that are important for bats. This project proposes a permanent loss of 0.65 acres of three ponds and impacts to perennial streams. On a local scale alteration of these water resources may not be significant to the very few bats found to utilize the CRN Site given the availability of alternate local sources.

Effects Pathway 4

Activity – Fill of 0.65 ac of semi-permanent wetlands and 3,585 lineal feet of impacts to 11 perennial/intermittent streams, warm water discharge into the Clinch River, and potential water quality degradation from runoff.

Stressor – Reduction of drinking water and significant source of food production.

Exposure (time) – Temporary and permanent loss or alteration

Exposure (space) – Semi-permanently and permanently flooded wetlands and streams within removed forest or within 1000 ft of remaining contiguous forest and quarry holding ponds.

Resource Affected – Individual foraging bats and potential, unknown maternity colonies that may have relied on the water sources within the female home range.

Individual Response – Modification of habitat altering essential feeding behavior; loss of drinking water and insect biomass sources within home range of pregnant or lactating females; reduction of insect biomass to sustain colonies; reduced fitness and reproductive success;

potential toxicity of holding ponds that bioaccumulate or may be directly ingested as drinking water.

Conservation and Minimization Measures

- Divert runoff away from disturbed areas
- Provide for dispersal of surface flow that carries sediment into undisturbed surface zones with high infiltration capacity and ground cover conditions
- Prepare drainage ways and outlets to handle concentrated/increased runoff
- Minimize length and steepness of slopes; Interrupt long slopes frequently
- Keep runoff velocities low and/or check flows
- Trap sediment on-site
- Inspect/maintain control measures regularly and after significant rain
- Re-vegetate and mulch disturbed areas as soon as practical
- Extra precaution (wider buffers) within SMZs is taken to protect stream banks and water quality for streams, springs, sinkholes, and surrounding habitat
- BMPs are implemented to protect and enhance wetlands.
- Vegetation removal in streamside management zones (SMZs) and wetlands would be restricted to trees tall enough, or with the potential to soon grow tall enough, to interfere with conductors. Clearing in SMZs would be accomplished using hand-held equipment or remote-handling equipment, such as a feller buncher, to limit ground disturbance.
- The quarry design would include equipment and/or holding ponds within the disturbed area for managing run-off and wastewater generated by the quarry. Stormwater BMPs would be instituted and maintained during the entire period of building and quarry operations.

Interpretation - Loss of insect biomass will reduce fitness because bats will not gain the energy reserves needed to maintain hibernation and survive WNS. Drinking water is essential to bats and reducing these waters on the landscape forces bats to travel farther; this can be particularly detrimental to pregnant and lactating females that have smaller home ranges to conserve energy. Drinking water sources and aquatic insect prey are not expected to be eliminated from the home range given the amount of adjacent flooded habitats along the Clinch River. Bats have shown they can use a variety of drinking water and prey sources and do not forage exclusively on aquatic insect prey. By itself, loss of the wetlands and impacts to the perennial streams is not expected to be significant effect in addition to the loss of forested habitat, especially given the small amount in comparison to the remaining available amount. However, continued

development and loss of these wetlands in the larger area may contribute to reduced population level fitness. Finally, it is unknown at this time if heating of the Clinch River from the SMR discharge would have any measurable effects on insect biomass or emergence and drinking water sources.

5.4. Stressor: Collision

Increased vehicle traffic may pose a risk to bats due to increased risk of collision caused by the Action. During the post-construction (operations) component of the Action, collisions could potentially occur between foraging bats and traffic. The majority of studies on vehicle collisions with bats examine highway traffic effects (e.g., Russell et al. 2009, Butchkoski and Hassinger 2002, Lesinski et al. 2011). However, the majority of traffic movement will occur during daylight hours when bats are inactive, the speed of travel is expected to be slow on the new access road and the volume of traffic is expected to be mainly those working at the facility. Therefore, we consider the likelihood of collisions from the new road to be discountable.

5.5. Summary of Effects

The proposed Action will result in 250 ac of clearing of forested habitat, disturbance to known tricolored bat hibernacula and gray bat colony, harmful noise and lighting effects over remaining forest habitat within the 1.1 mi radius of 120 dBA noise source (as measured at 50 ft) and loss or degradation of aquatic resources. The effects of 250 ac of habitat removal will result in indirect harm to forest-dwelling bats from tree removal during the inactive season, but may cause direct effects from loss of trees that moderate climate, noise and lighting effects within 0.25 mi of known occupied caves. The above-listed adverse effects would occur primarily for gray and tricolored bats, although a very low number of Indiana bats could be affected. Northern long-eared bats are not expected to be exposed to effects from this Action.

Table 5-1. Breakdown of the Action by effects and expected stressors.

Activity	Tree Removal	Noise and Lighting	Impacts to Waters
Temporary construction	X	X	X
Permanent lighting		X	
Operations and Maintenance		X	unknown

6. CUMULATIVE EFFECTS

In the context of a consultation, cumulative effects are the effects of 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 section 7 of the ESA.

The CRN site will eventually include the construction of three additional SMRs within the action area footprint. No additional tree clearing is anticipated to cover that construction. At this point

in time, there are no estimates of cooling water withdrawals and discharges associated with the operation of four SMRs simultaneously.

The Action Area is entirely under federal ownership and management; all future actions would be federal actions subject to consultation, and, therefore, cumulative effects are not relevant to this consultation.

7. CONCLUSION

The Service concludes that forest-dwelling bats (Indiana bat and tricolored bat) and cave roosting, gray bats may be directly and indirectly affected by the project. Given the documented presence of these species in the Action Area, the Service anticipates that effects to all of these species may occur.

In summary, the following direct and indirect effects to these bats are possible:

1. Injury from indirect harm as a result of loss of 250 acres of suitable habitat;
2. Injury or mortality from impairment of essential behaviors as a result of loud and very loud construction activities out to 1.1 miles of the CRN-1 activities; and
3. Injury from degraded habitat quality of remaining contiguous habitat as a result of lighting and impacts to aquatic resources.

After reviewing the current status of Indiana bat, northern long-eared bat, tricolored bat, and gray bat and the environmental baseline for the Action Area, the Service confirms, in this BO that construction of the proposed Action in Roane County, TN, is not likely to jeopardize the continued existence of these bat species because: (1) the adversely affected project area would be small relative to the species' ranges, and therefore, include only a small fraction of their overall populations, (2) direct effects related to construction would be temporary, (3) a relatively low number, if any, of each species is expected to occur in the action area, and (4) an appropriate level of compensatory mitigation would be implemented to identify and protect maternity colonies where needed. No critical habitat has been designated for these species in the Action Area; therefore, none would be affected.

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, 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. TVA has a continuing duty to regulate the activities covered by this ITS.

For the tricolored bat, considered as part of the CO with this BO, the prohibitions against taking endangered species under section 9 of the ESA or under a Section 4(d) rule for threatened species do not apply until the species is listed. If the CO is adopted as a BO following a listing or designation under section 4 of the ESA, the Reasonable and Prudent Measures (RPMs), with their implementing T&Cs, will be nondiscretionary for the tricolored bat. T&Cs must be undertaken, for the exemption in section 7(o)(2) to apply. See Section 10 of this document for instructions on adopting the CO.

The ITS provided in the CO does not become effective until the species is listed, and the CO is adopted as the BO issued through formal consultation. At that time, the project will be reviewed to determine whether any take of the species or its critical habitat has occurred. Modifications of the opinion and incidental take statement may be appropriate to better reflect take. No take of the species or its critical habitat may occur between the listing effective date of a species and the adoption of the CO through formal consultation, or the completion of a subsequent formal consultation.

8.1. Amount or Extent of Take Anticipated

The amount of incidental taking of gray and tree-roosting bats that the Service anticipates in the forest environment is calculated as acres of habitat and a qualitative description of individuals because the number of individual bats cannot be accurately predicted from survey data and habitat quality, though past attempts have been tried..

The Service anticipates that the Action is reasonably certain to cause incidental take of individual gray, Indiana, and tricolored and that they will be difficult to detect for the following reasons:

1. The individuals are small and occupy forested habitats or caves where they are difficult to find;
2. Tree-roosting bats form small, widely dispersed maternity colonies, some species occur under loose bark or in the cavities of trees, and males and non-reproductive

females may roost individually, which makes finding the species or occupied habitats difficult. In particular, tricolored bats quickly release from their leaf cluster and cannot be detected with emergence surveys;

3. Finding dead or injured specimens during or following project implementation is unlikely;
4. Gray and tree-roosting bats are mostly nocturnal; and
5. Most incidental take will be non-lethal and undetectable (e.g., bats fleeing disturbances caused by proposed activities, which creates the likelihood of death or injury due to predation and reduced fitness).

Due to the difficulty of detecting take of gray and tree-roosting bats, TVA will monitor the extent of take using the surrogate of acreages of forested habitats altered by the proposed Action. The amount of anticipated taking depends upon the seasonal timing of these activities and conservation and minimization measures that are implemented. **Therefore, TVA will monitor effects of the project to the bats within the [redacted], HPA, tricolored bat hibernacula and [redacted] and adjacent contiguous forest to ensure take, as described in Table 8-1, is not exceeded.**

Table 8-1. Allocation of take by species, life stage, and type of take.

	Species	Harm	Harass
Cave Life-stage	*Gray*	up to 50 individuals	no additional
	Indiana	NA	NA
	Tricolored	NA	up to 5 individuals
Forest Life-stage	*All three species*	250 ac	3,844 ac

8.1.1. Methodology for estimating take

The number of individuals harmed or harassed during their cave-dwelling life stage was based on the maximum count identified in the cave surveys (Section 4) and buffered to allow for annual variation. Given the restriction on drilling or blasting within 0.5 mile of the tricolored bat hibernacula from November 15 to March 31, blasting from 0.5 out to 1.1 miles of the hibernacula is less likely to result in harm and may instead result in harassment.

Indirect harm from removal of a significant amount of acres (250 ac) will occur for all three species. These acres are adjacent a gray bat maternity colony and are thus significant to this colony. Greater than 100 ac of forest is considered significant to forest-dwelling bats such as the northern long-eared bat and tricolored bat according to recent Service guidance (Service 2024d). It is unknown, given the low number of Indiana bats in the project area, if the habitat loss is

significant for this species, but we conservatively assume it is similar to loss for the other bat species.

National Land Cover Data from 2023 indicates 32.5% of the project area is forested and another 8.7% is wooded wetland area, totaling 41.2%. If this percentage was applied to the entire 120 dBA (1.1 mi) area encompassing the 536-ac disturbance area (Figure 2-2), or 9331 ac, then 3,844 ac of remaining forest roosting and foraging habitat may be impacted by loud construction activities for a few years and bats roosting and foraging in this area may be exposed to effects and take in the form of harassment. The occupancy of gray bats in this area could be around 65%; however gray bats have very large home ranges (50 km). The occupancy of Indiana bats is expected to be less than 31% and the occupancy of tricolored bats is expected to be over 70% based on unpublished data from ORR.

8.1.2. Effect of the take

In this BO, we determined that the anticipated level of incidental take would not result in jeopardy to the continued existence of the gray bat, Indiana bat, or tricolored bat (see Section 7). Previous BOs, completed for populations of gray bats, Indiana bats, and northern long-eared bats within Tennessee, which identified incidental take, have been included in Appendix B.

The use of BMPs and conservation measures provided in Section 2 have significantly reduced the likelihood for direct harm and will work to reduce overall impacts The conservation measures and offset of the take described in Section 2.4 will significantly benefit the species and the local populations affected by the action.

8.2. Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures (RPMs), in addition to the best management practices and conservation measures in the Action description that TVA pledged to implement, are necessary and appropriate to minimize impacts of incidental take of bats:

1. Where nuclear safety regulations allow, TVA will integrate downward-facing, cut-off lens lights to the maximum extent practicable in the CRN-1 lighting design. This design approach will minimize effects to remaining habitat for bats and other nocturnal species.
2. TVA will monitor quarry holding ponds and any post-construction pooled waters within the quarry for selenium concentrations in order to determine if selenium bioaccumulation becomes an issue for bats in the area.
3. TVA must adequately monitor the action area during construction of CRN-1 to document and report to the Service any potential changes to the expected effects resulting from the Action.
4. TVA must report any excessively loud blasting above 120 dBA at 50 ft to the Service immediately to determine if take has been appropriately assessed.

5. TVA will ensure that post-construction monitoring occurs to determine any changes to local bat populations within the action area. This monitoring is central to understanding the occurrence, distribution, and relative abundance of the bat species on the CRN site and the success of conservation measures.
6. TVA will delineate and report the acreage of trees removed within 0.25 mi of the [redacted] known tricolored bat hibernacula and [redacted].
7. TVA will monitor bat occupancy in the aforementioned four caves pre- and post-construction for abundance of endangered bats during the winter season and continue periodic monitoring of these caves in conjunction with state and federal partners to support the goals of Tennessee's WNS response efforts.

8.3. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the TVA must comply with the following terms and conditions (T&Cs), which carry out the RPMs described above. These T&Cs are non-discretionary.

1. TVA will develop a post-construction monitoring plan in coordination with the Service. The plan must be submitted for approval at least 60 days prior to the commencement of post-construction activities and include specific methodologies for revisiting sites where environmental baseline data were gathered to facilitate a robust assessment of any changes in conditions.
2. TVA will sample selenium concentrations in the quarry holding ponds on at least one occasion using a minimum of three distributed samples once significant rock exposure and runoff from the quarry has occurred. This will ensure proactive management if selenium levels are deemed a concern based on initial results. Results of the selenium sampling will be reported to the Service within two weeks after receipt of the laboratory analyses, alongside a discussion of the need for further monitoring.
3. TVA will report CRN Site bat survey data to the Service within 6 months of collection, along with other relevant site information such as hibernacula tree removal and selenium concentrations. TVA will outline potential adaptive management actions in the reporting, detailing how findings will guide future actions to mitigate impacts on bat populations. This may include specific examples of habitat enhancement or monitoring adjustments as needed.
4. All bat survey data will be uploaded to the North American Bat Monitoring Program (NABat) within 3 months of data collection. Full point-data access will be provided to the Tennessee Ecological Services Field Office, ensuring collaboration and allowing for independent verification.

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification shall be made to the Service's Law Enforcement Office in Nashville, Tennessee (telephone: 615/736-5532). Additional notification shall be made to the Service's TNFO in Cookeville, Tennessee (telephone: 931/528-6481). Care shall be taken in handling sick or injured individuals and in the preservation of specimens in the best possible condition

for later analysis of cause of death or injury.

The RPMs, with their implementing T&Cs, are designed to minimize the effect of incidental take that might otherwise result from the proposed action. **The Service believes that no more than 4,094 ac of gray, Indiana and tricolored bat habitat, and no more than an additional 50 gray bats and 5 tricolored bats will be incidentally taken.** If, during the course of the Action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The federal Action Agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

9. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. To further minimize or avoid potential adverse effects of the proposed action on listed species and critical habitats, the Service strongly recommends the TVA consider the following discretionary agency activities. These recommendations are align with TVA's 2020 Natural Resource Plan (NRP) (TVA 2020) and seek to enhance the ecological integrity of the Tennessee Valley while supporting TVA's mission.

1. TVA should explore creating enhanced habitat connectivity by evaluating options for linking preserved habitats in the area. By considering actions that allow bats greater access to foraging and roosting sites critical to their survival, TVA will contribute to the overall ecological health of the region. This approach aligns with TVA's objectives to promote biodiversity and enhance habitat stewardship (NRP Section 5.4).
2. TVA should view proposed actions, such as the Action covered by this consultation, as opportunities to raise awareness and promote conservation of bats on TVA lands, aligning with the strategies outlined in NRP Section 11.2. Such outreach activities would be invaluable in making residents and developers in Anderson and Roane counties aware of the need to protect these species and their habitat.

By integrating these recommendations, TVA can further align its actions with Congressional intent under the ESA, promoting effective conservation of federally listed species and enhancing the region's ecological integrity. Implementing these strategies not only minimizes adverse effects on bat populations but also reinforces TVA's commitment to responsible resource management as articulated in the 2020 NRP. This proactive approach heightens TVA's role as a leader in environmental stewardship while simultaneously encouraging community engagement and fostering sustainable energy and economic development in the Tennessee Valley.

10. REINITIATION NOTICE

This concludes formal consultation on construction and operation of CRN -1 in Roane County, Tennessee (the Action). As written in 50 CFR Section 402.16, reinitiation of formal consultation is required where discretionary TVA involvement or control over the Action have been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the Action that may affect listed species or critical habitat in a

manner or to an extent not considered in this BO; (3) the Action is later modified in a manner that causes an effect to a listed species or critical habitat not considered in this BO; or (4) a new species is listed or critical habitat designated that may be affected by the Action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease until reinitiation.

This also concludes the conference on the Action outlined in the consultation request. You may ask the Service to confirm the CO as a BO issued through formal consultation if the tricolored bat is listed or critical habitat is designated at a later date. The request must be in writing. If the Service reviews the proposed Action and finds that there have been no significant changes in the Action as planned or in the information used during the conference, the Service will confirm the CO as the BO for the Action and no further section 7 consultation will be necessary.

After listing of the tricolored bat as endangered/threatened and/or designation of critical habitat and any subsequent adoption of this CO, the Federal agency shall request reinitiation of consultation if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency Action that may affect the species or critical habitat in a manner or to an extent not considered in this CO; (3) the agency Action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this CO; or (4) a new species is listed or critical habitat designated that may be affected by the Action.

The Service appreciates the cooperation of TVA during this consultation. For further coordination please contact Steve Alexander with the Tennessee Ecological Services Field Office at 931/650-0004 or by email at steven_alexander@fws.gov.

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12. APPENDIX A

Summary and comparison of species-specific foraging and roosting requirements during the non-hibernation period for tree-roosting bats in the Action Area (Service 2022).

Activity	Indiana bat	Northern long-eared bat	Tricolored bat
Roost Trees	Dead (sometimes live); under loose bark or in crevices; maternal rooCRN -1 typically larger diameters and require solar exposure but during cold, wet, and excessively hot weather, and males, seek less-exposed rooCRN -1 (e.g., live trees, primarily shagbark hickory (*Carya ovata*), and higher canopy cover	Roost generaliCRN -1: live or dead; cavity, crevices, and (under bark); small or large diameters, tree can have solar exposure but not required (i.e., often associated with relatively high canopy cover)	Live (or dead) trees; in dead (seldom live) leaf clusters among foliage; solar exposure seasonally variable; in South, cavities in live trees during winter.
Use of Man-made RooCRN -1?	Yes, but less common than trees: solar-exposed rocket-style bat box or simulated bark rooCRN -1 preferred and have occasionally been found in buildings	Yes, but use less than trees: bat boxes, sometimes crevices in buildings (e.g., in walls or other tight spaces)	Yes, but less use than trees: open, lighted areas, e.g., under porch roofs. Culverts and bridges and other transportation structures (summer and winter use)
Roost Tree Species	Oak (*Quercus spp.*), hickory (*Carya spp.*), cottonwood (*Populus spp.*), elm (*Ulmus spp.*), maple (*Acer spp.*), pine (*Pinus spp.*), and other species that typically develop required micro- habitat, e.g., large chunks of sloughing bark or crevices	Pine, oak, maple, ash (*Fraxinus spp.*), black locust (*Robinia pseudoacacia*) and suppressed understory trees (e.g., sassafras [*Sassafras albidum*], sourwood [*Oxydendrum arboreum*], dogwood [*Cornus spp.*], redbud [*Cercis canadensis*]) that develop cavities or loose bark	Primarily deciduous forest, especially in oaks; occasionally in pine-dominated stands and in pine.
Roost Tree Habitat	Bottomland, riparian, wetland, or upland; choose rooCRN -1 in hydric habitats and along edges of harvest openings	Upland forest; do not avoid managed stands (e.g., harvest, prescribed fire), and sometimes use trees within them	Upland or riparian, retention areas within or near partially harvested (i.e., more open) stands
Roost Area Fidelity	Yes, but with frequent roost switching within an area	Yes, but with frequent roost switching within an area	Yes, especially compared to other foliage-roosting bats
Foraging Habitat	Forested streams, upland trails, edges, ponds, in open understory conditions, canopy gaps, woods roads	Cluttered forest conditions under forest canopy in uplands: paths, edges of harvest areas; forested ponds, streams, and cluttered riparian habitat (e.g., upland swamps)	Forested streams with open spaces, edge habitats, uplands & bottomlands, large reservoirs, and other water bodies
Foraging Strategy (see Faure et al. 1993)	Aerial hawker	Gleaner & aerial hawker	

13. APPENDIX B

Incidental Take of Gray Bats from Previous Consultations in Tennessee

Biological Opinions Issued (Year)	Incidental Take Numbers
2015	32.5 ac of suitable swarming or roosting habitat, and impacts to greater than 0.23-ac of wetlands of 717 linear ft of streams in Van Buren and Bledsoe counties
2016	An unknown number of individuals within 577 ac of summer foraging habitat on Arnold Air Force Base
2023	Up to four disturbance events/year equating to 48 individual bats/year (720 over the 15-yr action period) on Arnold Air Force Base
2024	Loss of foraging habitat for 25 gray bats within 223 ac of on Oak Ridge Reservation
2025	Very low number of individuals in 935 ac of tree removal and 10,691 ac of remaining affected habitats on Milan Volunteer Training Site.

Post-WNS (2015 on) Incidental Take of Indiana Bats from Previous Consultations in Tennessee

Biological Opinions Issued (Year)	Incidental Take Numbers
2015	Unspecified number within 25,700 ac of the Cherokee National Forest
2015	Unspecified number of individuals within 32.5 ac of suitable swarming or roosting habitat in Van Buren and Bledsoe counties
2015	Unspecified number of individuals within 15,925 ac of suitable summer habitat on Arnold Air Force Base
2016	All Indiana bats occurring within 13.2 ac of suitable Indiana bat summer roosting habitat in Van Buren County
2016	All Indiana bats inhabiting 298.5 ac of golden-winged warbler (*Vermivora chrysoptera*) habitat within the Appalachian portion of their range in Tennessee
2016	All Indiana bats inhabiting 106 ac of suitable summer habitat on property where mine development and operations would occur in Franklin County
2016	180 individuals occupying 2,920 ac of forested habitat in Claiborne County
2016	180 individuals occupying 4,858 ac of forested habitat in Campbell County
2016	Using habitat as a surrogate, incidental take of up to 10,000 ac
2017	180 individuals occupying 7,476 ac of forested habitat in Claiborne County

2018	Seven individuals annually and 50 individuals over 20 years within the seven-state Tennessee Valley Authority Region, including portions of Tennessee
2022	85 individuals annually within 21,240 ac of summer roosting habitat in the Cherokee National Forest over 15 years
2022	No more than four individuals in 139.2 ac of suitable summer habitat on Volunteer Training Site-Tullahoma/Arnold Air Force Base, Coffee and Franklin Counties
2023	45 ac of suitable summer habitat affected by the action equating to 3 individual bats on Arnold Air Force Base
2024	16 Indiana bats in 223 ac of suitable roosting and foraging habitat on Oak Ridge Reservation
2025	61 Indiana bats in 889 acres of occupied habitat on Bridgestone-Firestone Wildlife Management Area
2025	10 Indiana bats in 144 ac of suitable roosting and foraging habitat on Oak Ridge Reservation.
2025	Very low number of individuals in 935 ac of tree removal and 10,691 ac of remaining affected habitats on Milan Volunteer Training Site.

Post-WNS (2015 on) Incidental Take of Northern Long-eared Bats from Previous Consultations in Tennessee

Biological Opinions Issued (Year)	Incidental Take Numbers
2015	Unspecified number of individuals within 32.5 ac of suitable swarming or roosting habitat in Van Buren and Bledsoe counties
2015	Unspecified number of individuals within 15,925 ac of suitable summer habitat on Arnold Air Force Base
2016	Using habitat as a surrogate, incidental take of up to 10,000 ac
2018	Seven individuals annually and 50 individuals over 20 years within the seven-state Tennessee Valley Authority Region, including portions of Tennessee
2022	No more than three individuals in 139.2 ac of suitable summer habitat on Volunteer Training Site-Tullahoma/Arnold Air Force Base, Coffee and Franklin Counties
2023	Four individuals annually and 24 individuals over 15 years within the seven-state Tennessee Valley Authority Region, including portions of Tennessee
2023	Five individuals annually within 578 ac of post-WNS documented occurrence buffers on the Cherokee National Forest over 14 years

2023	84 ac of suitable summer habitat affected by the action equating to five individual bats on Arnold Air Force Base
2024	13 northern long-eared bats in 223 ac of suitable roosting and foraging habitat on Oak Ridge Reservation
2025	17 northern long-eared bats in 889 acres of occupied habitat on 3,554 ac of Bridgestone-Firestone Wildlife Management Area
2025	Loss of 144 ac of suitable roosting and foraging habitat on Oak Ridge Reservation.