Programmatic Biological Opinion and Conference Opinion For Imperiled Bats on the Ozark-St. Francis National Forest

FWS Project Code: 2023-0008211

Prepared by:

U.S. Fish and Wildlife Service
Arkansas Ecological Services Field Office
110 South Amity Road, Suite 300
Conway, Arkansas 72032

MELVIN TOBIN Digitally signed by MELVIN TOBIN
Date: 2023.04.19 09:46:05 -05'00'

April 19, 2023

Melvin L. Tobin
Field Supervisor

Date

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This Endangered Species Act (ESA) Biological Opinion (BO) of the U.S. Fish and Wildlife Service (Service) addresses the Ozark-St. Francis National Forests (Forest) proposed implementation of the Revised Land and Resource Management Plan (Forest Plan; implementation of the Forest Plan will herein be referred to as "the Action"). The Forest proposes to conduct routine activities implemented by or authorized by the Forest to achieve the goals and objectives of the Forest Plan. The Forest determined that the Action is likely to adversely affect Indiana bat (*Myotis sodalis*; IBAT), northern long-eared bat (*Myotis septentrionalis*; NLEB), and tricolored bat (*Perimyotis subflavus*; TRBA) and requested formal consultation with the Service. The BO concludes that the Action is not likely to jeopardize the continued existence of these species. This conclusion fulfills the requirements applicable to the Action for completing consultation under §7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, with respect to these species and designated critical habitats.

The Forest also determined that the Action is not likely to adversely affect little brown bat (*Myotis lucifugus*; LBBA) and requested Service concurrence. The Service concurs with this determination for LBBA.

Reinitiating consultation is required if the Forest retains discretionary involvement or control over the Action (or is authorized by law) when:

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

CONSULTATION HISTORY

This section lists key events and correspondence during the course of this consultation. A complete administrative record of this consultation is on file in the Service's Arkansas Ecological Service Field Office (AFO).

2005-08-09 – The Forest sent a biological assessment (BA) of the effects of implementing the Forest Plan to the AFO for review.

2005-09-22 – A BO for the American Burying Beetle and concurrence on the effect determinations to other listed species was issued on the Forest Plan.

2013-07-30 – A supplemental BA to the Forest Plan addressing new additions to the proposed, threatened and endangered list, including Speckled Pocketbook, Spectaclecase, Neosho Mucket, Rabbitsfoot, and Yellowcheek Darter, was sent to the AFO in June 2013. The AFO concurred with the effects determination via letter dated July 30, 2013.

2014-03-26 – The Forest proposed an implementation plan for "compliance" survey protocols and protections applied when IBAT or roost trees were detected during surveys. The AFO concurred with the proposed compliance surveys, proposed active season buffers surrounding positive captures, and protections for known roost trees.

2014-07-31 – The Forest prepared a "Non-jeopardy Interim Conference Report for the Continued Implementation of Forest Service Southern Region Land and Resource Management Plans and Associated Projects," as related to the distribution range of NLEB in Southern Region National Forests. This interim conference report document analyzed effects of the U.S. Forest Service's routine Forest management, as outlined in Forest Plans for each National Forest. The Service provided written concurrence to the U.S. Forest Service's "no jeopardy" determination on August 27, 2014.

2015-01-12 – The U.S. Forest Service transmitted the "Biological Assessment for Activities Affecting Northern Long-eared Bats on Southern Region National Forests," signed December 22, 2014 to the Service. This document assessed Forest Plan activities occurring after April 1, 2015, for the Forest Plan duration, including activities that occur during winter hibernation. This document developed programmatic level potential effects from Forest management activities to support determinations for the species by compiling annual acreages corresponding to Forest Plan objectives for each activity type that may affect the NLEB.

2016-02-16 – The Service implemented the NLEB final 4(d) rule. On February 11, 2016, the Forest Service Regional Forester sent a letter to the Service's Region 4 Director providing their decision to implement the NLEB final 4(d) rule using the voluntary process outlined in the January 5, 2016, NLEB Programmatic BO.

2019-03-04 – Forest met with AFO to initiate discussion regarding amending Forest Plan standards and conservation measures pertaining to IBAT.

2019-05-01 – Forest sent an email to AFO describing proposed Forest Plan standards and conservation measures pertaining to IBAT.

2019-05-03 – AFO met with Forest to discuss proposed Forest Plan standards and conservation measures pertaining to IBAT, as well as how best to move forward with reinitiating consultation with the Service. During this meeting, Forest described how new data collected on IBAT in Arkansas and on the Forest provides new information on potential effects of their actions.

2019-05-20 – Forest sent an email to AFO containing an updated draft of the amended IBAT conservation measures, as discussed in the May 3, 2020, meeting.

2019-08-21 – Forest sent an email to AFO seeking guidance on inclusion of Snuffbox mussel and Ozark Hellbender in the Forest Plan amendment. AFO suggested a "no effect" determination was appropriate for these species at this time.

2019-08-25 – Forest sent an email to AFO providing an updated draft of proposed conservation measures for IBAT to include in the Forest Plan amendment.

2019-10-21 – Forest sent an email to AFO providing a draft BA for Service review.

2019-11-08 – AFO responded via email with no comments to the draft biological assessment.

2020-02-10 – Forest sent via email the final biological assessment to AFO, formally reinitiating consultation on the Forest Plan.

2020-02-13 – AFO responded via email confirming receipt of biological assessment and concurring with Forest request to reinitiate consultation.

2022-05-07 – AFO issued the "Programmatic Biological Opinion on Implementation of the Revised Land and Resource Management Plan for the Ozark-St. Francis National Forests" for IBAT.

2022-11-17 – Forest met with AFO and agreed on the need to reinitiate consultation to cover NLEB, IBAT, TRBA, and LBBA.

2022-12-02 – Forest submitted via email the first draft of the BA for AFO review and comment.

2022-12-19 – AFO provided comments via email for the draft BA.

2023-01-10 – Forest submitted via email the final draft BA for AFO review and comment.

2023-01-25 – AFO provided comments via email for the final draft BA.

2023-01-31 – Forest submitted via email the final BA and transmittal letter to initiate formal consultation with the AFO.

2023-04-12 – Forest submitted via email the final BA with a minor revision.

BIOLOGICAL OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the findings of the U.S. Fish and Wildlife Service (Service) required under section 7 of the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal action is likely to:

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

The Federal action addressed in this BO is the Forest's proposed implementation of the Forest Plan. The Forest requested to reinitiate consultation on the Forest Plan for IBAT, initiate consultation on NLEB, and conference on TRBA and LBBA. This consultation request is in response to the recent reclassification of NLEB to endangered, proposal to list TRBA as endangered, and the current Discretionary Status Review and potential future listing of the LBBA. Although the Forest recently completed a consultation that included a programmatic BO for IBAT (FWS Log # 04ER1000-2020-F0869), there was interest in re-assessing and including IBAT to improve consistency in management as well as provide some moderate changes to species specific measures.

The Forest's BA addresses the expected effects to the above listed species from implementation of routine activities implemented by or authorized by the Forest to achieve the goals and objectives of the Forest Plan. The Forest determined that the Action is not likely to adversely affect LBBA and requested Service concurrence. The Service concurs with this determination for LBBA. This concurrence fulfills the Forest's responsibilities for the Action under §7(a)(2) of the ESA for this species. Therefore, this BO considers the effects of the Action on IBAT, NLEB, and TRBA. The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat.

<u>BO Analytical Framework</u>

A BO that concludes a proposed Federal action is *not* likely to *jeopardize the continued existence* of listed species and is *not* likely to result in the *destruction or adverse modification* of 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).
>
> "*Destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02).

The Service determines in a BO whether we expect an action to satisfy these definitions using the best available relevant data in the following analytical framework (see 50 CFR §402.02 for the regulatory definitions of *action, action area, environmental baseline, effects of the action*, and *cumulative effects*).

a. *Proposed Action*. Review the proposed Federal action and describe the environmental changes its implementation would cause, which defines the action area.
b. *Status*. Review and describe the current range-wide status of the species or critical habitat.
c. *Environmental Baseline*. Describe the condition of the species or critical habitat in the action area, without the consequences to the listed species caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early consultation, and the impacts of State or private actions which are contemporaneous with the consultation.
d. *Effects of the Action*. Predict all consequences to species or critical habitat caused by the proposed action, including the consequences of other activities caused by the proposed action, which are reasonably certain to occur. Activities caused by the proposed action would not occur but for the proposed action. Effects of the action may occur later in time and may include consequences that occur outside the action area.
e. *Cumulative Effects*. Predict all consequences to listed species or critical habitat caused by future non-Federal activities that are reasonably certain to occur within the action area.
f. *Conclusion*. Add the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, formulate the Service's opinion as to whether the action is likely to jeopardize species or adversely modify critical habitat.

2. PROPOSED ACTION

The Action includes all routine activities involved in the continued implementation of the Forest Plan. These activities include commercial timber harvest, non-commercial silvicultural activities, prescribed fire, forest site clearing for roads, trails, openings, mineral development, restoration activities, individual tree removals, bridge and culvert constructions and repair, and opening and right-of-way maintenance. Furthermore, the Forest proposes implementation of bat specific conservation measures (listed below) to avoid and/or minimize effects to bats and support their recovery. Additionally, the Forest will continue to implement the forest-wide bat specific measures described in the Forest Plan (Appendix A). Projects covered by this BO will implement all of the aforementioned conservation measures. If a proposed project is inconsistent with these measures, then the Forest will seek separate consultation coverage for these species.

2.1. Commercial Timber Harvest

Commercial timber harvests, including regeneration harvest, thinning, salvage, and sanitation cuts, are important management activities on the Forest that have the potential to affect these bat species and their habitat. Timber harvest is conducted to achieve various objectives including improved structure and composition of the forested stands and regeneration to promote stand age diversity, which is important for forest health, wildlife habitat, and commodity production in support of local economies. The projected harvest level for the Forest under Objective 62 of the Forest Plan are 731 million board feet (MMBF) over a decade (2023 - 2033). The FEIS for the Forest Plan estimated that timber harvest would occur on approximately 145,000 acres per decade (2023 - 2033). Annual commercial timber management may occur on ≤1.4% of the acres managed by the Forest. Regeneration timber harvest treatment methods include shelterwood, seedtree, or clearcut. Shelterwood and seedtree harvests are treatments of mature stands that involve removal of most canopy trees, leaving a residual basal area of 10 - 40 ft^2/acre. After the stand has advanced regeneration of young trees established, there is an option to remove or retain the residual overstory trees. Clearcuts are similar, except they have a target residual basal area of 0 - 10 ft^2/acre. Single tree selection and group selection are treatments that result in regeneration of stands that favor shade-tolerant species or if there is a need for a stand with multiple age classes of trees. Commercial thinning is an intermediate treatment, typically resulting in a residual basal area of 50 - 80 ft^2/acre or restoration thinning, resulting in a residual basal are of 40 - 60 ft^2/acre for woodland restoration or 0 - 40 ft^2/acre for savannah or glade.

Timber sales are offered through a competitive bid process. Once the timber sale contract is awarded, the contractor has a specified timeframe, typically 3 - 5 years, to complete all specified items within the contract. Timber harvest operations include clearing land for the construction of log landings and temporary roads; felling of trees according to the silvicultural prescription; yarding trees to the landings via skid trails; erosion control and site restoration on skid trails, landings, and temporary roads. Timber felling, skidding, and erosion control are all typically done with heavy equipment. Temporary roads, landings and skid trails are left in a stable condition when operations are not active and closed after use.

Salvage and sanitation harvests are conducted in the same way as a typical timber harvest; however, the objective is to salvage trees for use as wood products following natural disasters such as windstorms, tornados, heavy snow/ice, and floods or to control insect or disease outbreaks (e.g., gypsy moth, southern pine beetle). Although salvage sales are like other timber sales, they are typically implemented quickly to recover dead or damaged trees for forest products before they decay or become unsuitable for commercial use or to reduce spread of insects and disease. Potential salvage depends on the amount and severity of future tree mortality and damage resulting from events such as insect outbreaks, ice storms, and windstorms. Designated firewood collection areas on the Forest allow the public to remove wood and can include standing or downed wood. Firewood removal by the public involves chainsaws and vehicles. In these cases, stands are marked for a silvicultural prescription, either leave trees are marked or removal trees are marked, and the firewood collection is the tool used to meet the prescription. Larger areas may be designated for general collection within 300 feet of the road and include only dead and downed trees. In some cases, standing dead trees are marked as hazard trees and will be made available for firewood collection. These trees would only be available during the period when bats are hibernating.

Maximum annual activities for consultation:
- *Thinning, firewood cutting, salvage, and sanitation (12,000 acres)*
- *Regeneration timber harvests (4,000 acres)*
- *Temporary road construction and decommissioning (100 acres)*

2.2. Non-commercial Silvicultural Activities

Non-commercial silvicultural activities are conducted to improve forest health, structure, or composition and are most frequently conducted in young age stands or to treat sub-canopy layers in more mature stands. Although this type of treatment often targets smaller diameter trees than commercial timber activities, many of these trees can still be suitable for bat roosting, and there are cases that large diameter trees are removed.

Precommercial thinning or tree release is the removal of trees to create desired stocking levels and to shape the species composition of the stand by removing trees manually, mechanically, or chemically that are too small to be commercially viable. Understory removal targets 1 inch diameter or smaller stems and is typically conducted to achieve target stocking density and species composition. Midstory removal targets 1 - 8 inch diameter stems and has the goal of promoting desirable seedling recruitment or promoting grasses, forbs, or cane stalks for wildlife habitat benefit. Precommercial thinning involves mechanical or chemical treatments to remove competing trees that are generally ≤ eight inches in diameter. Wildlife stand improvement (WSI) or Timber stand improvement (TSI) involves removal of trees to improve stand structure, favor certain tree species, or improve wildlife habitat. A wide range of tree sizes and species can be included in these treatments. Finally, eastern red cedar removal is conducted to restore stand composition and may target all stem sizes. For cedar removal, the trees are fallen and left with limbs, fallen and limbs bucked, or masticated with a machine mulching head.

Typically, non-commercial activities do not involve removal of fallen trees from the stand, so skidding, log landings and temporary road construction are not required for these activities. Biomass material is typically left in the stand to decompose or be consumed with prescribed fire.

Maximum annual activities for consultation:
• *Tree release, wildlife or timber stand improvement, mulching, precommercial thinning (17,000 acres)*

2.3. Prescribed Fire

Prescribed fire is used to manage forest fuels to reduce the risk of severe wildfire and to manage habitats and ecological conditions that favor many species of native plants and wildlife. Fire has played an important role in the development of ecosystems of the Arkansas Highlands, Arkansas River Valley, and Crowley's Ridge, providing a disturbance element that creates heterogeneity in the midstory and understory vegetation, favors fire-tolerant tree species on drier forest sites, and creates gaps and variability in the canopy. The prescribed fire program on the Forest is intended to mimic the historic fire frequency and intensity for management of species that are adapted to fire-related ecological disturbances. According to the Forest Plan, prescribed burning annually across the Forest should treat an average of 120,000 acres. Between 2016 and 2022, an average of 62,340 acres (range 33,917 to 80,784 acres) were treated annually with prescribed fire.

When establishing new prescribed fire areas, managers must identify control lines around the fire perimeter. Control lines consist of existing roads, trails, and streams wherever possible. In areas where control lines need to be constructed, methods include use of hand tools and/or bulldozers to create a strip 2 - 10 feet wide, dug to mineral soil. Some trees are fallen with heavy equipment during initial line construction. Snags (standing dead trees) near the line, which pose a hazard to personnel, or which may burn and fall across the line and ignite fire outside the containment line, are felled by either bulldozer or chainsaw. During fire line preparation, snags are fallen from an area one tree length from the containment line inside the burn block. When establishing a new burn block, approximately 50 snags per mile of line need to be fallen for safety and containment. On burn blocks with prescribed fire treatments in the recent past (<7 years), approximately 25 snags per mile are cut because crews only have to remove those trees that died since the last time. Crews also use gas-powered hand tools, such as leaf blowers, trimmers, or weed eaters to remove fuels from the line.

During a prescribed fire, crews will ignite fires using drip torches, flare pistols, or with helicopter or drones dropping delayed aerial ignition devices. There are many factors that influence the fire behavior and effects, including weather conditions during the burn, the type, quantity and moisture level of the fuels, and the pattern of ignition. On the Forest, most containment is done by hand crews, which can dig hand lines, and occasionally dozer line, around any escape fires, called spots. Fire engines are also available to provide water or fire-suppression foam if needed. After the day of the burn, crews will typically inspect the fire line daily until all risk of escape has past. In some cases, fire-weakened trees near the line will be fallen during this period.

Maximum annual activities for consultation:

- *Prescribed fire: 120,000 acres*
- *Fire line construction and preparation during the bat active season: 500 acres (calculated as 50 miles of line with snags removed and average of 75 feet inside the control line).*

2.4. Forest Site Clearing

Numerous small-scale, non-timber projects on the Forest involve clearing trees. Examples of projects that involve tree clearing include road, trail, and parking area construction, mineral development, pond construction and maintenance, and bank stabilization. This type of work typically involves using heavy equipment to remove standing trees, for subsequent earthwork and construction and results in land managed in a non-forested condition for the indefinite future.

In general, road management entails the maintenance or improvement of existing corridors (reconstruction) rather than establishing new roadways (construction), although small sections of new or rerouted roads are needed at times. Both road construction and reconstruction typically require tree removal. Clearing forested areas for roadwork may involve clearing for a re-routed road, for a new stream crossing alignment, or for equipment staging area during construction. When roads are rerouted, the original roadbed is reclaimed and revegetated. New or expanded parking areas or other construction projects, such as reconstruction of a lake spillway, also a require tree removal. Trees removed for construction projects are most frequently removed with heavy equipment. Road maintenance includes brushing, surfacing, culvert and bridge replacement, and grading to assure safe public access within the Forest. Both road reconstruction and construction can remove trees, but generally road maintenance does not remove trees, unless the tree poses a safety hazard. Depending on the amount and quality of the timber, it is either sold and taken to a mill or piled and burned. Road decommissioning may involve removing young trees to recontour the slope to a natural shape to improve stability and drainage.

Trail construction, reconstruction and maintenance typically involves removal of small diameter trees (<8 inches diameter at breast height (DBH)). Clearing areas are typically less than 10 feet wide and maintained as short, non-woody vegetation. Small areas of clearing are occasionally required (e.g. development of a trailhead or installation of a trail bridge).

The Forest Plan identifies the need for creation of wildlife openings and ponds. Openings provide early favorable foraging opportunities for wildlife game species. Most wildlife openings are 1 - 5 acres in size and managed as a grassland. Initial tree removal may be completed as a timber operation and then the stumps are removed from the ground to allow future management by tractor, or whole trees are pushed by heavy equipment. Pond creation and reconstruction is conducted with heavy equipment to remove trees and other vegetation and for earthwork. Reconstruction and maintenance of ponds may only occur every couple of decades when trees grow to larger sizes on the banks and during dam removal for restoring ponds.

The Forest implements soil and water improvement projects, which generally include closing illegal roads and trails, installing gates, and stabilizing streambanks. Individual trees may be felled across illegal roads and trails to block access and small areas may need to be cleared for the structural improvements for streambank restoration projects during the installation of the structural improvements on the bank.

The Forest removes trees or authorizes permittees to clear forested areas to meet management needs beyond ecological restoration. These generally affect small acreage areas or linear corridors for development of recreation facilities, special uses, minerals development activities, right-of-way creation or maintenance, dam maintenance, grazing infrastructure maintenance, and recreation site maintenance.

Managing existing recreation areas periodically involves projects that require clearing small acreage areas for updating or increasing the size of parking areas, adding additional facilities, management of utilities and other new developments. The Forest installs, maintains, and improves recreation sites including trailheads, campgrounds, kiosks, toilets, shooting ranges, vistas, hunting and fishing access points, and developed sites such as campgrounds and parking lots.

The Forest issues special use authorizations for multiple purposes to individuals, corporations, and other government agencies. The predominant uses are for public roads, communication facilities, oil and gas leasing, and utility rights of way. Oil and gas development involves clearing trees and other vegetation for drill pads or other facilities and can result in openings 1 - 5 acres in size. These sites can remain in production phase for many years, and they are reclaimed and revegetated when the production is complete.

Maximum annual activities for consultation:
• *Forest site clearing: 230 acres annual site clearing*

2.5. Individual Tree Removal

Individual tree removal covers projects that involve removing few trees or scattered trees that are more easily quantified by a count of trees removed than acres cleared. Trees being removed may include either live or dead trees. Removal of individual trees is commonly accomplished with a chainsaw, but in some cases heavy equipment may be used to push a tree over. Some examples include hazard trees that need to be removed from recreation areas, rights of way, and administrative areas for the safety of workers or the public or due to risk of damage to infrastructure. Recreation area hazard trees are routinely assessed and removed during the winter months, when sites are closed to the public or have few forest users. In some cases, trees become a hazard during the active season and immediate removal may be required.

Tree removal may be needed for stream and lake habitat enhancement activities that involve felling trees into streams or along a lakeshore for fish habitat structure. Other soil and water projects may require tree removal for equipment access. For soil, water, and wildlife work, snags and other high-quality wildlife trees are not cut.

Maximum annual activities for consultation:
• *500 tree removals during the bat active season (outside of site clearing acres)*

2.6. Mowing, Brush Removal, and Herbicide

Mowing, brush removal, and herbicide applications are used to maintain areas in a condition of low-growing vegetation, such as grass, shrubs or small trees. Areas that receive mowing treatments include, developed recreation sites, administrative sites, wildlife openings, roads, rights-of-way for roads, pipelines, and utilities. Mowing may include lawnmowers, weed eaters, or tractor pulled brush hogs. Although some small trees may be mowed, they are unlikely to provide roosting habitat for bats. Within the proclamation boundary of the Forest, there are approximately 5,000 miles of road, 500 miles of powerline, 114 miles of aerial telephone line, and 140 miles of gas pipeline. The width of vegetation management area depends on the use and right of way width according to the specific use.

Brush removal involves cutting of small diameter woody stems or limbs to create and maintain forest openings. Although this work can be done with powered hand tools like trimmers or weed eaters with rotating blades and chainsaws, it is more commonly accomplished with a brush head with rotating blades mounted on heavy equipment, such as a tractor, skid steer, or excavator. Brush removal can cut vegetation at the ground level or side-trim trees to remove limbs that are growing into a right-of-way. Limbing taller trees is typically conducted on overhead utility lines and occasionally along roads. There are 615 miles of powerlines and overhead telephone lines on the Forest, for which limbing typically occurs every 5 - 10 years to maintain those rights-of-way conditions.

Herbicide is used to control select species or groups of species to maintain desired vegetation on a site. Herbicide is applied for forestry applications, including foliar spray, stem injection, hack-and-squirt, and cut-stump treatments. In open lands settings, herbicide is used to control non-native, invasive plants and woody species. This occurs primarily near roadsides, along rights-of-way, in wildlife openings, and areas that are managed in an open condition, such as glades.

Maximum annual activities for consultation:
• *Mastication, limbing, roadside vegetation clearing: 60 acres (Calculated as length of road, aerial phone, powerline, and pipeline 20 foot width cleared once every 5 years)*

2.7. Maintenance and Non-tree removal Activities

The Forest conducts or authorizes many maintenance activities or other activities that do not require tree removal. The purposes of these activities include maintenance of roads, trails, user

access sites, recreation site maintenance, toilet pumping, buildings, or dams. The Forest conducts activities to enhance lakes for fisheries by adding lime, fertilizer, forage fish, or constructed fish habitat. Special events are conducted by the Forest, such as kids fishing derbies, trainings, stream clean-ups or other group activities. The Forest authorizes activities including forest product collection, research, recreation special events, and regular recreational activities.
The activities covered by this category may involve using equipment ranging from hand tools to heavy equipment. The activities may be wide-spread and routine, such as grading road surfaces and clearing ditches and culverts. In other cases, they are occasional or one-time actions.

2.8. Bridge and Culvert Replacement

Culverts and bridges on the Forest occasionally require major repair or may need to be demolished for replacement or during road decommissioning. Some culvert or bridge structures, particularly concrete elements over three feet in height, have been found to serve as roosts for bats. Although the project may require emergency action, more often the projects require planning, design, and contracting, which allows plenty of opportunity to evaluate if the structures are being used by bats.

2.9. Conservation Measures

2.9.1. General Forest Management

- Retain all snags unless removal is required for safety or prevents implementation of an authorized construction or vegetation management activity. For example, snags may be removed to clear landings, to clear areas for construction, to remove snags that would fall across a road or fireline, or other operationally required elements or if they would threaten worker or public safety in high traffic and developed recreation areas.

- Cutting of standing dead trees for firewood is allowed only during the winter hibernation period (*December 1 to February 28*) and only within 100 feet of a road or fireline.

- Develop strategies in prescribed fire burn plans to prevent excessive heat and smoke impacts to moderate to high-use hibernacula. All moderate to high use hibernacula would be individually evaluated by fire staff and a Forest Service biologist prior to the burn to determine if special preparation or ignition strategies are needed to protect hibernacula.

- Fireline snag removal for prescribed fire shall not occur during the pup season (June 1 - July 31) unless the snag threatens containment in a way that cannot be addressed by removal of fuels from the base of the snag.

- Prior to major repair or demolition of bridges or concrete culverts over 3 feet in diameter, survey for roosting IBAT, NLEB, TRBA, or LBBA. If bats of these species are present, either delay the project until the species vacates the site or coordinate with the Fish and Wildlife Service to determine appropriate exclusion methods.

2.9.2. Maternity Roost Zone Protection

- Tree cutting is prohibited within 150 feet of a known maternity tree except during the hibernation season. Tree removal is typically only conducted to enhance the condition of the roost tree or for safety. Coordinate all tree removal in this area with the Service.
- Tree cutting is prohibited during the summer activity period (March 15 to October 15) within a Maternity Roost Zone (see Table 2-1) unless an emergence survey is conducted the evening before removal of the individual tree to determine that no bats are present.
- In a Maternity Roost Zone, regeneration harvest will not be conducted if it would cause greater than 10% of the area to be in 0 - 10 year age class; regeneration units will not exceed 40 acres; reserve a minimum average of 10 basal area per acre of overstory trees for roost recruitment in regenerated timber stands.
- Prior to prescribed fire, remove fuels from around known maternity trees to prevent damage during the burn.
- New permanent developments within Maternity Roosting Zones, such as construction of new roads, motorized trails, pastures, or special use right of ways are excluded from this consultation. Exceptions may be made where coordination with the Service determines these activities to be compatible with recovery of these species.

Table 2-1. Maternity Roost Zone buffer distances around sites demonstrating evidence of maternity use by the bats under consideration. An area with new or existing evidence of maternity use by any of the covered bat species will be considered a Maternity Roost Zone through the duration of this consultation unless otherwise coordinated with the AFO.

Bat Species	Maternity Roost Zone Distance Around Roosts	Maternity Roost Zone Distance Around Reproductive Capture
Indiana Bat[1]	0.7 mile	1.8 miles
Little Brown Bat[2]	0.7 mile	1.8 miles
Northern Long-eared Bat[3]	0.25 mile	0.75 mile
Tricolored Bat[4]	0.25 mile	0.75 mile

[1] U.S. Fish and Wildlife Service TNFO 2018 Prog BO for TVA, IBat Movement Spreadsheet in References folder
[2] Bergeson 2012, Broders et al. 2006, Henry et al. 2002
[3] Broders et al. 2006, Foster and Kurta 1999, Henderson and Broders 2008, Lacki et al. 2009, O'Keefe 2009, Owen et al. 2003, Perry and Thill 2007, Silvis et al. 2015a, U.S. Fish and Wildlife Service TNFO 2018 Prog BO for TVA
[4] Quinn and Broders 2007, Veilleux et al. 2003, Veilleux and Veilleux 2004

2.9.3. Hibernacula Protection

- Removal of live or dead trees that are potential roosting habitat for bats is prohibited in the hibernacula buffers during the spring staging (March 1 to April 30) and fall swarming (Aug 15 to Nov 30) periods unless an emergence survey is conducted on the tree the evening before removal to determine that no bats are present.

- Prohibit prescribed fire in the hibernacula buffers during the fall swarming period (Aug 15 to Nov 30) if temperatures are <50F.

- Within 500 feet of tricolored bat, northern long-eared bat, and little brown bat hibernacula, new permanent development, such as construction of roads, motorized trails, wildlife openings, pastures or special use right of ways are excluded from this consultation. Exceptions may be made where coordination with the Service determines these activities to be compatible with recovery of these species. Indiana bat hibernacula are protected from permanent development within the primary Indiana bat conservation zone described in FW64 and FW65.

- In the hibernacula buffer, regeneration harvest would not be conducted if it would cause greater than 10% of the area to be in 0 - 10 year age class; regeneration units would not exceed 40 acres; reserve a minimum average of 10 ft^2/acre of overstory trees for roost recruitment in regenerated timber stands.

- White-nose syndrome decontamination protocol shall be required for any underground access.

Table 2-2. Hibernacula buffers. Indiana bat hibernacula protection buffers are protected by Forest Plan Standards: FW 65 and FW 66; see the Forest's BA for detailed descriptions.

Species	Low Abundance	Buffer Distance	Moderate to High Abundance	Buffer Distance
Little brown bat	1-19	0.25 mi	20+	2 miles
Northern long-eared bat	Historic occupancy	500 ft	1+	0.25 miles
Tricolored bat	1-9	500 ft	10+	0.25 miles

*Buffer distance literature (LBBA: Lowe, 2012; NLEB: Environmental Solutions & Innovations, Inc., 2018; TRBA: Tate, 2020; Environmental Solutions & Innovations, Inc., 2018)

2.10. Other Activities Caused by the Action

A BO evaluates all consequences to species or critical habitat caused by the proposed Federal action, including the consequences of other activities caused by the proposed action, that are reasonably certain to occur (see definition of "effects of the action" at 50 CFR §402.02). Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities caused by the proposed action (but not part of the proposed action) are reasonably certain to occur. These factors include, but are not limited to:

(1) past experiences with activities that have resulted from actions that are similar in scope, nature, and magnitude to the proposed action;
(2) existing plans for the activity; and
(3) any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

In its request for consultation, the Forest did not describe, and the Service is not aware of, any additional activities caused by the Action that are not included in the previous description of the proposed Action. Therefore, this BO does not address further the topic of "other activities" caused by the Action.

2.11. Action Area

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). Delineating the action area is necessary for the Federal action agency to obtain a list of species and critical habitats that may occur in that area, which necessarily precedes any subsequent analyses of the effects of the action to particular species or critical habitats.

It is practical to treat the action area for a proposed Federal action as the spatial extent of its direct and indirect "modifications to the land, water, or air" (a key phrase from the definition of "action" at 50 CFR §402.02). Indirect modifications include those caused by other activities that would not occur but for the action under consultation. The action area determines any overlap with critical habitat and the physical and biological features therein that we defined as essential to the species' conservation in the designation final rule. For species, the action area establishes the bounds for an analysis of individuals' exposure to action-caused changes, but the subsequent consequences of such exposure to those individuals are not necessarily limited to the action area.

Figure 2-1 shows the locations of all activities that the proposed Action would cause and the spatial extent of reasonably certain changes to land, water, or air caused by these activities, based on the descriptions and analyses of these activities in sections 2.1 - 2.9. The Action Area for this BO includes approximately 1.2 million acres of National Forest System lands in the Ozark Highlands, Arkansas River Valley, and Crowley's Ridge areas of Arkansas. The Forest is divided into six ranger districts located in 18 counties. The Ozark National Forest is located in northwest and north central Arkansas in Baxter, Benton, Conway, Crawford, Franklin, Johnson, Logan, Madison, Marion, Newton, Pope, Searcy, Stone, Van Buren, Washington, and Yell counties. The St. Francis National Forest is located in eastern Arkansas in Lee and Phillips counties.

3. SOURCES OF CUMULATIVE EFFECTS

A BO must predict the consequences to species caused by future non-Federal activities within the action area, *i.e.,* cumulative effects. "Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 CFR §402.02). Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities are reasonably certain to occur. These factors include, but are not limited to: existing plans for the activity; and any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

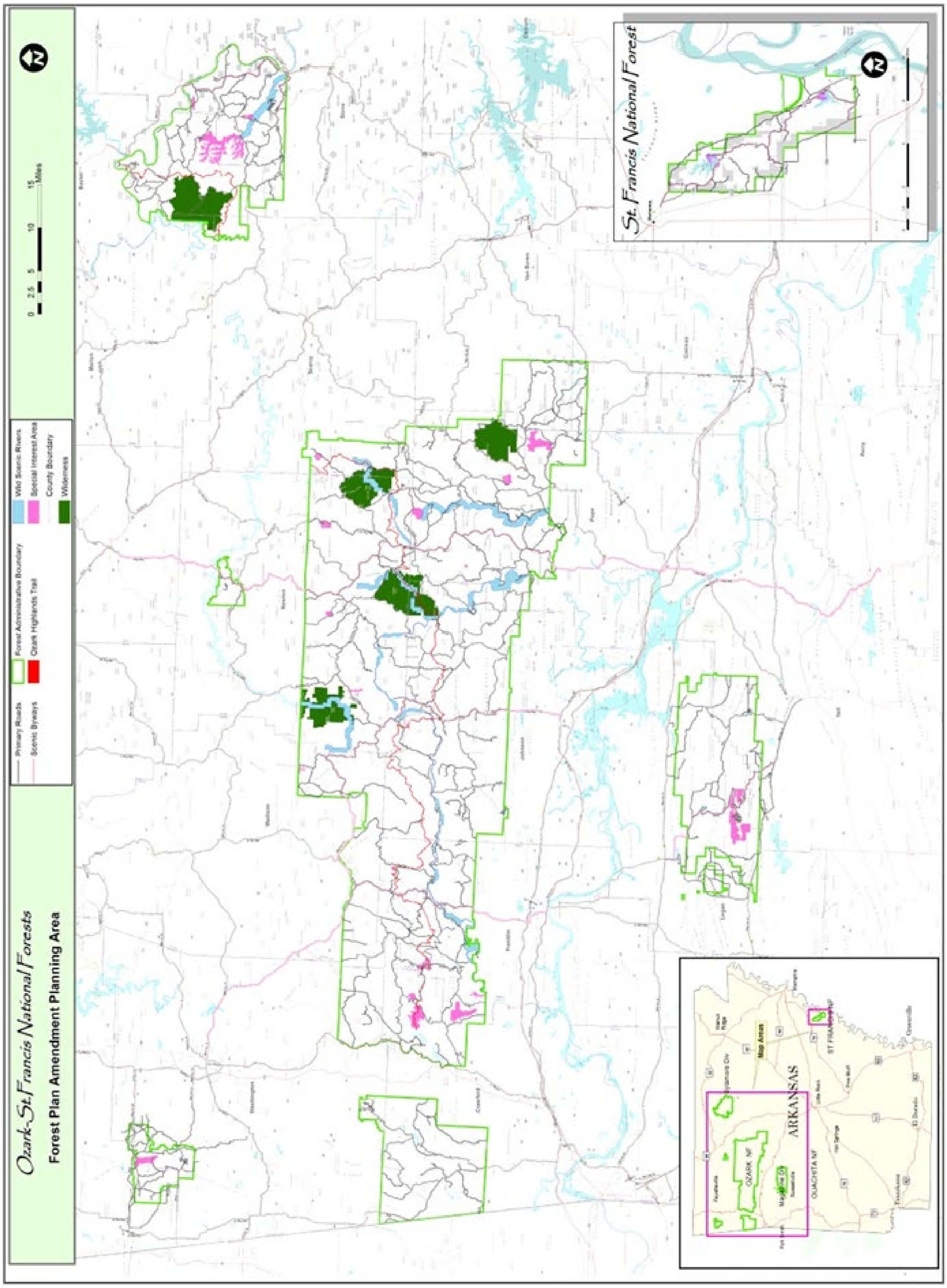

Figure 2-1. The Action Area includes all Forest owned tracts in Arkansas.

In its request for consultation, the Forest did not describe, and the Service is not aware of, any future non-Federal activities that are reasonably certain to occur within the Action Area. Therefore, we anticipate no cumulative effects that we must consider in formulating our opinion for the Action.

4. STATUS OF THE SPECIES

This section provides the Service's biological opinion of the Action for IBAT, NLEB, and TRBA.

4.1. Status of Indiana Bat

This section summarizes best available data about the biology and condition of the IBAT throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the IBAT as endangered on March 11, 1967 (32 (48) FR 4001).

4.1.1. Species Description

The IBAT is a temperate, insectivorous, migratory bat of the family Vespertilionidae that hibernates in caves and mines in the winter and summers in Forested areas. It is a medium-sized bat, having a wing span of 9 to 11 inches and weighing only one-quarter of an ounce. It has brown to dark-brown fur; the facial area often has a pinkish appearance. The IBAT closely resembles the LBBA and NLEB. It is distinguished from these species by its foot structure and fur color.

4.1.2. Life History

The life cycle of IBAT is summarized in Figure 4-1. The species hibernates in caves and mines in the winter (typically October through April) and migrates to forested summer habitat. When arriving at their traditional hibernacula in August to September, IBATs "swarm" for several weeks prior to hibernation. Some male bats may begin to arrive at hibernacula as early as July, but females typically arrive later. The highest swarming activity in Indiana and Kentucky is early September (Cope and Humphrey 1977). Swarming, a critical part of the IBAT life cycle, occurs when they converge at hibernacula, mate, and forage to store sufficient fat reserves to sustain them through the winter (USFWS 1983). Swarming behavior typically involves large bat numbers flying in and out of cave entrances throughout the night, while most bats continue to roost in trees during the day (Cope and Humphrey 1977). Body weight may increase by 2 grams within a short time, mostly in the form of fat. Copulation occurs on cave ceilings near the entrance during the latter part of the swarming period (USFWS 2007). Females may mate their first autumn, whereas males may not mature until the second year (USFWS 2007). By late September, many females enter hibernation, but males may continue swarming well into October in what is believed to be an attempt to breed with late arriving females.

Hibernation initiation may vary by latitude and annual weather conditions. However, most bats hibernate by the end of November (USFWS 2007). Hibernation facilitates survival during winter when insect prey is unavailable. Hibernating IBATs cluster on cave ceilings in densities of approximately 300-484 bats/ft^2, from approximately October through April. Clusters may protect individuals from temperature changes and reduce sensitivity to disturbance. Like other cave bats, the IBAT naturally arouses during hibernation (Sealander and Heidt 1990). Arousals are more frequent and longer at the beginning and end of the hibernation period (Sealander and Heidt 1990). Limited mating occurs throughout the winter and in early April as bats emerge (USFWS 2007).

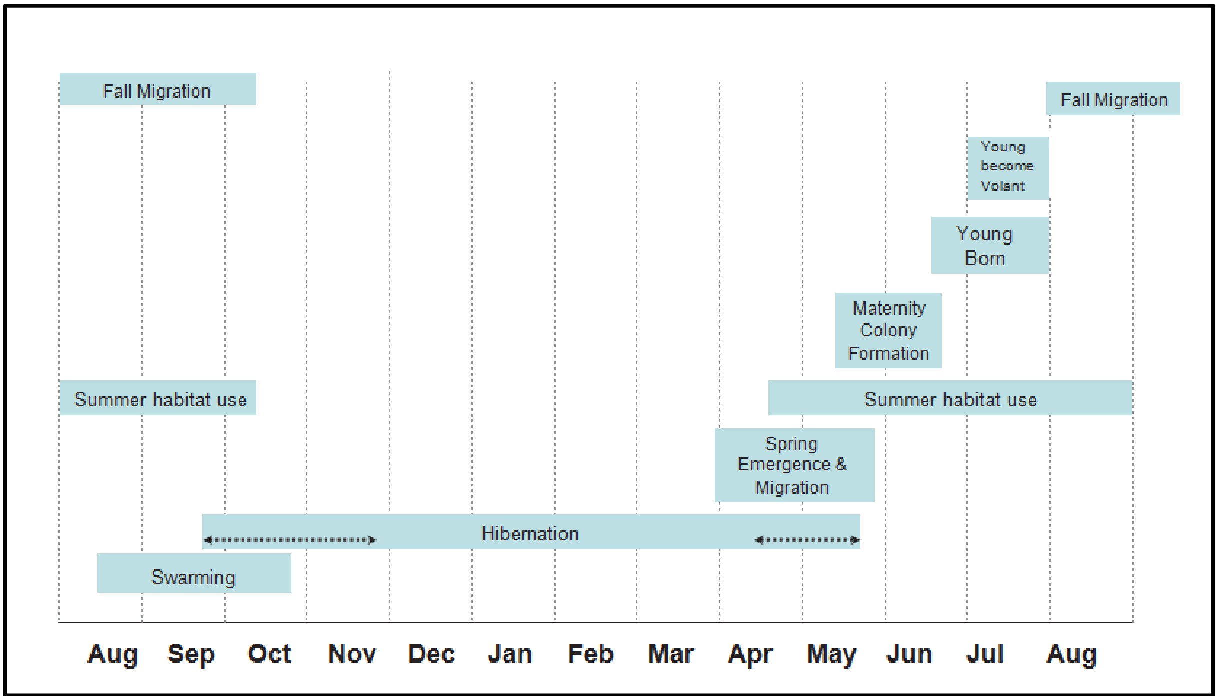

Figure 4-1. Indiana Bat Annual Chronology (USFWS 2007)

Spring emergence occurs when outside temperatures increase and insects (prey) are more abundant (Richter et al. 1993). Most IBATs emerge in late March or early April; the timing of annual emergence may vary across the range depending on latitude and annual weather conditions. Females emerge before males. Shortly after emerging from hibernation, the females become pregnant via delayed fertilization from the sperm that has been stored in their reproductive tracts through the winter (USFWS 2007). During the "staging" period, the bats forage for a few days or weeks near their hibernaculum before migrating to their traditional summer roosting areas. Most populations leave their hibernacula by late April. Migration is stressful for the IBAT, particularly in the spring when their fat reserves and food supplies are low. As a result, adult mortality may be the highest in late March and April.

Most published literature indicates IBATs migrate north for the summer maternity season (USFWS 2007, Gardner and Cook 2002). However, recent migration studies also document lateral and southward migrations (Copperhead 2017, Copperhead 2018, Copperhead 2019, Roby et al. 2019). Some reproductive females migrate up to 357 miles (Winhold and Kurta 2006) to form maternity colonies, while others form maternity colonies within a few miles of their hibernacula (U.S. Army Garrison Fort Drum 2011). Males and non-reproductive females roost individually and in colonies (Hall 1962, Carter et al. 2001, Whitaker and Brack 2002). Males are commonly found roosting near the hibernacula and migrate long distances to their summer habitat (Kurta and Rice 2002).

Female IBATs give birth to one young each year (Mumford and Calvert 1960, Humphrey et al. 1977, Thomson 1982). The proportion of female IBATs that produce young is not well documented. At a colony in Indiana, 23 of 25 female IBATs produced volant young during one year and 23 of 28 females the following year (Humphrey et al. 1977). Based on cumulative mist-netting captures over multiple years, Kurta and Rice (2002) estimated that 89% of adult females in Michigan maternity colonies were in reproductive condition (pregnant, lactating, or post-lactating). Racey (1982) notes that a particular ratio of fat to lean mass is normally necessary for puberty and the maintenance of female reproductive activity in mammals. He suggests further that the variation in bat puberty age is due to nutritional factors, possibly resulting from the late birth of young and their failure to achieve threshold body weight in their first autumn. Once puberty is achieved, reproductive rates frequently reach 100% among healthy bats of the family Vespertilionidae and young, healthy female bats can mate in their first autumn, as long as their prey base is sufficient to allow them to reach a particular fat to lean mass ratio.

Studies by Belwood (2002) show asynchronous births among members of a colony. This results in great variation in juvenile size (newborn to almost adult size young) in the same colony. Young IBATs are capable of flight within a month of birth. Young born in early June may be flying as early as the first week of July (Clark et al. 1987), with others flying from mid- to late July. Mortality between birth and weaning was found to be about 8% (Humphrey et al. 1977).

The average life span of the IBAT is 5 - 10 years, but some individuals may live as long as 15 years (Humphrey and Cope 1977). Using winter sampling of unknown-age bats over a 23-year period, female survivorship in an Indiana population was 76% for ages 1 - 6 years and 66% for ages 6 - 10 years. Male survivorship was 70% for ages 1 - 6 years and 36% for ages 6 - 10 years. Following 10 years, the survival rate for females dropped to 4% (Humphrey and Cope 1977).

4.1.3. Numbers, Reproduction, and Distribution

Indiana bat occurs throughout most of the eastern United States. The recovery program for the IBAT delineates four Recovery Units (RUs): the Ozark-Central, Midwest, Appalachian Mountains, and Northeast RUs (USFWS 2007). Because the vast majority of IBATs form dense aggregations or "clusters" on the ceilings of a relatively small number of hibernacula (i.e., caves and mines) each winter, conducting standardized surveys of the hibernating bats during that time is the most feasible and efficient means of estimating and tracking population and distribution trends across the species' range. Collectively, winter hibernacula surveys provide the Service with the best representation of the overall population status and relative distribution that is available.

The data regarding IBAT abundance prior to federal listing are limited, but the information suggests that IBAT was once far more abundant than they were in the 1960s. Tuttle and colleagues, for example, believe the overall abundance of IBAT likely rivaled that of the now extinct passenger pigeon (USFWS 2007). The basis for the estimates of millions of IBATs prior to European settlement is primarily historical accounts (e.g., Blatchley 1897, Silliman et al.

1851), extensive staining left on the ceilings of several historical hibernacula (Tuttle 1997, 1999), and other paleontological evidence (Munson and Keith 1984, Toomey et al. 2002). For example, an analysis of bone deposits in Bat Cave, Kentucky revealed an estimated 300,000 IBATs died during a single flood event at some point in history (Hall 1962).

When the IBAT was originally listed as endangered in 1967, there were approximately 883,300 bats, and most of these hibernated in a small number of hibernacula (Clawson 2002). Since the species was listed, its population numbers have apparently continued to decline through approximately 2001. Although some winter bat surveys began as early as the late 1950s, systematic surveys were not conducted across the range until the mid-1980s when there were an estimated 678,750 IBATs (Clawson 2002). Since being listed, large population declines occurred especially at hibernacula in Kentucky and Missouri. Caves in Kentucky suffered dramatic losses due to changes in microclimate caused by poor cave gate design at two of the three most important hibernacula (Humphrey 1978), and IBAT numbers in Kentucky hibernacula continued to decline until 2005 (USFWS, unpublished data, 2007). Despite recovery efforts, IBAT in Missouri caves declined with a loss of more than 80% of the previous population size (Clawson 2002). The range-wide population estimate dropped approximately 57% from 1965 to 2001 (USFWS 2007).

The range-wide, biennial population estimates were increasing from 2001 – 2007, indicating an arrest to the species' long-term decline (USFWS 2019). However, declines since 2007 are attributable to White-Nose Syndrome (or "WNS"; see discussion below), especially in the Northeast Recovery Unit. The Service estimated the 2022 rangewide population at 596,431 bats (Figure 4-2) occurring in 223 hibernacula in 16 states, with the 3 most populous states being Missouri (228,333), Indiana (219,459), and Illinois (77,196). This represents a 10.3% decrease from the 2007 (WNS begins) range-wide population estimate of 664,637. However, there has been an 11% increase since the 2019 survey.

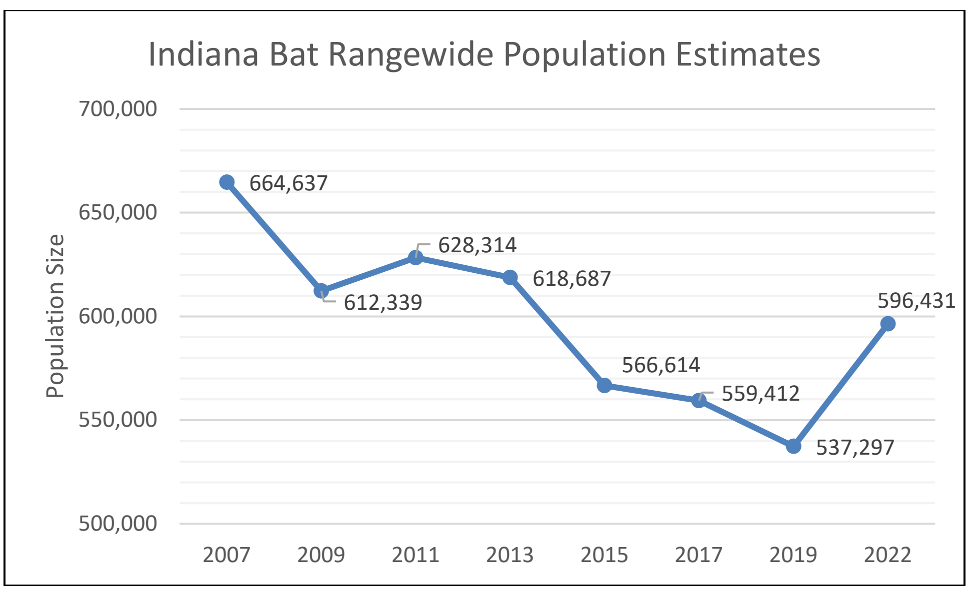

Figure 4-2. Indiana bat range-wide population estimates from 2007 - 2022.

Summer distribution of IBAT occurs throughout a wider geographic area than its winter distribution. Most summer occurrences are from the upper Midwest, including southern Iowa, northern Missouri, much of Illinois and Indiana, southern Michigan, Wisconsin, western Ohio, and Kentucky. In the past decade, many summer maternity colonies have been found in the northeastern states of Pennsylvania, Vermont, New Jersey, New York, West Virginia, and Maryland. Maternity colonies also occur in the south, including northern Arkansas, Georgia, Alabama, Mississippi (Roby et al. 2019, Copperhead 2019), and southwestern North Carolina (Britzke et al. 2003, USFWS 2007). Non-reproductive summer records exist for eastern Oklahoma, northern Mississippi, Alabama, and Georgia.

4.1.4. Conservation Needs and Threats

Destruction/Degradation of Hibernacula

There are well-documented examples of modifications to IBAT hibernacula that affected the thermal regime of caves and, thus, the ability to support hibernating IBATs, as summarized in the draft revised Recovery Plan (USFWS 2007). Generally, threats to the integrity of hibernacula decreased since the listing of IBAT under the ESA. Increasing awareness of the importance of cave microclimates to hibernating bats and regulatory authorities under the ESA helped reduce, but not eliminate, this threat. In addition to purposeful modifications, there are threats from stochastic events (e.g., collapse in mines, flooding).

Loss/Degradation of Forested Habitat

Loss of Forest cover and degradation of Forested habitats contributed to the decline of IBAT (USFWS 1983, Garner and Gardner 1992, Drobney and Clawson 1995, Whitaker and Brack 2002). Throughout the IBAT, range there is less Forest land now than prior to European settlement (Smith et al. 2003), particularly within the species' core range in the Midwest. Conversion to agriculture is the largest single cause of Forest loss. The conversion of floodplain and bottomland forests, recognized as high quality habitats for IBAT, has been a particular cause of concern (Humphrey 1978). More recently, since the 1950s, abandonment of some marginal farmlands helped revert these lands back to Forest resulting in a net increase in Forest land within the IBAT range, particularly in the Northeast (Smith et al. 2003). Forest cover increased within the Midwest Recovery Unit (Smith et al. 2003). Not only has the amount of Forest cover increased since the 1950s, but also the average diameter of trees increased (Smith et al. 2003), which may equate to an increased supply of suitable roost trees for IBAT.

Urbanization and development is currently the greatest contributor to forested habitat loss within the IBAT range (Wear and Greis 2002; USFS 2005, 2006). At a study site in central Indiana, IBATs avoided foraging in a high-density residential area (Sparks et al. 2005), although maternity roosts occur in some low-density residential areas (Belwood 2002). Duchamp (2006) found greater amounts of urban land use was negatively related to bat species diversity in north-central Indiana. Several bat species, including the IBAT, were less likely to occur in landscapes with greater amounts of urban and suburban development.

Forest cover is not a completely reliable predictor of where IBAT maternity colonies occur on the landscape (Farmer et al. 2002). Indiana Bat maternity colonies occupy habitats ranging from completely forested to areas of highly fragmented Forest. Nonetheless, trends in forest cover are of interest relative to IBAT, with increasing Forest cover suggesting at least the potential for improved habitat conditions.

Throughout the IBAT range, forest conversion is expected to increase due to commercial and urban development, energy production and transmission, and natural changes. The 2010 Resources Planning Act Assessment projects forest losses of 6.5 - 13.8 million hectares (16–34 million acres) (or 4–8% of 2007 forest area) across the conterminous United States, and Forest loss is expected to be concentrated in the southern United States, with losses of 3.6 - 8.5 million hectares (9–21 million acres) (USFS 2012). Forest conversion causes loss of potential habitat, fragmentation of remaining habitat, and if occupied at the time of the conversion, direct injury or mortality to individuals.

Disturbance of Hibernating Bats

The original recovery plan stated that human disturbance of hibernating IBATs was one of the primary threats (USFWS 1983). The primary forms of human disturbance to hibernating bats result from cave commercialization (cave tours and other commercial uses of caves), recreational caving, vandalism, and research-related activities. There has been progress in reducing disturbance at caves with hibernating IBATs, but the threat still occurs.

White-nose Syndrome

WNS is an infectious wildlife disease caused by a fungus of European origin, *Pseudogymnoascus destructans* (Pd), and poses a considerable threat to hibernating bat species throughout North America, including the IBAT. White-nose syndrome is responsible for unprecedented mortality of insectivorous bats in eastern North America (Blehert et al. 2009; Turner et al. 2011). No other threat is as severe and immediate for the IBAT as WNS. Since the disease was first observed in New York in 2007 (later biologists found evidence from 2006 photographs), WNS has spread rapidly in bat populations from the East to Midwest and South.

WNS may affect behavioral changes in infected individuals. For example, at some WNS-affected sites, researchers observed a shift of hibernating bats from traditional winter roosts to roosts unusually close to hibernacula entrances. They also observed bats flying outside of hibernacula during winter (often during the day) at some affected sites. At some sites, they found bat carcasses (particularly of the LBBA) outside affected hibernacula. Many infected bats do not survive the winter. The exact processes by which the fungal skin infection leads to death are unknown, but depleted fat reserves (i.e., starvation) contribute to mortality (Reeder et al. 2012, Warnecke et al. 2012) and dehydration may also have a role (Willis et al. 2011, Cryan et al. 2013b, Ehlman et al. 2013). It is also suspected that some affected bats that survive hibernation emerge in such poor condition they soon die. Among those bats that do survive, it appears that productivity of female survivors declines (Francl et al. 2012; Pettit and O'Keefe 2017).

The Northeast Recovery Unit, where WNS was first observed in the winter of 2006 - 2007, lost over 70% of its IBATs between 2007 and 2015. Based on subsequent observations as WNS spread, it appears that the arrival of the fungus in an area may precede large-scale fatality of bats by several years. Between 2011 and 2015 the Appalachian Recovery Unit, where WNS was confirmed in the winter of 2008 - 2009, declined by 84%. The Midwest Recovery Unit, where

WNS was confirmed in the winter of 2010 - 2011, declined by 16% between 2011 and 2015. The Ozark-Central Recovery Unit, where WNS was confirmed in the winter of 2011 - 2012, declined by less than 1% between 2013 and 2015. As of 2016, WNS was confirmed in all the states within the species' range. We expect further declines in IBAT populations from the disease in the future. Additional information on WNS, which is constantly evolving, can be found online at http://whitenosesyndrome.org/.

Environmental Contaminants
Restrictions on the use of organochlorine pesticides in the 1970s reduced this significant threat to IBAT. However, cholinesterase-inhibiting insecticides, organophosphates, and carbamates have now become the most widely used insecticides (Grue et al. 1997), and the effects of these chemicals on IBAT is unknown. Because of the unique physiology of bats in relation to reproduction, high energy demands and sophisticated thermoregulatory abilities, much more research needs to be done with these pesticides and their effects on bats. These and other contaminants likely remain a significant and poorly understood threat to IBAT. USFWS (2007) summarizes known and suspected contaminant threats to bats.

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 the IBAT, are limited. During winter, only a small proportion of caves provide the right conditions for hibernating IBATs. Surface temperature is directly related to cave temperature, so climate change that involves increased surface temperatures will inevitably affect the suitability of hibernacula. Impacts on the availability or timing of emergence of insect prey are also likely. Loeb and Winters (2013) forecasted significant changes in IBAT summer maternity range within the United States due to climate change.

Wind Turbines
There is growing concern that IBAT (and other bat species) may be threatened by the recent surge in construction and operation of wind turbines across the species' range. Eight IBAT mortalities occurred at wind turbines; five of those were during the fall migration period (USFWS 2014). Not all facilities conduct fatality monitoring and, even with monitoring, the proportion of dead bats found is low. Based on this information, it is likely that additional IBAT mortality occurred at these facilities and at other wind facilities throughout the range of the species.

Recovery
The Service published a recovery plan that outlines recovery actions (USFWS 1983). The draft revised recovery plan (USFWS 2007) focuses on four broad components: 1) range-wide population monitoring at hibernacula with improvements in census techniques, 2) conservation and management of habitat (hibernacula, swarming, and to a degree, summer), 3) further research into requirements of and threats to the species, and 4) public education and outreach.

The Service's Bloomington, Indiana Field Office completed a 5-Year Review of the IBAT (USFWS 2019), which summarizes the current species status, its progress toward recovery, and threats. In this report, the Service concluded that the IBAT should remain listed as 'endangered' because the species status has not improved since listing and new and old threats have not been sufficiently ameliorated. For instance, WNS has significantly and rapidly raised the degree of threat against the IBAT by causing reductions in its fitness, reproductive success and survival, which has lowered the species' overall recovery potential.

4.2. Status of Northern Long-eared Bat

This section summarizes best available data about the biology and condition of NLEB throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the NLEB as endangered on November 29, 2022 (87 FR 73488).

4.2.1. Species Description

The NLEB is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. The key stages in its annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy/weaning, fall migration and swarming. Northern long-eared bats generally hibernate between mid-fall through mid-spring each year. Spring migration period likely runs from mid-March to mid-May each year. Females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. Young are born between mid-May and early July, with nursing continuing until weaning, which is shortly after young become volant in mid- to late-July (Sasse et al. 2014). Fall migration likely occurs between mid-August and mid-October.

4.2.2. Life History

Northern long-eared bat roosts in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches DBH). Northern long-eared bats are known to use a wide variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. Northern long-eared bats have also been occasionally found roosting in structures like barns and sheds (particularly when suitable tree roosts are unavailable). Roosting areas utilized by this species average 66.8 ha with a maximum of 186.3 ha (Carter and Feldhamer 2005, Henderson and Broders 2008, Johnson et al. 2012, Silvis et al. 2015).
Young NLEBs are typically born in mid-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant (able to fly) between early-June and mid-July. Mist netting in Arkansas from 1996 - 2013 resulted in captures of pregnant females from May 3 – June 24, lactating females from May 19 – July 30, and the first capture of volant juveniles occurred from June 6 – July 20 (Sasse et al. 2014).

Males and non-reproductive females may summer near hibernacula or migrate to summer habitat some distance from their hibernaculum. Though little is known of this aspect of its life history, the NLEB is not considered to be a long distance migrant. Small groups of pregnant NLEB have been observed during multiple spring migration periods in a mine in the Ouachitas, but it is not known whether this represents typical roosting ecology in that season (Sasse et al. 2014). Migration is an energetically demanding behavior for the NLEB, particularly in the spring when their fat reserves and food supplies are low and females are pregnant.

Suitable summer habitat for NLEBs consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts, and 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.

Northern long-eared bats tend to roost singly or in small groups (USFWS 2014), with hibernating population sizes ranging from just a few individuals to around 1,000 (USFWS unpublished data). In Arkansas, there are only ten caves where > 10 NLEB have been observed during winter surveys and only two with more than 100 (Sasse et al. 2014). Northern long-eared bats display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940, Whitaker and Rissler 1992, Caceres and Barclay 2000). Northern long-eared bats have shown a high degree of philopatry to the hibernacula used, returning to the same hibernacula annually.

Upon arrival at hibernacula in mid-August to mid-November, NLEB "swarm," a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum as they had been mating at. A majority of bats of both sexes hibernate by the end of November.

Suitable winter habitat (hibernacula) includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by NLEBs during the winter that have yet to be documented. Generally, NLEBs hibernate from October to April depending on local weather conditions (November - December to March in southern areas). These bats have been captured in mist nets in Arkansas as early as March 17 and specimens have been submitted for rabies testing as early as March 11 (Sasse et al. 2014). Hibernacula for NLEBs typically have significant cracks and crevices for roosting; relatively constant, cool temperatures 32 - 48º F (0 - 9º C) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

After hibernation ends in March or early April, most NLEB migrate to summer roosts. Females emerge from hibernation before males. Reproductively active females store sperm from autumn copulations through winter. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as "staging," a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

4.2.3. Numbers, Reproduction, and Distribution

The NLEB ranges across much of the eastern and north central United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Nagorsen and Brigham 1993; Caceres and Pybus 1997; Environment Yukon 2011). In the United States, the species' range reaches from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east through the Gulf States to the Atlantic Coast (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006). The species' range includes the following 37 States (plus the District of Columbia): Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Historically, the species has been most frequently observed in the northeastern United States and in Canadian Provinces, Quebec and Ontario, with sightings increasing during swarming and hibernation (Caceres and Barclay 2000). However, throughout the majority of the species' range it is patchily distributed, and historically was less common in the southern and western portions of the range than in the northern portion of the range (Amelon and Burhans 2006).

More than 780 hibernacula have been identified throughout the species' range in the United States, although many hibernacula contain only a few (1 to 3) individuals (Whitaker and Hamilton 1998). Known hibernacula (sites with one or more winter records of NLEB) include: Alabama (2), Arkansas (71), Connecticut (8), Delaware (2), Georgia (3), Illinois (21), Indiana (25), Kentucky (119), Maine (3), Maryland (8), Massachusetts (7), Michigan (103), Minnesota (11), Missouri (more than 269), Nebraska (2), New Hampshire (11), New Jersey (7), New York (90), North Carolina (22), Oklahoma (9), Ohio (7), Pennsylvania (112), South Carolina (2), South Dakota (21), Tennessee (58), Vermont (16), Virginia (8), West Virginia (104), and Wisconsin (67). Northern long-eared bats are documented in hibernacula in 29 of the 37 states in the species' range. Other States within the species' range have no known hibernacula (due to no suitable hibernacula present, lack of survey effort, or existence of unknown retreats).

The current range and distribution of NLEBs must be described and understood within the context of the impacts of WNS. Before the onset of WNS, the best available information on NLEBs came primarily from surveys (primarily focused on IBAT or other bat species) and some targeted research projects. In these efforts, the NLEB was very frequently encountered and was considered the most common myotid bat in many areas. Overall, the species was considered to be widespread and plentiful throughout its historic range (Caceres and Barclay 2000).

4.2.4. Conservation Needs and Threats

<u>Destruction/Degradation of Hibernacula</u>
The NLEB require hibernation sites with specific microclimates and NLEB exhibit high interannual fidelity to their hibernacula. Therefore, similar to IBAT, threats associated with the complete loss of or modification of winter roosts, can result in impacts to individuals or at the population level.

Loss/Degradation of Forested Habitat

Over the long-term, sustainable forestry benefits NLEB by maintaining suitable habitat across a mosaic of forest treatments. However, forest practices can have a variety of impacts on the NLEB depending on the quality, amount, and location of the lost habitat, and the time of year of clearing. Depending on their characteristics and location, forested areas can function as summer maternity habitat, staging and swarming habitat, migration or foraging habitat, or sometimes, combinations of more than one habitat type. Impacts from tree removal to individuals or colonies would be expected to range from indirect impact (e.g., minor amounts of forest removal in areas outside NLEB summer home ranges or away from hibernacula) to minor (e.g., largely forested areas, areas with robust NLEB populations) to significant (e.g., removal of a large percentage of summer home range, highly 19 fragmented landscapes, areas with WNS impacts).

Disturbance of Hibernating Bats

Disturbance within hibernacula can render a site unsuitable or can pose harm to individuals using the site. For example, human entry to hibernating bats can result in additional arousals from hibernation which require an increase in total energy expenditure at a time when food and water resources are scarce or unavailable. There are many conservation efforts and protections (e.g., bat-friendly gates, closure of caves during hibernation) in place that attempt to reduce the risk of modifications to hibernacula and disturbance to overwintering bats.

White-nose Syndrome

No other threat is as severe and immediate for the NLEB as the disease white-nose syndrome (WNS). Although IBAT populations, for example, have been imperiled for decades, it is unlikely that NLEB populations would be declining so dramatically without the impact of WNS. Since the disease was first observed in New York in 2006, WNS has spread rapidly in bat populations from the Northeast to the Midwest and the Southeast. Population numbers of NLEB have declined by 99% in the 18 Northeast, which along with Canada, has been considered the core of the species' range. WNS related declines in IBAT populations are estimated at up to 75%, with the disease recently moving into the Midwest core of the species range. Although there is uncertainty about how quickly WNS will spread through the remaining portions of these species' ranges, it is expected to spread throughout their entire ranges. In general, the Service believes that WNS has significantly reduced the redundancy and resiliency of NLEB.

Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines. Specifically, declines due to WNS have significantly reduced the number and size of NLEB populations in some areas of its range. This has reduced these populations to the extent that they may be increasingly vulnerable to other stressors that they may have previously had the ability to withstand. These impacts could potentially be seen on two levels. First, individual NLEBs sickened or struggling with infection by WNS may be less able to survive other stressors. Second, NLEB populations impacted by WNS, with smaller numbers and reduced fitness among individuals, may be less able to recover making them more prone to extirpation. The status and potential for these impacts will vary across the range of the species.

Bats affected but not killed by WNS during hibernation may be weakened by the effects of the disease and may have extremely reduced fat reserves and damaged wing membranes. These effects may reduce their capability to fly or to survive long-distance migrations to summer roosting or maternity areas. Affected bats may also be more likely to stay closer to their hibernation site for a longer time period following spring emergence.

In areas where WNS is present, there are additional energetic demands for NLEBs. For example, WNS-affected bats have less 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 the migration to their summer habitat must partition energy resources between foraging, keeping warm, successful pregnancy and pup-rearing, and healing and may experience reduced reproductive success. In addition, with wing damage, there may be an increased chance of WNS-affected bats being killed or harmed as a result of proposed action, particularly if timber harvest or burns are conducted early in the spring (April – May).

<u>Climate Change</u>
Climate change variables, such as changes in temperature and precipitation, may influence NLEB resource needs, such as suitable roosting habitat for all seasons, foraging habitat, and prey availability. Although there may be some benefit to NLEB from a changing climate, overall negative impacts are anticipated, especially at local levels.

<u>Wind Turbines</u>
There is growing concern that bats, including the NLEB (and other bat species) may be threatened by the recent surge in construction and operation of wind turbines across the species' range. Mortality of NLEB has been documented at multiple operating wind turbines/farms. The Service is now working with wind farm operators to avoid and minimize incidental take of bats and assess the magnitude of the threat.

4.3. Status of Tricolored Bat

This section summarizes best available data about the biology and condition of the TRBA throughout its range that are relevant to formulating an opinion about the Action. A petition to list the TRBA as threatened was received by the Service on June 16, 2016. On December 20, 2017, the Service found that the petition presented substantial scientific or commercial information indicating that the petitioned actions may be warranted and commenced a review (as a 12-month finding) to determine if listing of the TRBA is warranted (82 C.F.R. 60362; December 20, 2017). On September 14, 2022, the Service posted a completed species status assessment (SSA) report for the TRBA (USFWS 2021) and published a proposed rule to list the TRBA as endangered. The proposed rule noted that WNS has caused estimated declines of more than 90% in affected TRBA colonies and is currently present across 59% of the species' range.

4.3.1. Species Description

Tricolored bat is one of the smallest bats in eastern North 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, p. 115). The TRBA often appear yellowish (varying from pale yellow to nearly orange), but may also appear silvery-gray, chocolate brown, or black (Barbour and Davis 1969, p. 115). Males and females are colored alike, but females are consistently heavier than males (LaVal and LaVal 1980, p. 44). Newly volant young are much darker and grayer than adults (Allen 1921, p. 55). Other distinguishing characteristics include 34 teeth (compared with 38 teeth in eastern North American *Myotis* spp. for which it is sometimes confused), a calcar (i.e., spur of cartilage arising from the inner side of the ankle) with no keel, and only the anterior third of the uropatagium (i.e., the membrane that stretches between the legs) is furred (Barbour and Davis 1969, p. 115; Hamilton and Whitaker 1979, p. 85).

4.3.2. Life History

Tricolored bats are known to hibernate in caves, mines, and rock crevices during the winter months (Harvey et al. 1999). In areas where caves are sparse, TRBAs hibernate in road-associated culverts (Sandel et al. 2001, Katzenmeyer 2016, Limon et al. 2018, Bernard et al 2019, Lutsch 2019, Meierhofer et al. 2019), abandoned water wells (Sasse et al. 2011), and sometimes tree cavities (Newman 2020). In Missouri and Pennsylvania, TRBAs are one of the first cave-hibernating species to enter hibernation in the fall and one of the last to leave in the spring (LaVal and LaVal 1980, Merritt 1987). However, in the southern U.S., hibernation length is shorter compared to northern portions of the species' range, with some individuals exhibiting shorter torpor bouts and remaining active and feeding during the winter (Layne 1992, Grider et al. 2016, Limon et al. 2018, Newman 2020, Stevens et al. 2020).

Tricolored bats are observed in more caves and mines than any other cave-hibernating bat species in eastern North America (Sealander and Young 1955, Barbour and Davis 1969, Brack et al. 2003). Tricolored bats are observed in small caves and mines that are unsuitable to other cave-hibernating bat species; although, generally in small numbers (Barbour and Davis 1969, Mumford and Whitaker 1982, Hamilton and Whitaker 1979). During hibernation, TRBAs most commonly roost singly, but sometimes in pairs or small clusters of both sexes (Hall 1962, Barbour and Davis 1969, Mumford and Whitaker 1982, Raesly and Gates 1987, Briggler and Prather 2003, Vincent and Whitaker 2007). Tricolored bats are most commonly observed roosting on cave walls and ceilings and rarely are found in crevices (Mumford and Whitaker 1982). Compared to other cave-hibernating species, tricolored bats are generally found at the warmest locations within hibernacula with a mean temperature of 10.9 ºC (51.6 ºF; Barbour and Davis 1969, Raesly and Gates 1987). Tricolored bats prefer high-humidity roosts ranging from 80 - 99% within hibernacula (Mohr 1976, Ploskey and Sealander 1979).

Tricolored bats disperse from winter hibernacula to summer roosting habitat in the spring. Fraser et al. (2012) concluded that at least some TRBAs engage in latitudinal migration that is more typically associated with tree-roosting bats (e.g., hoary bats [*Lasiurus cinereus*], eastern red bats [*Lasiurus borealis*], and silver-haired bats [*Lasionycteris noctivagans*]). The maximum migration distance for a female TRBA was a straight-line distance of 151 mi (243 km) from her winter hibernaculum to summer roost (Samoray et al. 2019). Other migration records between winter hibernacula and summer habitat include less than 50 mi (80 km; Barbour and Davis 1969), 27 mi (44 km; Samoray et al. 2019), and 85 mi (137 km; Griffin 1940). Additionally, the maximum recorded hibernaculum to hibernaculum movement between two consecutive winters is 130 mi (209 km; Lutsch 2019).

Tricolored bat reproduction occurs during fall swarming following migration from summer habitat and prior to entering hibernation. Swarming occurs at cave and mine entrances between mid-August and mid-October. Females store sperm in their uterus during the winter, and fertilization occurs after spring emergence from hibernation (Guthrie 1933). Mating likely does not occur in females entering their first hibernation (i.e., subadults; Fujita and Kunz 1984).

Summer habitat for TRBA includes suitable food, water, and roost resources. Tricolored bat is a forest-dwelling species and can be found in a variety of predominantly deciduous forest vegetation communities throughout their summer range. At the landscape scale, they are more abundant in highly forested landscapes with adequate connectivity and are less abundant in open areas such as predominantly urban and agricultural landscapes (Duchamp and Swihart 2009, Farrow and Broders 2011).

Tricolored bat primarily roosts in live and dead foliage of live or recently dead deciduous trees (Veilleux et al. 2003, Perry and Thill 2007, Thames 2020). Tricolored bat exhibits high site fidelity to summer roosting habitat (Veilleux et al. 2003). Males roost singly and females congregate into maternity colonies to reproduce communally (Perry and Thill 2007, Poissant et al. 2010).

Tricolored bat maternity colonies are small compared to other cooperative breeding bat species. The largest colony on record consisted of 19 adult females and 37 pups in Massachusetts (Hoying and Kunz 1998). Females give birth from May - July, and typically have two pups (Harvey et al. 2011). Maternity colonies consist of multiple roosts near one another, and females change roosts frequently. In Indiana, females changed roosts between 1.2 - 7 days (Veilleux and Veilleux 2004). Males will roost in forested habitat occupied by maternity colonies, but males are solitary (Veilleux and Veilleux 2004, Perry and Thill 2007, Poissant et al. 2010).

4.3.3. Numbers, Reproduction, and Distribution

Tricolored bat is known from 39 states (from New Mexico north to Wyoming and all states to the east), Washington D.C., 4 Canadian Provinces (Ontario, Quebec, New Brunswick, Nova Scotia), and Guatemala, Honduras, Belize, Nicaragua, and Mexico. The species current distribution in New Mexico, Colorado, Wyoming, South Dakota, and Texas is the result of westward range expansion in recent decades (Geluso et al. 2005; Adams et al. 2018; Hanttula and Valdez 2021) as well as into the Great Lakes basin (Kurta et al. 2007; Slider and Kurta 2011). This expansion is largely attributed to increases in trees along rivers and increases in suitable winter roosting sites, such as abandoned mines and other human-made structures (Benedict et al. 2000; Geluso et al. 2005; Slider and Kurta 2011).

Prior to the onset of WNS, tricolored bats were highly abundant and widespread throughout their range. The Service estimates that there were over 140,000 bats observed during hibernacula surveys of 1,951 wintering sites. Tricolored bat occurrence varied spatially and temporally; however, overall abundance on the landscape was stable (Cheng et al. 2021, Wiens et al. 2021).

Available evidence from both winter and summer data, indicates that tricolored bat abundance has and will continue to decline substantially over the next 10 years under current conditions. Range-wide winter abundance has declined by 52%, and the number of extant winter colonies by 29% since 2000. There has also been a noticeable shift towards smaller winter colony sizes. The magnitude of winter declines, although widespread, varies spatially. The largest decline has been in the northeastern U.S. (89%), where WNS was first discovered, followed by northern states and Canadian providences (57% decline). The southern portion of the range has seen only a 24% decline.

Summer occurrence and abundance data also show a declining trend for tricolored bats. Irvine and Stratton (2021) found that range-wide occupancy declined by 28% from 2010 - 2019. Similarly, Whitby et al. (2021) analyzed range-wide mobile acoustic data and found a 53% decline from data collected between 2009 - 2019. Finally, Deeley and Ford (2021) observed a significant decline in mean capture rates from 1999 - 2019 across the TRBA's range.

4.3.4. Conservation Needs and Threats

White-nose Syndrome

WNS is the primary threat influencing TRBA populations. Since the discovery of the fungal pathogen *Pd* in New York in 2007, WNS has spread rapidly is now predicted present at 85–100% of documented TRBA hibernacula. WNS alters physiological and behavioral processes, often causing direct mortality (Reeder et al. 2012, McGuire et al. 2017). Cheng et al. (2021) estimated that TRBA populations have declined 90–100% across 59% of their range from 1995–2018 resulting from WNS. *Pd* has also been detected in culverts where TRBA colonies hibernate in the southern U.S.; however, WNS-induced mortality has not been documented in these hibernacula (Cross 2019). While state and federal agencies and non-profit conservation organizations have allocated millions in funding to better understand and reduce WNS, impacts from the disease on TRBAs are expected to continue.

Wind Turbines

Wind related mortality is another threat influencing tricolored bat populations and often overshadowed by WNS. Bat fatality rates vary across facilities, between seasons, and among species. Numerous tricolored bat fatalities have been documented and based on an October 2020 installed capacity of 104,628 MW (Hoen et al. 2018, USFWS 2021 - *3546*), it is estimated that 3,227 tricolored bats are killed annually at wind facilities (Udell et al. 2022). Wind power is a rapidly growing portion of North America's renewable energy portfolio, providing 10.2% of U.S. energy in 2021 (American Wind Energy Association (AWEA) 2021). It is expected that wind facilities will continue to be threat influencing tricolored bat populations; however, the Service is actively working with wind energy operators to avoid, minimize, and mitigate incidental take of bats (USFWS 2021).

Climate Change

There is growing concern about impacts to bat populations in response to climate change (Jones et al. 2009, Jones and Rebelo 2013, O'Shea et al. 2016). The entire range of the TRBA will be affected by climate change. However, the magnitude, direction, and seasonality of climate changes is not consistent range-wide. It is not expected that every representation unit (RPU; as described in the species status assessment) will respond in the same way to similar changes across the range, which makes predicting how climate change will influence tricolored bat populations challenging to describe. There may be some benefit to TRBA; however, overall negative impacts are anticipated (USFWS 2021).

Habitat Loss and Disturbance

Although a lesser threat compared to WNS and wind energy related fatalities, habitat loss is also recognized as a potential threat to TRBA. Habitat loss can occur during the active season (spring, summer, and fall) as well as during hibernation. During the active season, tree-clearing and forest and/or wetland conversion are associated with losses in suitable roosting or foraging habitat, longer flight distances between roosting and foraging habitats, fragmentation of maternity colonies, and direct injury or mortality. The impacts of habitat loss on TRBA vary based on the timing, location, and extent of habitat removal and the overall landscape composition. For example, removal of forested habitat in an agriculturally dominated landscape will likely have a larger adverse impact on local tricolored bat populations than the same amount of habitat removal in a heavily forested landscape (USFWS 2021).

Habitat loss and disturbance can also occur during hibernation. Examples of this threat are modification of hibernacula entrances, which may alter hibernacula microclimates and potentially result in direct mortality. Disturbance caused by human activity during hibernation may result in more frequent arousals when food and water resources are scarce. Due to WNS, reducing human disturbance during hibernation is critical, because more frequent arousals from torpor increases the probability of mortality in bats (Boyles and Willis 2010). Currently, there are multiple conservation efforts to help minimize the threat of habitat loss and disturbance during hibernation, including bat-friendly gates, seasonal cave closures, and conservation easements.

5. ENVIRONMENTAL BASELINE

This section describes the best available data about the condition of the IBAT, NLEB, and TRBA in the Action Area without the consequences caused by the proposed Action.

Over the past decade, there has been a substantial investment in survey and monitoring of bats on the Forest. Surveys included mobile and stationary acoustic sites, mist-netting, summer emergence counts from caves and tree roosts, and winter internal cave counts. These surveys helped inform the distribution, abundance, and population trends of bats on the Forest. Summer mist-netting has been conducted on 2,230 nights on the Forest at 1,413 different sites. Each night consists of ≥ 2 nets open for 3 - 5 hours. Captured bats are evaluated for species, sex, age, maturity, size, weight, and health condition factors. Bats that may be resighted in caves are typically banded. Radio transmitters were placed on select bats to determine their roosting or foraging locations. The Forest Service conducted mobile acoustic routes on each district for multiple subsequent years. They also conducted stationary acoustic monitoring at over 150 sites across the Forest to further identify habitat areas being utilized by these species. For TRBAs and NLEBs that have substantially declined in numbers, acoustic monitoring has been used as a method to determine where the bats still occur on the Forest. In partnership with other agencies, winter counts provide information on population trends on the Forest.

5.1. Environmental Baseline for Indiana Bat

5.1.1. Action Area Numbers, Reproduction, and Distribution

The Forest is located near the south-western edge of the range of IBAT, which extends from several Midwestern states to the mid-Appalachian Mountains. In Arkansas, there are currently estimated to be just under 5,000 IBATs that hibernate in a limited number of caves scattered through the northern and western part of the state (Figure 5-1).

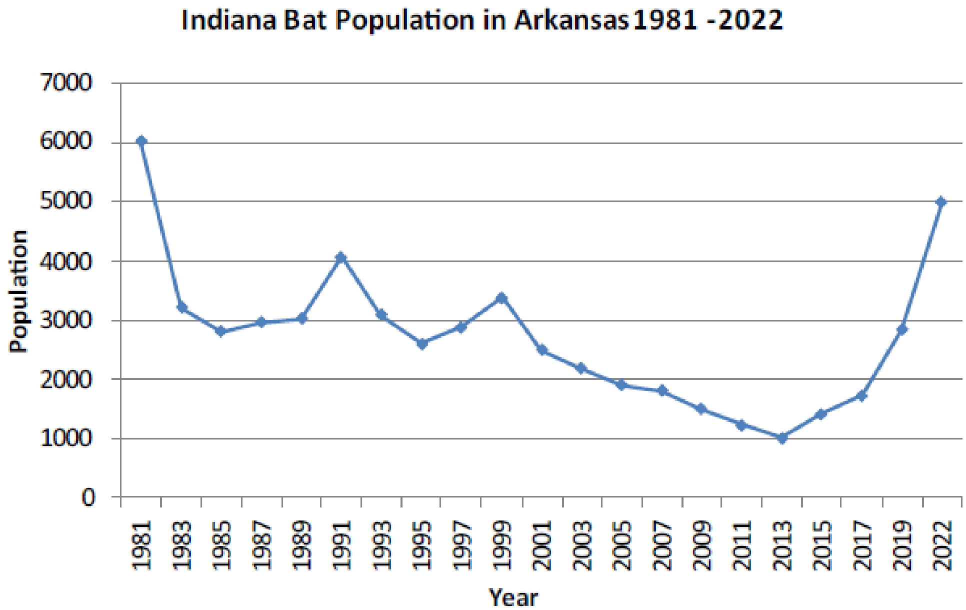

Figure 5-1. Indiana bat population estimate in Arkansas based on winter cave counts (Sasse, 2022).

Indiana bat has very specific requirements for cave hibernating habitat, and although there are approximately 500 cave features on the Forest, IBATs are known to inhabit only 10. There are an additional three known hibernacula located on lands nearby, one in Washington County and two in Newton County. Most known caves on the Forest have been surveyed for bats or evaluated for the potential for IBAT hibernation habitat. Hibernacula are located on the Sylamore, Big Piney, and Boston Mountain ranger districts.

Indiana Bat use of winter hibernacula declined since 2000, based on winter count numbers in caves on the Forest. Eight Forest caves have historical counts >100 bats with >600 bats observed in two caves on the Sylamore Ranger District. The numbers declined substantially over the past 20 years across all IBAT hibernacula on the Forest. Cave gates occur at five of the known IBAT hibernacula to reduce the threat of human disturbance.

Although they hibernate together, male and female IBATs in Arkansas have different active season patterns. Males and non-reproductive females are believed to stay closer to the hibernacula or travel only limited distances to active season foraging habitats, whereas females have been found to migrate, in some cases long-distances, to summer maternity habitat (USFWS

2007, Roby 2019, Custer, 2022). Male IBATs have been caught during summer netting efforts on the Sylamore and Big Piney ranger districts and have been caught near streams, on mid-slopes and ridges. Although there has been an effort to sample broadly across the Forest, much of the netting effort occurred within the Indiana Bat Management Zones.

Recent work has been conducted to improve our understanding of the migratory patterns of female IBATs that hibernate in caves in the Ozark Plateau in Arkansas (Roby *et al*., 2021, Custer 2022). Female bats have been tracked from hibernation caves both on or near the Forest to better understand the migration patterns and find the summer maternity colony sites. Females have been found to use short-term roost trees in the area around the caves, typically within 5 miles of the hibernacula for spring staging prior to their migration. Once migration begins, the bats will use stop over roost trees, including at locations on the Forest, for one or more nights on their migration (Roby *et al*., 2021). Female bats were tracked migrating north into Missouri, south into southern Arkansas and southern Oklahoma, and east to bottomland hardwood forests in the Black River area, where a maternity colony was documented (Custer, 2021). On the Forest, one post-lactating female IBAT was captured on the Big Piney Ranger District in the headwaters of the Buffalo River watershed in 2015. Mist netting resulted in the capture of a male IBAT near that area in 2018, and three female and two male IBATs were captured in that same area in 2021. Radio-tracking of four of those individuals in 2021 resulted in documentation of the first IBAT maternity colony on the Forest.

Several male IBATs have been captured on the Sylamore Ranger District. Most of those captured since 2013 have been tracked with radio telemetry to roost trees. Most commonly, these bats on the Sylamore Ranger District have been found to roost in pine snags, but they have also been tracked to roosts in oak and hickory snags and live pine trees. In studies across the species range, IBAT has been found to roost in trees larger than the surrounding area in moderate to large canopy gaps (Silvis et. al. 2016). That pattern seems to generally hold true with the limited number of male bats captured on the Forest during the summer, as they have been found to frequently use roost trees in forest stands with recent thinning and prescribed fire activities. Most of the roost trees used on the Forest have been snags that are in advanced decay stages. A recent status review of the known IBAT roost trees on the Forest indicates the ephemeral nature of the roosts (Table 5-1).

Table 5-1. Indiana bat roost tree status on the Forest in 2019 compared to the year that bats were found roosting in the tree.

	Year Bat Roosting Detected						
Roost Status	2013	2014	2015	2016	2017	2018	2019
Standing*			**1**		**1**	**2**	**1**
Down	**2**	**2**	**2**	**1**	**1**		

*All of the trees were standing dead snags during the detected roosting events except for one live shortleaf pine in 2018.

5.1.2. Action Area Conservation Needs and Threats

Indiana bat populations have been declining since the early 1960s. The declining numbers were observed at winter hibernacula sites, such as caves and abandoned mines, where the bats gather in large numbers. On the Forest, the primary threats include disturbance in the hibernacula and WNS. Additionally, individual bats are at risk of being killed, injured or harassed by falling occupied roost trees or activities that may disturb a roosting bat and cause it to fly during the day.

The Forest Plan prioritizes protection of known sites used by IBAT and management practices that will improve the quality and availability of preferred habitat to promote the species recovery. The Forest Plan addresses protection of known hibernacula through gating, when appropriate, and by managing the forested habitat around known hibernacula for the benefit of IBAT. Timing restrictions on tree falling activities around the hibernacula reduce the risk of injury and harassment to individuals during the critical fall swarming and spring emergence periods. Habitat management, such as pond creation and maintenance, tree cutting and prescribed fire for forest health and habitat diversity, and watershed and riparian zones management are key to the survival of this species.

The Forest will conduct surveys for new populations and improve and maintain favorable habitat conditions for IBAT. The Forest intends to monitor and protect areas of use, as described in the amended Forest Plan, based on past and ongoing surveys, such as mist netting, harp trapping, radio telemetry, acoustic monitoring, and hibernacula surveys.

5.2. Environmental Baseline for Northern Long-eared Bat

5.2.1. Action Area Numbers, Reproduction, and Distribution

Northern long-eared bat was one of the most common and abundant forest bats in the karst region of Arkansas prior to the arrival of WNS and has been detected on every district on the Forest except the St. Francis Ranger District, which is outside of the species known range. Between 2013 and 2018, there was a precipitous decline in the number of NLEB caught during mist-netting surveys (Figure 5-2). Range-wide, observed declines include a significant reduction in winter colonies (-81%) and summer occupancy (-80%) (USFWS, 2022).

Northern long-eared bats utilize a variety of forest stand types for foraging and roosting, and there is mixed evidence in the literature about the specific forest habitat types preferred by the species. Based on years of surveys of NLEB on the Forest, the species forages across a wide range of forest types, frequently along low-use roads, trails, or small streams in forested stands. Based on the foraging habitat types used by NLEB and the historic abundance of the species on the Forest, suitable foraging habitat is available in abundance on the Forest.

Studies on the roosting habits of NLEB indicated that the species can use a wide range of sizes and species of trees for roosting (Silvis et. al., 2015). However, a recent study on the Forest found that female NLEB on the Mt. Magazine Ranger District selected mostly oak or hickory trees as maternity roosts, and those were most commonly dead trees (88%) with cavities (Edmonds, 2020). Several roost trees including maternity trees were identified during that study.

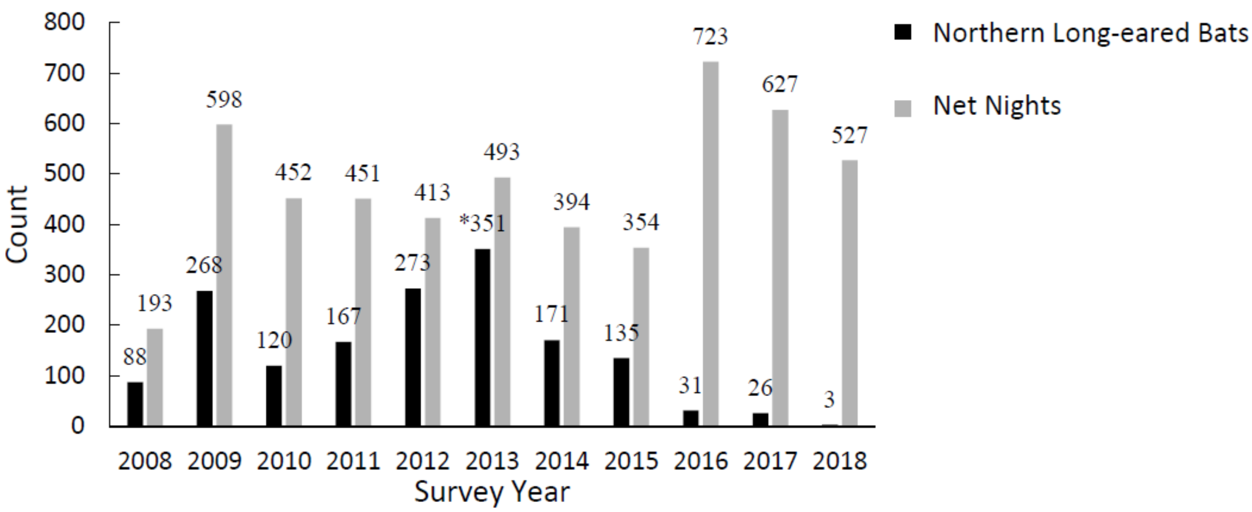

Figure 5-2. Number of summer net-nights compared to number of NLEB (black) captures across the Forest compared to number of net nights of survey (gray) by year (2008–2018; asterisk denotes year WNS was detected in Arkansas – From Edmonds, 2020).

5.2.2. Action Area Conservation Needs and Threats

The factors affecting NLEB in the Action Area are a subset of the threats affecting the species' range-wide and include WNS, wind energy development, disturbance, and habitat conversion. White-nose Syndrome was first detected in Arkansas in the winter of 2011 – 2012 and apparently has caused a 99% decline in summer captures of this species in the Ozarks (Edmonds 2020). Although there are no completed wind farms in Arkansas to date, there are a couple proposed for the state. Also, neither of these farms are within the Action Area. However, individuals hibernating or summering on the Forest could interact with proposed wind farms when migrating in the spring or fall. In-cave disturbance is another factor and is regularly addressed (e.g., cave gates, signs, etc.) for known caves in the Action Area. Habitat conversion does happen, although most tree removal occurring in the Action Area is occurring in the form of habitat modification or management. The Forest Plan contains measures specific to habitat management for bats.

5.3. Environmental Baseline for Tricolored Bat

5.3.1. Action Area Numbers, Reproduction, and Distribution

Tricolored bats occupy every district on the Forest during the active season and are widespread in the caves and crevices in the Ozark and Boston Mountain ecoregions in the winter. The species has been found hibernating in caves or crevices on every district except the St. Francis. As with NLEB, the species has declined substantially and WNS is the primary influence of those declines. From 2010 - 2019, range wide winter abundance declined by 52% and summer occupancy declined by 28% (USFWS, 2021). Winter survey data in Arkansas indicates that the declines in abundance in the state have been closer to 90% (Figure 5-3).

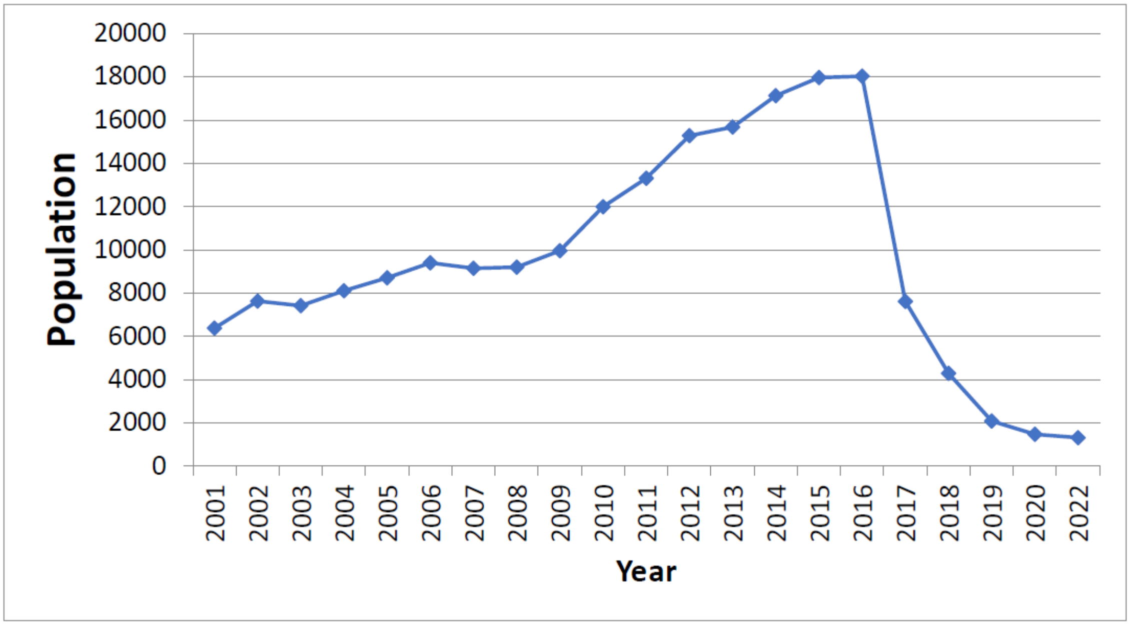

Figure 5-3. Tricolored bat population estimates for Arkansas based on winter counts (Sasse 2022).

On the Forest, three males and one female TRBA were tracked to roost trees in 2017. The female roosted in a large live red oak that was taller than most of the trees in the stand. The male bats all roosted in snags, two in dead white oaks and one in a dead cucumber magnolia (K. Edmonds, unpublished data, 2017 bat survey).

5.3.2. Action Area Conservation Needs and Threats

The factors affecting TRBA in the Action Area are a subset of the threats affecting the species' range-wide and include WNS, wind energy development, disturbance, and habitat conversion. Winter survey data in Arkansas indicates that the declines in abundance in the state have been closer to 90%. Although there are no completed wind farms in Arkansas to date, there are a couple proposed for the state. Also, neither of these farms are within the Action Area. However, individuals hibernating or summering on the Forest could interact with proposed wind farms when migrating in the spring or fall. In-cave disturbance is another factor and is regularly addressed (e.g., cave gates, signs, etc.) for known caves of *Myotis* species in the Action Area. Caves with large numbers of TRBA are being considered for greater protective measures. However, the Service is still assessing what affect in-cave disturbance has on this species. Habitat conversion does happen, although most tree removal occurring in the Action Area is occurring in the form of habitat modification or management. The Forest Plan contains measures specific to habitat management for bats.

6. EFFECTS OF THE ACTION

In a BO for a listed species, the effects of the proposed action are all reasonably certain consequences to the species caused by the action, including the consequences of other activities caused by the action. Activities caused by the action would not occur but for the action. Consequences to species may occur later in time and may occur outside the action area.

We identified and described the activities included in the proposed Action in sections 2.1–2.9. In order to adequately evaluate the effects of the action, the proposed Forest Plan activities are broken down into two sub-activities that could result in adverse effects to the species: (1) tree removal and (2) prescribed burning. Based on the Proposed Action, species biology and relevant literature, the Service identified stressor(s) (i.e., the alteration of the environment that is relevant to the species) that may result from the Action. Below, we discuss the best available science relevant to each likely effect on IBAT, NLEB, and TRBA collectively. Then, we describe the Stressor-Exposure-Response (SER) pathways that identify the circumstances for an individual bat's exposure to the stressor (i.e., the overlap in time and space between the stressor and a bat). Finally, we identify and consider how proposed conservation measures may reduce the severity of the stressor or probability of an individual bat's exposure for each pathway.

Tree Removal and Prescribed Burning

The Service expects tree removal (suitable habitat) (up to 33,890 acres and 500 individual trees annually) and prescribed burning (up to 120,000 acres annually) practices to occur in IBAT, NLEB, and TRBA habitat anywhere within the 1.2 million acres of forested habitat available for Forest Plan implementation on the Forest.

Tree removal will occur during timber harvest (i.e., regeneration harvest, thinning, salvage/sanitation, and firewood collection), road and trail projects (i.e., construction, reconstruction, maintenance, and decommissioning), and non-timber harvest clearing (i.e., wildlife opening creation and maintenance, glade restoration, minerals development, pond construction/reconstruction, stream and lake large woody debris, recreation site maintenance, and ROW maintenance), as well as some fire lane development and hazard tree removal during prescribed burning. The Service expects tree removal to result in the following stressors: noise/vibration, loss of roosts, forest loss/fragmentation, and loss of prey base. The Service expects prescribed burning to result in the following stressors: noise, loss of roosts, loss of prey base, and heat/smoke. We evaluate the applicable science and SER pathways for tree removal and prescribed burning below.

6.1.1. Stressor: Noise/Vibration (Tree Removal and Prescribed Burning)

The people, chainsaws, and heavy equipment involved in forest management activities as described above generate noise and/or vibrations that could disturb IBAT, NLEB, and TRBA. During the active season, this disturbance could cause volant bats to temporarily flee or permanently abandon roosts during the day. Refer to Effects Pathway 1 for conservation measures to avoid and minimize effects to IBAT, NLEB, and TRBA.

Applicable Science

Bats may be disturbed while roosting by noises of activities on the Forest created by Forest staff, contractors, or the public. Noise disturbance comes from vehicle traffic on Forest or other connected roads, heavy equipment involved in timber, non-commercial silviculture treatments, or construction projects. Smaller equipment can create noise disturbance such as mowers, leaf blowers, toilet pumpers, chainsaws, and similar equipment.

Bats may be less likely to roost in areas of the forest near high use roads due to the regular sound disturbances (Bennett and Zurcher, 2013). These species of bats may be disturbed while roosting near a project activity area by heavy equipment sounds or vibrations due to construction work or timber harvest such as engine sounds, track noise, back-up warnings, or activities such as excavation, tree falling, blading, dumping rock, demolition, or pile driving. Noise disturbance could also occur due to chainsaws, mowers, or other small equipment. Bats have been shown to come partially out of torpor when stimulated by noise and that bats habituate to predictable noise levels (Luo et al., 2014). A bat that is roosting near this type of activity may rouse and leave the roost during the day, which could have a cost in energy reserves, a stress response, and an increased risk of predation due to daytime flight. Noise and activity may help provide a warning to bats in the area of forest site clearing or another activity area, which might cause the bat to leave a roost prior to that tree being fallen.

Gardner et al. (1991) found that IBAT continues to roost and forage in areas with active timber harvest. This suggested that noise and exhaust emissions from machinery could possibly disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment. Callahan (1993) noted the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree. In another study near I-70 and the Indianapolis Airport, a primary maternity roost was located 1,970 ft (0.6 km) south of I-70 (3D/International, Inc. 1996). This primary maternity roost was not abandoned despite constant noise from the Interstate and airport runways. However, the roost's proximity to I-70 may be related to a general lack of suitable roosting habitat in the vicinity, and the bats had become habituated to the noise from the airport (USFWS 2002).

Mikula et al. (2016) reviewed approximately 1,500 reports from 109 countries of attacks by 143 species of diurnal birds on 124 species of bats. The family Vespertilionidae, to which the genus Myotis belongs, represented 22.8 and 58.8 percent of cases of bats taken by raptors of the hawk and falcon families, respectively, and 77 percent of bats taken by non-raptors (e.g., gulls, crows). Citing data from other studies, the authors surmised that the diurnal predation rate on bats is likely 100–1,000 times higher than the nocturnal predation rate when standardized relative to the duration of day versus night bat activity. Therefore, forest management activities causing daytime disturbances that may flush bats from roosts could increase predation threats.

Effects Pathway 1

Activity: Tree removal and prescribed burning	
Stressor: Noise/vibration	
Exposure (time)	March 1 – November 30; annually; specific duration will vary
Exposure (space)	~153,890 acres of forested habitat on Forest annually
Resource affected	Individuals (juveniles, adults)
Individual response	Extra energy expenditure; decreased fitness; mortality
Effect	Direct and indirect harm
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. Prescribed burn strategies near moderate to high-use hibernacula, AFO coordination on activities occurring within primary

Effects Pathway 1	
Activity: Tree removal and prescribed burning	
Stressor: Noise/vibration	
	management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees, and snag retention are examples of measures being proposed to avoid or minimize the effect of noise/vibration on the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.
Interpretation	Bats may become startled by the noise and flush from their roosts during tree removal or prescribed burning actions that could occur March 1 – November 30 when bats are present on the landscape. Bats that flush during the daytime are at greater risk of harm due to predation. We expect the Forest to mitigate potential adverse effects resulting from flushing females in a roost tree with pups upon implementation of the Forest Plan conservation measures.

6.1.2. Stressor: Loss of Roosts

All forest management activities proposed by the Forest that include tree removal and prescribed fire could remove suitable roost trees. Refer to Section 2.9 and Appendix A for a complete list of measures to avoid or minimize direct effects to IBAT, NLEB, and TRBA.

6.1.2.1. **Loss of Occupied Roosts**

Applicable Science
Tree Removal: Risk of injury or death from being crushed when a tree is felled is most likely to affect non-volant pups and occasionally adults (Belwood 2002). This risk is greater for adults during cooler weather when bats periodically enter torpor and cannot arouse quickly to respond (i.e., flush and potentially avoid being in the roost when it is felled). Indiana bat is also at an increased predation risk when flushed during daylight hours due to the felling of an occupied roost, or disturbance associated with habitat removal adjacent to an occupied roost (Mikula et al. 2016).

Trees fallen during the pup season (June 1 to July 31) could potentially have nursing young bats that have not yet developed the ability to fly. Indiana bat often have larger maternity colonies in a single tree with 50 or more mother and pup pairs not uncommon. Tricolored bat has solitary or small summer maternity colony roosts primarily in vegetation clusters (Perry and Thill, 2007; Veilleux *et al*., 2003). Although the mothers can carry the young, pups are at greater risk of injury or death if a tree that they are roosting in is fallen compared to a bat that can fly. If a mother can leave the roost before or while it is being fallen, they would still be exposed to additional predation risk and would need to find another suitable roost tree.

We are aware of three accounts of occupied IBAT roost trees being felled. In all cases, it was not known that the tree contained a bat roost, and, in all cases, some bats in the tree were killed or injured. Cope et al. (1974) reported on the first known IBAT maternity roost tree, a dead elm in Wayne County, Indiana. The original account stated that eight bats were "captured and identified as IBATs," and that about 50 bats flew from the tree. Although, the original account did not specify how the eight bats were captured, J. Whitaker (Indiana State University, pers. comm., 2005, as cited in the draft revised IBAT recovery plan) recounted that those bats were killed or disabled, retrieved by the landowner, and subsequently identified by a biologist.

In another case, Belwood (2002) reported on the felling of a dead maple in a residential lawn in Ohio. One dead adult female and 33 non-volant young were retrieved by the researcher. Three young bats were already dead when they were picked up, and two more died subsequently. The rest were apparently retrieved by surviving adult bats. In a third case, 11 dead adult female IBATs were retrieved (by people) when their roost was felled in Knox County, Indiana (J. Whitaker, pers. comm., 2005, as cited in the draft revised IBAT recovery plan).

Prescribed Burning: Fire use is generally advocated as a way of improving bat habitat, through snag production, creation of more open stands preferred for foraging, and increased insect abundance and diversity (e.g., USFWS 2007a). Fires both create and destroy snags, with unknown long-term effects in eastern hardwood forests (Dickinson et al. 2009). Roost characteristics, such as height above ground, snag condition, and landscape position, also influence fire risk. Fires not only create snags by killing trees, some of which may be live roosts, but also fell snags through the structural weakening caused by smoldering combustion (Carter et al. 2002). Burning may create more suitable snags for roosting through exfoliation of bark (Johnson et al. 2009), mimicking trees in the appropriate decay stage for roosting bats. Perry (2012) suggests that depending on fire severity, seasonality, and frequency, evidence from the east suggests that fire can often recruit more trees or snags into conditions suitable for day-roosts for bark- and cavity-dwelling bat species than are lost.

Effects Pathway 2

Activity: Tree removal	
Stressor: Loss of occupied roost trees	
Exposure (time)	March 1 – November 30; annually; specific duration will vary
Exposure (space)	~33,890 acres of forested habitat and ~500 individual trees on Forest annually
Resource affected	Individuals (juveniles, adults), habitat (roost trees)
Individual response	Injury/mortality; flushing from the roost tree; predation; energy expenditure; decreased fitness
Effect	Direct and indirect harm
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. AFO coordination on activities occurring within primary management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees, and snag retention are examples of measures being proposed to avoid or minimize the effect of tree removal and potential loss of occupied trees on the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.

Effects Pathway 2

Activity: Tree removal	
Stressor: Loss of occupied roost trees	
Interpretation	Bats that remain in felled trees may be struck or crushed. Bats that flush from the tree will be exposed to increased levels of predation. Bats that survive may experience reduced fitness due to the additional energy expenditure associated with finding a new, suitable roost tree. The implementation of the Forest Plan conservation measures will minimize adverse effects to non-volant pups and pregnant or lactating females.

Effects Pathway 3

Activity: Prescribed Burning	
Stressor: Loss of occupied roost trees	
Exposure (time)	March 1 – November 30; annually; specific duration will vary
Exposure (space)	~120,000 acres of forested habitat on Forest annually
Resource affected	Individuals (juveniles, adults), habitat (roost trees)
Individual response	Flushing from the roost tree; predation
Effect	Direct and indirect harm
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. Prescribed burn strategies near moderate to high-use hibernacula, AFO coordination on activities occurring within primary management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees, and snag retention are examples of measures being proposed to avoid or minimize the effect of prescribed burning and potential loss of occupied roost trees on the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.
Interpretation	Fire may consume roost trees and snags, causing bats to flush. Bats will be more susceptible to predation and could experience reduced fitness due to the additional energy expenditure associated with fleeing the burning area and finding a new suitable roost tree. The implementation of the Forest Plan conservation measures will minimize adverse effects to non-volant pups and pregnant or lactating females while in occupied roost trees.

6.1.2.2. **Loss of Unoccupied Roosts**

<u>Applicable Science</u>

Indiana bat forms summer maternity colonies that exhibit "fission-fusion" behavior (Barclay and Kurta 2007; Garroway and Broders 2007). Members coalesce to form a group (fusion), but the composition of the main unit is dynamic. Individuals exit the main unit for solitary roosting or to form smaller roosting groups (fission), and later return to the main unit, which may sometimes move to another roost. Indiana bat switches roosts often, typically every 2–3 days (Kurta et al. 2002; Kurta 2005; Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). Female TRBA also form maternity colonies and switch roost trees regularly (e.g., between 1.2 days and 7 days at roost trees in Indiana) (Veilleux and Veilleux 2004a, p. 197; Quinn and Broders 2007, p. 19; Poissant et al. 2010, p. 374). Males roost singly (Perry and Thill 2007, p. 977; Poissant et al. 2010, p. 374). Because these species will rely on previously established roosts, roost tree loss, regardless of whether it occurs during the active or inactive (winter) seasons, may affect the fission-fusion dynamics of maternity colonies that can lead to a reduction in individual fitness as a result of increased energy expenditure.

These effects are compounded in the action area because most of the returning bats are coming from hibernacula infected with white-nose syndrome (WNS). Individuals surviving WNS have additional energetic demands. For example, WNS-affected bats have less fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2012) and have wing damage (Reichard and Kunz 2009, Meteyer et al. 2009) that makes migration and foraging more challenging. Females that survive the migration to their summer habitat must partition energy resources between foraging, keeping warm, maintaining a successful pregnancy, rearing pups, and healing their own bodies.

Effects Pathway 4

Activity: Tree removal and prescribed fire	
Stressor: Loss of unoccupied roost trees	
Exposure (time)	Annually; specific duration will vary
Exposure (space)	~153,890 acres of forested habitat on Forest annually
Resource affected	Individuals (juveniles, adults), habitat (roost trees)
Individual response	Energy expenditure; reduced fitness
Effect	Indirect harm
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. Prescribed burn strategies near moderate to high-use hibernacula, AFO coordination on activities occurring within primary management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees, and snag retention are examples of measures being proposed to avoid or minimize the effect of tree removal and prescribed fire for the potential loss of unoccupied trees on the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.
Interpretation	Removal and loss of roost trees during the unoccupied timeframe may result in increased energy expenditure due to increased time spent seeking out new roosting habitat that would have otherwise been spent on foraging, pup rearing, social interactions, or other activities. We expect the use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle

Effects Pathway 4	
Activity: Tree removal and prescribed fire	
Stressor: Loss of unoccupied roost trees	
	processes (e.g., recovery from WNS effects, pup rearing, etc.) or other stressors to result in delayed reproduction, spontaneous abortion, hypothermia, and starvation in some cases. While some adverse effects resulting from roost tree loss are unavoidable, the Forest will implement conservation measures to create/retain suitable roosting habitat to minimize indirect harm as indicated in Section 2.9 and Appendix A.

6.1.3. Stressor: Forest Loss and Fragmentation

All habitat management that includes tree removal is designed to improve bat habitat in the short- and/or long-term and ensure overall quantity and quality of treated habitat is not degraded by forest management prescriptions.

Applicable Science
In highly fragmented landscapes, loss of connectivity among remaining forest patches may degrade IBAT habitat (USFWS 2007). Bat mobility allows them to exploit habitat fragments (Patterson et al. 2003). However, they cautioned that reliance on already diffuse resources (e.g., roost trees) leaves bats highly vulnerable, and energetics may preclude the use of overly patchy habitats. Racey and Entwistle (2003) discussed the difficulties of categorizing space requirements in bats, as they are highly mobile and show relatively patchy use of habitat (and use of linear landscape features), although connectivity of habitats has some clear advantages (e.g., aid orientation, attract insects, provide shelter from wind and/or predators). Wooded travel corridors are important for IBATs within their maternity habitat because they did not fly over open fields (in Michigan) but traveled along wooded corridors, even though use of these corridors increased commuting distance by > 55 percent (Murray and Kurta 2004; Sparks et al. 2005). In the Ozarks, occupancy increased with percent forest area for NLEB but decreased for TRBA (Starbuck et al., 2015). Habitat use of bat species in a savannah to forest gradient found that TRBA occupancy was unrelated to vegetation structure (Starbuck et al., 2015). Tricolored bat used stands that were heavily thinned and received prescribed burning treatments at a higher level on the Cumberland Plateau in Tennessee despite evidence that prey availability was not higher, indicating that open forest structure plays an important role in foraging quality (Cox et al., 2016).

Indiana bat roosts in a southern Illinois study area were located in highly fragmented forests, although both the number of patches and mean patch size of bottomland hardwood forest and closed-canopy deciduous forest were higher in the area surrounding roosts than around randomly selected points (i.e., IBATs were using the least fragmented forest blocks available to them in that landscape) (Carter et al. 2002). Mean patch size of bottomland forest for circles 1.2 mi (2 km) in diameter surrounding roosts was 88.7 acres (35.9 ha), compared to 3.7 acres (1.5 ha) around random locations. Mean patch size of closed-canopy deciduous forest was 19.5 acres (7.9 ha) around roosts compared to 8.4 acres (3.4 ha) around random locations. In both cases, the difference was statistically significant (Carter et al. 2022).

This analysis shows the likelihood of IBATs roosting in a particular forest patch increases with the size and connectivity of the forest patch. In landscapes dominated by agriculture or other non-forested cover types, IBAT may use all or most available forest patches as part of their home range and may stretch their home range beyond 2.5 miles from roosting areas. Indiana bat must commute longer distances more frequently in highly fragmented landscapes with smaller, more distant suitable habitat patches to obtain similar resources (Kniowski and Gehrt 2014). In Ohio, radio tagged bats moved the farthest in areas with limited forested cover. Several traveled 5 – 6 miles (8 - 9.7 km), and one bat flew straight-line distance of about 7 miles, but may have flown approximately 10 miles (16.1 km) (K. Lott, USFWS, pers. comm.).

In a fragmented landscape, IBAT may fly across less suitable habitat. This could pose greater risk of predation (e.g., raptors). IBAT consistently follows tree-lined paths rather than crossing large open areas (Gardner et al. 1991, Murray and Kurta 2004). Murray and Kurta (2004) found IBAT increases its commuting distances by 55 percent to follow these paths rather than flying over large agricultural fields. However, if these corridors are not available, IBAT may be forced over open areas such as cropland > 0.6 miles (1 km) to reach remote, isolated woodlots or riparian corridors (Kniowski and Gehrt 2014).

Although researchers found it difficult to predict where maternity colonies may occur relative to forested habitat, researchers can reliably predict that once IBAT colonizes maternity habitat, they will return to the same maternity areas annually (USFWS 2007). Philopatry of IBAT maternity colonies to their summer range is well documented. Indiana bat likely returns to the same place each year whether there is enough habitat in the immediate vicinity to support a colony or not. Given the additional energy expenditures expected in fragmented landscapes, the status of colonies is unclear at the lower end of the percent forest cover spectrum. Colonies may be smaller in size in areas with reduced forest (Callahan 1993).

Kurta (2005) noted that impacts on reproductive success of IBAT are a likely consequence of traditional roost site loss. He suggested that reduced reproductive success may be related to stress, poor microclimate in new roosts, a reduced ability to thermoregulate through clustering, or reduced ability to communicate and thus locate quality foraging areas. He further suggested that the magnitude of impacts would vary greatly depending on the scale of roost loss (i.e., how many roosts are lost and how much alternative habitat is left for the bats in the immediate vicinity of the traditional roost sites).

In areas with WNS, there are additional energetic demands for IBAT. For example, WNS-affected bats have less fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2012) and have wing damage (Reichard and Kunz 2009, Meteyer et al. 2009) that makes migration and foraging more challenging. Females that survive the migration to their summer habitat must partition energy resources between foraging, keeping warm, successful pregnancy and pup-rearing, and healing.

The species covered by the existing consultation have a much higher tolerance for forest fragmentation than what will be experienced under this proposal, and there may be some benefit of increased edge habitat and fragmentation for foraging and travelling. A limited amount of fragmentation may benefit bats by providing more diverse habitat in closer proximity. For example, bats may be able to find sufficient roosting and foraging habitats that are closer together in areas with greater habitat complexity (Ethier and Fahrig, 2011).

Effects Pathway 5	
Activity: Tree Removal	
Stressor: Forest loss and fragmentation	
Exposure (time)	Year-round
Exposure (space)	~33,890 acres of forested habitat on Forest annually
Resource affected	Individuals (juveniles, adults), habitat (roost trees)
Individual response	Reduced fitness
Effect	Insignificant
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. AFO coordination on activities occurring within primary management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees, and snag retention are examples of measures being proposed to avoid or minimize the effect of tree removal pertaining to forest loss and fragmentation on the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.
Interpretation	The primary goal of forest management activities within the Action Area is to improve habitats for wildlife species, including bats. Forest will implement conservation measures designed to preserve existing bat habitat and enhance habitat in the long-term for treatments within suitable habitat. Therefore, given the nature of the treatments and implementation of conservation measures, it is unlikely that forested corridors used for commuting or foraging will be fragmented to a degree that significantly alters the behavior of the covered species. In the long-term, habitat continuity and habitat availability are expected to improve for the species.

6.1.4. Stressor: Heat and Smoke

<u>*Applicable Science*</u>
Little is known of the direct effects of fire on cavity and bark roosting bats, and few studies have examined escape behaviors, direct mortality, or potential reductions in survival associated with effects of fire. Bat species in the Southeast have evolved in fire-dominated ecosystems and exposure to heat and smoke has likely shaped their roosting strategies.

Roosting location, including roosting height may be part of the roosting strategy to avoid effects of heat and smoke during a forest fire. Although the literature on this issue is limited, there is evidence that smoke can cause arousal from torpor in some bats, although there is limited testing in the species currently under consultation (Scesny and Robbins, 2006, Doty *et al*., 2018). Bat species studied showed an arousal response from smoke and an indication of an escape response; however, the arousal time has been shown to be related to ambient temperatures, which may affect the ability of the bat to avoid injury due to acute respiratory failure or burn injury (Doty *et* *al*., 2018). Dickinson et al. (2009) monitored two NLEBs during a controlled summer burn. Both bats exited their roosts within 10 minutes of ignition near their roosts and flew to areas where the fire was not occurring. Among four bats they tracked before and after burning, all switched roosts during the fire, and no mortality was observed. Likewise, Rodrigue et al. (2001) reported flushing of a *Myotis* bat from an ignited snag during an April controlled burn in West Virginia.

Fire could have mixed effects on IBAT habitat (e.g. burning a suitable roost tree that kills, weakens the tree, or peels away bark). Perry (2012) found that bats often take advantage of fire-killed snags. Overall, fire may result in both the loss and production of snags. Fire in any season that results in tree mortality may provide more benefit to IBAT through snag creation than negative impacts. In the long term, fire may benefit IBAT habitat by reducing the threat of future severe fires. Removing fuel biomass will decrease the risk of major fire events within a stand, which ensures continued presence of suitable roosts and foraging habitat. In addition, prescribed fire promotes the growth of remaining trees due to decreased competition with other vegetation.

Smoke exposure determined by fire behavior are a realm which the fire manager has substantial control through choice of burning conditions and firing methods (Dickinson et al. 2009). Choice of burning weather and season are well-known methods of manipulating fire behavior and, thus, smoke exposure.

Risk of direct injury and mortality to southeastern forest-dwelling bats resulting from summer prescribed fire is generally low (Carter et al. 2002). During warm temperatures, bats are able to arouse from short-term torpor quickly. Most adult bats are quick, flying at speeds > 18 miles/hour (> 30 km/hour) (Patterson and Hardin 1969), enabling escape to unburned areas. Dickinson et al. (2010) found that carbon monoxide levels did not reach critical thresholds that could harm bats in low-intensity burns at typical roosting heights for IBAT 28.2 ft (8.6 m). However, in this range of heights, direct heat could cause injury to the thin tissue of bat ears. Such injury would occur at roughly the same height as tree foliage necrosis (death), or where temperatures reach 140 °F (60 °C).

Effects Pathway 6

Activity: Prescribed burning	
Stressor: Heat/smoke	
Exposure (time)	March 1 – November 30
Exposure (space)	~120,000 acres of forested habitat on the Forest annually
Resource affected	Individuals (juveniles, adults), habitat (roost trees)
Individual response	Injury or death; flushing from the roost tree; predation
Effect	Direct/indirect harm
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. Prescribed burn strategies near moderate to high-use hibernacula, AFO coordination on activities occurring within primary management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees are examples of measures being proposed

Effects Pathway 6	
Activity: Prescribed burning	
Stressor: Heat/smoke	
	to avoid or minimize the effect of prescribed burning for heat and/or smoke on the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.
Interpretation	Bats that remain in trees could be injured or killed by heat/smoke. Bats that flush from the tree will be exposed to increased levels of predation and will experience reduced fitness due to the additional energy expenditure associated with fleeing the burning area. The implementation of the Forest Plan conservation measures will minimize adverse effects the covered species due to heat/smoke exposure from prescribed burns.

6.1.5. Stressor: Loss of Prey Base

<u>Applicable Science</u>
The effects of vegetation management on insect prey communities may vary and can be dependent on many factors, including management prescription, ecological type, vegetation condition, as well as a variety of landscape and climatic conditions that may vary both spatially and temporally. The high diversity of insect prey taxa and variation in response to vegetative treatments across differing landscapes and years precludes any broad-scale determination regarding the effect of vegetation management on prey populations. Some studies indicate that while regeneration cuts result in a decrease in the abundance of Lepidopterans, the primary prey for many bat species, the use of selective harvest management practices does not result in significant alteration of these prey (Summerville and Crist 2002, Dodd et al. 2012). However, moth abundance is often related to woody stem density, likely because woody plants are host for many species of moths. A study on the Forest found that moth abundance was lower in recently commercially thinned forest stands compared to unthinned stands (Tormanen and Garrie, 2021).

Prescribed fire can affect forest insect communities that are prey for these bat species. A study on the impact of prescribed fire on moth abundance in the Ozarks found that moths were more abundant in burned stands compared to unburned stands (Guerra et al., 2019). Another study in the Boston Mountains found that stands with high frequency burning had more moths, but sites with intermediate burn frequency had fewer moths than unburned control sites (Tormanen and Garrie, 2021). An investigation of a savannah site managed for 30 years with frequent fire found that some species abundances were affected in the growing season following a burn, but those same species benefitted in the long term from the effects to the habitat conditions promoted by prescribed fire (Sieman et al., 1997).

Ground-disturbing activities, such as timber harvest, heavy construction, road construction or maintenance, prescribed fire, and stream restoration can result in soil erosion and siltation of streams, which could affect aquatic invertebrate communities that are a portion of the prey base for the species included in this consultation. The foraging behavior of these species is somewhat different, but they each are known to use waterbodies or streams as foraging areas at times and each species can be opportunistic foragers even if aquatic macro-invertebrates are not the primary prey taxa of any of the species.

Effects Pathway 7	
Activity: Tree Removal and Prescribed burning	
Stressor: Loss of Prey Base	
Exposure (time)	March 1 – November 30
Exposure (space)	~153,890 acres of forested habitat on Forest annually
Resource affected	Individuals (juveniles, adults)
Individual response	Reduced fitness
Effect	Direct/indirect harm
Conservation Measures	The Forest proposes to implement multiple conservation measures in addition to existing measures for bat protection and management in the Forest Plan. Prescribed burn strategies near moderate to high-use hibernacula, AFO coordination on activities occurring within primary management zones, seasonal tree cutting restrictions, protection and buffering of known roost trees, and snag retention are examples of measures being proposed to avoid or minimize the effect of tree removal and prescribed fire on the prey base of the covered species. For a complete list of conservation measures, see Section 2.9. For a complete list of existing bat related Forest Plan measures, see Appendix A.
Interpretation	Bats that emerge from hibernation and migrate through or summer on the Forest may encounter recent or active management areas on the Forest. There may be short term affects to bats prey base during these instances that may reduce the fitness of individuals due to the additional energy expenditure associated with searching other areas for prey. However, the long term effects of the habitat management and implementation of the conservation measures in Section 2.9 and Appendix A, are expected to benefit the prey base for the covered species.

6.1.6. Summary of Effects

The stressors associated with each activity are summarized in Table 6-1.

Table 6-1. Summary of Stressors on the covered bat species.

Proposed Activities	Stressors				
	Noise/Vibration	Loss of Roosts	Heat/Smoke	Forest Loss Fragmentation	Loss of Prey Base
Prescribed Burning	x	x	x		x
Tree Removal	x	x		x	x

6.2. Cumulative Effects

In section 3, we did not identify any activities that satisfy the regulatory criteria for sources of cumulative effects. Therefore, cumulative effects to IBAT, NLEB, and TRBA are not relevant to formulating our opinion for the Action.

6.3. Conclusion

In this section, we summarize and interpret the findings of the previous sections (status, baseline, effects, and cumulative effects) relative to the purpose of the BO for the IBAT, NLEB, and TRBA, which is to determine whether the Action is likely to jeopardize its continued existence.

Tree removal (suitable habitat) (up to 33,890 acres and 500 individual trees annually) and prescribed burning (up to 120,000 acres annually) practices are proposed to occur in IBAT, NLEB, and TRBA habitat over the next 10 years and could occur anywhere within the 1.2 million acres of forested habitat available for Forest Plan implementation on the Forest. To date, IBAT, NLEB, and TRBA hibernacula and summer use, as well as some migratory behavior has been documented on the Forest. Additionally, ongoing mist netting and acoustic data collection efforts may yield additional information in the coming years.

We anticipate that activities listed in Section 2.1 – 2.8 conducted during the active season will result in adverse effects to IBAT, NLEB, and TRBA in summer (including possible unknown maternity), swarming and staging, and migratory/stop-over habitat on the Forest. Effects to individuals from the above listed activities are likely to occur any time during the active season and to any cohort of individuals present during proposed activities. Potential effects to bats in the absence of conservation measures range in intensity and severity from high to low depending on where, when, and over what size an area the activities occur. Considering actions that occur only in the active season, effects are greatest if activities occur during the summer, especially during the non-volant pup season, in known occupied areas, and over a large number of acres. Effects are lowest if activities occur during the migratory season, away from known bat occurrences, and include a small number of acres. Implementation of the conservation measures described in Sections 2.9 and Appendix A will avoid and minimize the highest potential effects by protecting known active season use areas through establishment of special management buffers and seasonal cutting and burning restrictions. Potential effects that are of low to moderate severity and intensity still could occur during the active season despite the conservation measures. Accordingly, our analysis indicates the proposed action is not likely to cause population-level (e.g., maternity colony or hibernacula) effects that would lead to a decrease in fitness and viability of a population unit.

After reviewing the status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's BO that the Action is not likely to jeopardize the continued existence of the IBAT, NLEB, or TRBA.

7. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) 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(19)). In regulations, the Service further defines:

- "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;" (50 CFR §17.3) and
- "incidental take" as "takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant" (50 CFR §402.02).

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to a Federal agency action that would not violate ESA §7(a)(2) is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

For the exemption in ESA §7(o)(2) to apply to the Action considered in this BO, the Forest must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. The Forest has a continuing duty to regulate the activity covered by this ITS. The protective coverage of §7(o)(2) may lapse if the Forest fails to:

- assume and implement the terms and conditions; or
- require a permittee, contractor, or grantee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, contract, or grant document.

In order to monitor the impact of incidental take, the Forest must report the progress of the Action and its impact on the species to the Service as specified in this ITS.

7.1. Amount or Extent of Take

This section specifies the amount or extent of take of listed wildlife species that the Action is reasonably certain to cause, which we estimated in the "Effects of the Action" sections of this BO.

Based on the results of the Effects of the Action analysis above, the Service anticipates that incidental take of IBAT, NLEB, and TRBA in the form of harm and kill is likely to occur because of the proposed action. Despite implementation of Forest conservation measures, we anticipate that some male, female, and juvenile IBAT, NLEB, and TRBA may be killed or injured while conducting forest management activities under the Forest Plan, as amended. This is likely to occur if an occupied roost tree is felled during summer roosting, migration, staging, or swarming. We anticipate that proposed Forest management activities (i.e., timber harvest, prescribed burning, road and trail work, and non-timber tree removal) will result in take in the form of harm of individuals over 153,890 acres (annually) of suitable summer roosting, swarming, staging, and migratory habitats. Take will be measured by the number of acres of suitable roosting habitat that are modified or removed during implementation of the amendment to the Forest Plan covered in this BO. Direct take also will be detected by observing disturbance, injury, or mortality of individuals or colonies.

The Forest must reinitiate consultation with the Service if more than 153,890 acres of suitable habitat are modified or removed annually by actions covered in this BO through April 19, 2033, or until a new revised Forest Plan is signed and implemented, whichever comes first.

Surrogate Measures for Monitoring

For the IBAT, NLEB, and TRBA, detecting take that occurs incidental to the Action is not practical. When it is not practical to monitor take in terms of individuals of the listed species, the regulations at 50 CFR §402.14(i)(1)(i) indicate that an ITS may express the amount or extent of take using a surrogate (*e.g.,* a similarly affected species, habitat, or ecological conditions), provided that the Service also:

- describes the causal link between the surrogate and take of the listed species; and
- sets a clear standard for determining when the level of anticipated take has been exceeded.

Indiana bat, NLEB, and TRBA are medium-sized bats weighing only one-quarter of an ounce, and detecting individuals subject to incidental take will be exceptionally difficult. For this reason, it is not practicable to monitor take in terms of individual bats. Strict adherence to the components of the proposed action through field monitoring and regular reporting during the term of the action as set forth in the **Monitoring and Reporting** below constitute a reasonable and practical alternative to ensure that the exempted take levels are not exceeded. The various components of the proposed action establish certainty that IBAT, NLEB, and TRBA are likely to be exposed to Forest management activities, at times, in a manner that conforms to take. In that way, components of the proposed action are linked to IBAT, NLEB, and TRBA incidental take. The Service believes that acreage of suitable habitat removed, which identifies the level of use associated with the action, is the most practical surrogate for measuring bat take. Therefore, the Service determined that if any actions exceed the acreage totals, this will trigger reinitiation. The Service will determine if the use associated with take is approaching the amount described above through review of annual monitoring reports submitted to the Service by the Forest. Any deviation from the proposed action that increases exposure of IBAT, NLEB, and TRBA to proposed Forest management activities and conservation measures will constitute exceedance of the exempted take level requiring immediate coordination with the Service to determine if reinitiation of formal consultation is warranted.

7.2. Reasonable and Prudent Measures

The Action includes conservation measures to avoid and minimize impacts to IBAT, NLEB, LBBA, and TRBA, promote recovery by improving bat habitat on Forest, and by maintaining a robust monitoring program. Therefore, the Service believes that no reasonable and prudent measures are necessary or appropriate to minimize the impact, *i.e.,* the amount or extent, of incidental take of the covered species caused by the Action. Minor changes that do not alter the basic design, location, scope, duration, or timing of the Action would not reduce incidental take below the amount or extent anticipated for the Action as proposed. Therefore, this ITS does not provide RPMs for these species.

7.3. Terms and Conditions

No reasonable and prudent measures to minimize the impacts of incidental take caused by the Action are provided in this ITS; therefore, no terms and conditions for carrying out such measures are necessary.

7.4. Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, the Forest must report the progress of the Action and its impact on the species to the Service as specified in the ITS (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting (M&R), including procedures for handling and disposing of any individuals of a species actually killed or injured. These M&R requirements are mandatory.

As necessary and appropriate to fulfill this responsibility, the Forest must require any permittee, contractor, or grantee to accomplish the M&R through enforceable terms that the Forest includes in the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify the Forest and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

In order to ensure the amount or extent of incidental take is not exceeded and activities in the Programmatic BO are carried out as described, Forest will provide an annual report that includes:

1. List of all completed projects in the calendar year that conducted Forest management activities that are considered an adverse effect as described in this BO.
2. Total annual acreage per activity described as follows:
    - Commercial timber harvest (by cutting method)
        - Regeneration harvest
        - Thinning
        - Salvage/Sanitation
        - Firewood collection
        - Temporary road construction and decommissioning
    - Prescribed burning
    - Forest site clearing
    - Non-commercial silvicultural activities

- Tree release
- Wildlife or timber stand improvement
- Mulching
- Precommercial thinning

3. Active Season (March 1 – November 30) Activities (no reporting required if conducted during the hibernation period)
    - Mastication, limbing, roadside vegetation clearing (acres)
    - Fire line construction and preparation (acres)
    - Individual tree removal – not included in above categories (trees)

4. Brief summary of the implemented activities.

The report should be received by the AFO no later than February 1 of each year, unless an extension is mutually agreed upon by the AFO and Forest.

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the local federal law enforcement officer located at the Arkansas Ecological Services Field Office at 110 South Amity Road, Suite 300, Conway, Arkansas 72032 (phone 501/513-4482).

8. CONSERVATION RECOMMENDATIONS

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

1. Meet at least once every two years with the Arkansas Field Office of the Fish and Wildlife Service, Arkansas Game and Fish Commission, and other bat conservation partners to prioritize and coordinate survey and conservation projects on the Ozark-St. Francis National Forests.

2. Conduct internal visual surveys of caves occurring on Forest for presence of bats and/or guano. Surveys should be conducted from November 15 – March 15 when bats are likely using the cave as a hibernacula. Surveys should focus on caves that have historic presence of the covered species every other year for moderate or high abundance hibernacula and every six years for low abundance hibernacula.

3. Due to the large number of caves occurring on the Forest, utilizing local grottos or other organizations interested in cave and bat conservation could allow for a more thorough evaluation of known caves.

4. Install signage at hibernacula informing forest users of cave closures.

5. In addition to FW 63 ("evaluate IBAT hibernacula for gating; see Appendix A), gates or fences should be evaluated for any priority hibernation site of the covered species, especially those that pose a risk to the public and sites with prior history of unauthorized and/or frequent entry. Gates or other physical barriers to entry will have a bat-friendly design and post-construction monitoring will be completed to ensure bats are able to successfully ingress and egress.

6. Strive to identify any new caves on the Forest that could be used by bats. Organizing cave searches/ridge walks would be a good approach. Utilizing new LiDAR data to help locate voids on the landscape can help focus the cave search efforts.

7. Consider snag creation (e.g., through girdling or stem-injection herbicides) in locations conducive to bat roosting, including in areas with an emphasis on pine-oak-hickory recruitment, in natural or anthropogenic openings near forest edges, along linear edges with solar exposure, and in riparian habitat when natural roosts are in short supply.

8. Continue to implement netting and acoustic data collection on Forest to better understand bat distribution. When searching for summer use, AFO recommends collecting data from May 15 – August 15, although surveys during the spring and fall period may be situationally valuable as well. Survey recommendations are as follows:
   - Employ stationary acoustic monitoring or bat netting surveys at a minimum of 100 sites every five years to search for occupied habitats of priority species for bat conservation across the Forest. Focus will be on areas without adequate prior surveys or to improve information in areas with suspected bat use.
   - Follow up on positive acoustic detections with mist-net surveys by the following summer in areas that have indication of occupancy by IBAT, LBBA, NLEB, or TRBA. If adult females of these species are caught during mist-net surveys, use radio tracking to locate specific roost sites or protect female captures as Maternity Roost Areas.
   - Survey priorities and acoustic detection follow up level of effort should be coordinated with the AFO.

9. REINITIATION NOTICE

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

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

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

10. LITERATURE CITED

3D/International, Inc. 1996. 1996 field studies for interim mitigation for impacts to Indiana bats at the Indianapolis International Airport in Marion County, Indiana. 125pp.

Abrams, M.D. 1992. Fire and the development of oak Forests. Bioscience. 42: 346-353.

Adams, R.A., B. Stoner, D. Nespoli, and S.M. Bexell. 2018. New records of tricolored bats (Perimyotis subflavus) in Colorado, with first evidence of reproduction. Western North American Naturalist 78: 212-215.

Allen, A.A. 1921. Banding Bats. *Journal of Mammalogy*, Volume 2, Issue 2, May 1921, Pages 53–57, https://doi.org/10.2307/1373683

American Wind Energy Association (AWEA). 2021. https://cleanpower.org/facts/wind-power/

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

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

Belwood, J.J. 2002. Endangered bats in suburbia: observations and concerns for the future. Pp. 193-198 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Benedict, R.A., H.H. Genoways, and P.W. Freeman. 2000. Shifting distributional patterns of mammals in Nebraska. Transactions of the Nebraska Academy of Sciences and Affiliated Societies, 50.

Bennett, V. J., & Zurcher, A. A. (2013). When corridors collide: Road-related disturbance in commuting bats. *The Journal of Wildlife Management*, *77*(1), 93-101.

Bergeson, S. M. 2012. Examining the suitability of the little brown bat (Myotis lucifugus) as a surrogate for the endangered Indiana bat (M. sodalis).

Bernard, R.F., J. Evans, N.W. Fuller, et al. 2019. Different management strategies are optimal for combating disease in East Texas cave versus culvert hibernating bat populations. *Conservation Science and Practice*. 1:e106. https://doi.org/10.1111/csp2.106

Blatchley, W.S. 1897. Indiana caves and their fauna. Indiana Department of Geological and Natural Resources Annual Report 21:121-212.

Blehert, D.S., A.C. Hicks, M. Behr, C.U. Meteyer, B.M. Berlowski-Zier, E.L. Buckles, J.T.H. Coleman, S.R. Darling, A. Gargas, R. Niver, J.C. Okoniewski, R.J. Rudd, and W.B. Stone. 2009. Bat white-nose syndrome: An emerging fungal pathogen? Science 323: 227

Boyles, J.G. and C.K.R. Willis. 2010. Could localized warm areas inside cold caves reduce mortality of hibernating bats affected white-nose syndrome? Frontiers in Ecology and the Environment 8:92–98.

Brack, V., Jr., S.A. Johnson, and R.K. Dunlap. 2003. Wintering populations of bats in Indiana, with emphasis on the endangered Indiana myotis, *Myotis sodalis*. Proceedings of the Indiana Academy of Science 112:61-74.

Briggler, J.T., and T.W. Prather. 2003. Seasonal use and selection of caves by the eastern pipistrelle bat (Pipistrellus subflavus). American Midland Naturalist 149: 406-412.

Britzke, E.R., M.J. Harvey, and S.C. Loeb. 2003. Indiana bat, *Myotis sodalis*, maternity roosts in the southern United States. Southeastern Naturalist 2(2):235-242.

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

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

Carter, T.C., G. Feldhamer, and J. Kath. 2001. Notes on summer roosting of Indiana bats. Bat Research News 42:197-198.

Carter, T. C., W.M. Ford, and M.A. Menzel. 2002. Fire and bats in the Southeast and Mid- Atlantic: more questions than answers *In*: W.M. Ford, K.R. Russell, C.E. Moorman, eds., Proceedings: the role of fire for nongame wildlife management and community restoration: traditional uses and new directions. General Technical Report GTR-NE-288 Newtown Square, PA: USDA Forest Service, Northeastern Research Station. pp. 139-143.

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

Carver, B.D. and A.E. Lereculeur. 2013. Predation on a Northern Long-Eared Myotis by a Gray Rat Snake. *Southeastern Naturalist* 12(4).

Cheng, T. L., Reichard, J. D., Coleman, J. T., Weller, T. J., Thogmartin, W. E., Reichert, B. E., ... & Frick, W. F. 2021. The scope and severity of white-nose syndrome on hibernating bats in North America. *Conservation Biology*, *35*(5), 1586-1597.

Clark, B.K., J.B. Bowles, and B.S. Clark. 1987. Summer status of the endangered Indiana bat.

The American Midland Naturalist 118(1): 32-39.

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

Cope, J. B., A. R. Richter, and R. S. Mills. 1974. Concentrations of the Indiana bat, *Myotis sodalis*, in Wayne County, Indiana. Proc. Indiana Acad. Sci. 83:482-484

Cope, J. B., and S. R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana bat, *Myotis sodalis*. J. of Mammalogy, 58:93-95.

Copperhead Environmental Consulting, Inc. 2017. Spring Migration of Female Indiana Bats (*Myotis sodalis*) from Signature and Tobaccoport Saltpeter Caves in Tennessee. Report submitted to the U.S. Fish and Wildlife Service Tennessee Field Office.

Copperhead Environmental Consulting, Inc. 2018. Final Report: Statewide Mitigation and Monitoring for Indiana Bats: Arkansas DOT Job 001799. Report submitted to the Arkansas Department of Transportation and U.S. Fish and Wildlife Service Arkansas Field Office.

Copperhead Environmental Consulting, Inc. 2019. Final Report: Statewide Mitigation and Monitoring for Indiana Bats: Arkansas DOT Job 001799. Report submitted to the Arkansas Department of Transportation and U.S. Fish and Wildlife Service Arkansas Field Office.

Cox, M.R., E.V. Wilcox, P.D. Keyser, and A.L. Yacht. 2016. Bat response to prescribed fire and overstory thinning in hardwood forest on the Cumberland Plateau, Tennessee. Forest Ecology and Management. Volume 359, pg 221-231.

Cross, K. 2019. Mississippi white-nose syndrome monitoring. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi. Museum Technical Report No. 206.

Cryan P. M., C.U. Meteyer, D.S. Blehert, J.M. Lorch, D.M. Reeder, G.G. Turner, J. Webb, M. Behr, M. Verant, R.E. Russell, K.T. Castle. 2013b. Electrolyte Depletion in white-nose syndrome bats. Journal of Wildlife Diseases 49:398-402.

Custer, H. N. (2021). *Spring Migration Behavior and Summer Habitat Associations of Female Indiana Bats (Myotis sodalis) in Arkansas* (Master's Thesis, Arkansas State University).

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

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

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

Dodd, L.E., M.J. Lacki, E.R. Britzke, D.A. Buehler, P.D. Keyser, J.L. Larkin, A.D. Rodewald, T.B. Wigley, P.B. Wood and L.K. Rieske. 2012. Forest structure affects trophic linkages: How silvicultural disturbance impacts bats and their insect prey. Forest Ecology and Management 267: 262–270.

Doty, A. C., Currie, S. E., Stawski, C., & Geiser, F. 2018. Can bats sense smoke during deep torpor? *Physiology & behavior*, *185*, 31-38.

Drobney, R.D. and R.L. Clawson. 1995. Indiana bats. Pp. 97-98 *in* E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac (eds.), Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, DC. 530 pp.

Duchamp, J.E. 2006. Modeling bat community structure and species distribution across fragmented landscapes within the Upper Wabash River Basin. PhD dissertation. Purdue University, West Lafayette, Indiana.

Duchamp, J.E. and R.K. Swihart. 2009. Shifts in bat community structure related to evolved traits and features of human-altered landscapes. Landscape Ecology 23(7):849–860.

Edmonds, K. N. 2020. Roosting ecology of a declining population of northern long-eared bats (*Myotis septentrionalis*) in the Ozark-St. Francis National Forest of Arkansas. Master Thesis: Arkansas State University, Jonesboro, AR.

Ehlman, S.M., J.J. Cox, and P.H. Crowley. 2013. Evaporative water loss, spatial distributions, and survival in white-nose syndrome affected little brown myotis: a model. Journal of Mammalogy 94(3):572-583.

Environmental Solutions & Innovations, Inc. 2018. Home range and habitat use of the northern long-eared bat during fall swarming on Ozark Plateau National Wildlife Refuge. Interim Performance Report. 83 pp.

Ethier, K., & Fahrig, L. 2011. Positive effects of forest fragmentation, independent of forest amount, on bat abundance in eastern Ontario, Canada. *Landscape Ecology*, *26*(6), 865-876.

Farmer, A.H., B.S. Cade, and D.F. Stauffer. 2002. Evaluation of a habitat suitability index model. Pp. 172-179 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Farrow, L.J. and H.G. Broders. 2011. Loss of forest cover impacts the distribution of the forest-dwelling tri-colored bat (*Perimyotis subflavus*). Mammalian Biology 72(2):172–179. doi: 10.1016/j.mambio.2010.04.004

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

Francl, K. E., W. M. Ford, D. W. Sparks, and V. Brack. 2012. Capture and reproductive trends in summer bat communities in West Virginia: Assessing the impact of white-nose syndrome. Journal of Fish and Wildlife Management 3(1): 33–42.

Fujita, M.S., and T.H. Kunz. 1984. *Pipistrellus subf]lavus*. Mammalian Species 228:1-6.

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

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

Garner, J.D., and J.E. Gardner. 1992. Determination of summer distribution and habitat utilization of the Indiana bat (*Myotis sodalis*) in Illinois. Unpublished Report. Endangered Species Coordinator, Region 3, Service, Twin Cities, MN.

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

Geluso, K., T.R. Mollhagen, J.M. Tinger, and M.A. Bogan. 2005. Westward expansion of the eastern pipistrelle (Pipistrellus subflavus) in the United States, including new records from New Mexico, South Dakota, and Texas. Western North American Naturalist 65:405-409.

Grider, J.F., A.L. Larsen, J.A. Homyack, and M.C. Kalcounis-Rueppell. 2016. Winter activity of coastal plain populations of bat species affected by white-nose syndrome and wind energy facilities. PloS one, 11(11):e0166512.

Griffin, D.R. 1940. Reviewed notes on the life histories of New England cave bats. Journal of Mammalogy, **21**(2):181-187.

Grue, C.E., P.L. Gibert, and M.E. Seeley. 1997. Neurophysiological and behavioral changes in non-target wildlife exposed to organophosphate and carbamate pesticides: thermoregulation, food consumption and reproduction. American Zoologist 37:369-388.

Guerra, Erin E.; Blanco, Cristina M.; and Garrie, Jorista. 2019. "The Impact of Prescribed Fire on Moth Assemblages in the Boston Mountains and Ozark Highlands, in Arkansas," Journal of the Arkansas Academy of Science: Vol. 73, Article 9. Guthrie 1933

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

Hamilton, W.J. and J.O. Whitaker. 1979. Mammals of the Eastern United States. Cornell University Press, Ithaca, New York.

Hanttula, M.K. and E.W. Valdez. 2021. First record and diet of the tri-colored bat (*Perimyotis subflavus*) from Guadalupe Mountains National Park and Culberson County, Texas. Western North American Naturalist 81(1): article 11. https://scholarsarchive.byu.edu/wnan/vol81/iss1/11

Harvey, M. J., J. S. Altenbach, and T. L. Best. 1999. Bats of the United States. Published by Arkansas Game and Fish Commission and in cooperation with Asheville Field Office, US Fish and Wildlife Service.

Harvey, M. J., J. S. Altenbach, and T. L. Best. 2011. Bats of the United States and Canada. Johns Hopkins University Press, Baltimore, Maryland, USA.

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

Hoen, B.D., J.E. Diffendorfer, J.T. Rand, L.A. Kramer, C.P. Garrity, and H.E. Hunt. 2018. United States Wind Turbine Database (V3.2, October 14, 2020): U.S. Geological Survey, American Clean Power Association, and Lawrence Berkeley National Laboratory data release, https://doi.org/10.5066/F7TX3DN0. Data downloaded 3 November 2020.

Hoying, K.M. and T.H. Kunz. 1998. Variation in size at birth and post-natal growth in the insectivorous bat *Pipistrellus subflavus* (Chiroptera: Vespertilionidae). Journal of Zoology 245(1):15–27.

Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*. Florida Scientist 41:65-76.

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

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

Irvine, K.M. and C. Stratton. 2021. Rangewide summertime model predictions for three bat species (*Myotis lucifugus, Myotis septentrionalis*, and *Perimyotis subflavus*) from acoustic and mist net data 2010 to 2019: US Geological Survey data release, https://doi.org/10.5066/P9XZ8D6N.

Jones G., D.S. Jacobs, T.H. Kunz, M.R. Willig, and P.A. Racey. 2009 Carpe noctem: the importance of bats as bioindicators. Endanger Species Res 8:93–115

Jones, G., and H. Rebelo. 2013. Responses of Bats to Climate Change: Learning from the Past and Predicting the Future. In: Adams, R., Pedersen, S. (eds) Bat Evolution, Ecology, and Conservation. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-7397-8_22

Katzenmeyer, J.B. 2016. Use of highway culverts, box bridges, and caves by winter-roosting bats in Mississippi. Master of Science in Wildlife and Fisheries Science, Mississippi State University, Mississippi. 70 pp.

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

Kurta, A. 2005. Roosting ecology and behavior of Indiana bats (*Myotis sodalis*) in summer. Pp. 29-42 *in* K.C. Vories and A. Harrington (eds.), Proceedings of the Indiana bat and coal mining: a technical interactive forum. Office of Surface Mining, U.S. Department of the Interior, Alton, IL.

Kurta, A., L. Winhold, J.O. Whitaker, Jr., and R. Foster. 2007. Range expansion and changing abundance of the Eastern Pipistrelle (Chiroptera: Vespertilionidae) in the central Great Lakes region. American Midland Naturalist 157:404-411.

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

Kurta, A. and H. Rice. 2002. Ecology and management of the Indiana bat in Michigan. Michigan Academician 33:361-376.

Lacki, M.J., D.R. Cox, L.E. Dodd, and M.B. Dickinson. 2009. Response of northern bats (*Myotis septentrionalis*) to prescribed fires in eastern Kentucky forests. Journal of Mammalogy 90:1165-1175.

LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Dept. of Conservation Terrestrial Series 8:1-53.

Layne, J.N. 1992. Status of the Eastern Pipistrelle, *Pipistrellus subflavus*, at its southern range limit in eastern United States. Bat Research News 33:43–46.

Limon, D.A., C.J. Garcia, B.B. Gregory, R.D. Stevens, and M.A. Barnes. 2018. The status of *Pseudogymnoascus destructans* in Louisiana. The Southwestern Naturalist 63(4):216–219.

Loeb, S.C. and E.A. Winters. 2013. Indiana bat summer maternity distribution: effects of current and future climates. Ecology and Evolution 3(1): 103-114.

Lowe, A. J. 2012. Swarming behaviour and fall roost-use of little brown (Myotis lucifugus), and Northern long-eared bats (Myotis septentrionalis) in Nova Scotia, Canada. Master's thesis. 95 pp.

Luo, J., Clarin, B. M., Borissov, I. M., & Siemers, B. M. 2014. Are torpid bats immune to anthropogenic noise?. *Journal of Experimental Biology*, *217*(7), 1072-1078.

Lutsch, K. 2019. Assessment of culverts and bridges as roosting habitat for *Perimyotis subflavus* (tri-colored bat) and disease transmission corridors for *Pseudogymnoascus destructans.* Master of Science in Integrative Biology, Kennesaw State University, Georgia. 44 pp.

McGuire, L.P., H.W. Mayberry, and C.K.R. Willis. 2017. White-nose syndrome increases torpid metabolic rate and evaporative water loss in hibernating bats. American Journal of Physiology; Regulatory, Integrative and Comparative Physiology 313: R680-R686.

Meierhofer, M.B., S.J. Leivers, R.R. Fern, L.K. Wolf, J.H. Young, Jr., B.L. Pierce, J.W. Evans, and M.L. Morrison. 2019. Structural and environmental predictors of presence and abundance of tri-colored bats in Texas culverts. Journal of Mammalogy 100(4):1274–1281.

Merritt, J.F. 1987. Guide to the Mammals of Pennsylvania. University of Pittsburgh Press, Pittsburgh, Pennsylvania.

Meteyer, C.U., E.L. Buckles, D.S. Blehert, A.C. Hicks, D.E. Green, V. Shearn-Bochsler, N.J. Thomas, A. Gargas, and M.J. Behr. 2009. Histopathologic criteria to confirm white-nose syndrome in bats. Journal of Veterinary Diagnostic Investigation 21:411-414.

Mikula, P., F. Morelli, R.K. Lucan, D.N. Jones, and P. Tryjanowski. 2016. Bats as prey of diurnal birds: a global perspective. Mammal Review. 46. 10.1111/mam. 12060.

Mohr, C.E. 1976. The World of the Bat. J.B. Lippincott Company, United States of America.

Mumford, R.E. and L.L. Calvert. 1960. *Myotis sodalis* evidently breeding in Indiana. Journal of Mammalogy 41:512.

Mumford, R.E. and J.O. Whitaker. 1982. Mammals of Indiana. Indiana University Press, Bloomington, Indiana.

Munson, P. J. and J. H. Keith. 1984. Prehistoric raccoon predation on hibernating *Myotis*, Wyandotte Cave, Indiana. Journal of Mammalogy 65:152-155.

Murray, S.W. and A. Kurta. 2004. Nocturnal activity of the endangered Indiana bat (*Myotis sodalis).* Journal of Zoology 262:197-206.

Newman, B.A. 2020. Winter torpor and roosting ecology of tri-colored bats (*Perimyotis subflavus*) in trees and bridges. Master of Science in Wildlife and Fisheries Biology, Clemson University, Clemson, South Carolina. 90 pp.

Nowacki, G.J., and M.D. Abrams. 2008. The demise of fire and “mesophication” of Forests in the eastern United States. Bioscience. 58: 123-138.

O'Keefe, J.M. 2009. Roosting and foraging ecology of forest bats in the Southern Appalachian Mountains. PhD Dissertation. Clemson University, Clemson, SC.

O’Shea, T.J., P.M. Cryan, D.T.S. Hayman, R.K. Plowright, and D.G. Streicker. 2016. Mammal Review. 13 pp.

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

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

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

Patterson, B.D., M.R. Willig, and R.D. Stevens. 2003. Trophic strategies, niche partitioning, and patterns of ecological organization. *In* T.H. Kunz and M.B. Fenton (Eds), Bat Ecology. The University of Chicago Press.

Perry, R.W. and R.E. Thill. 2007. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247:220-226.

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

Perry, R. W., Brandebura, S. C., & Risch, T. S. 2016. Selection of tree roosts by male Indiana bats during the autumn swarm in the Ozark Highlands, USA. Wildlife Society Bulletin, 40(1), 78-87.

Pettit, J.L. and J.M. O’Keefe. 2017. Impacts of white-nose syndrome observed during long-term monitoring of a Midwestern bat community. Journal of Fish and Wildlife Management 8(1): 69-78.

Ploskey, G.R. and J.A. Sealander. 1979. Lipid deposition and withdrawal before and during hibernation in *Pipistrellus subflavus* (Chiroptera: Vespertilionidae). The Southwestern Naturalist, pp.71–78.

Poissant, J.A., H.G. Broders, and G.M. Quinn. 2010. Use of lichen as a roosting substrate by *Perimyotis subflavus*, the tricolored bat, in Nova Scotia. Ecoscience 17(4):372–378.

Quinn, G.M. and H.G. Broders. 2007. Roosting and foraging ecology of eastern pipistrelle (*Perimyotis subflavus*) bats in SW Nova Scotia. Department of Biology, Saint Mary's University, Halifax, Nova Scotia. 34 pp.

Racey, P.A. 1982. Ecology of bat reproduction. Pp. 57-104 *in* T.H. Kunz (ed.), Ecology of bats. Plenum Press, New York, NY. 425 pp.

Racey, P.A., and A.C. Entwistle. 2003. Conservation ecology of bats. *In* T.H. Kunz and M.B. Fenton (Eds), Bat Ecology. The University of Chicago Press.

Raesly, R.L., and J.E. Gates. 1987. Winter habitat selection by north temperate cave bats. American Midland Naturalist 118:15-31.

Reeder, D. M., C. L. Frank, G. R. Turner, C. U. Meteyer, A. Kurta, E. R. Britzke, M. E. Vodzak, S. R. Darling, C. W. Stihler, A. C. Hicks, R. Jacob, L. E. Grieneisen, S. A. Borwnlee, L. K. Muller, and D. S. Blehert. 2012. Frequent arousal from hibernation linked to severity of infection and mortality in bats with white-nose syndrome. PLoS ONE 7:e38920.

Reichard, J.D. and T.H. Kunz. 2009. White-nose syndrome inflicts lasting injuries to the wings of little brown myotis (*Myotis lucifugus*). Acta Chiropterologica, 11(2):457-464.

Richter, A. R., S. R. Humphrey, J. B. Cope, V. Brack. 1993. Modified cave entrances: thermaleffect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). Conservation Biology, 7(2):407-415.

Roby, P.L., M.W. Gumbert, and M.J. Lacki. 2019. Nine years of Indiana bat (*Myotis sodalis*) spring migration behavior. Journal of Mammology, 100(5):1501-1511.

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

Samoray, S.T., S.N. Cotham, and M.W. Gumbert. 2019. Spring migration behavior of a *Perimyotis subflavus* (tri-colored bat) from Tennessee. Southeastern Naturalist 18(3):16–20.

Sandel, J.K., G.R. Benatar, K.M. Burke, C.W. Walker, T.E., Lacher, Jr., and R.L. Honeycutt. 2001. Use and selection of winter hibernacula by the eastern pipistrelle (*Pipistrellus subflavus*) in Texas. Journal of Mammalogy 82:173-178.

Sasse, D.B. 2022. Unpublished data. Arkansas Game and Fish Commission.

Sasse, D. B., Saugey, D. A., & Perry, R. W. 2011. Distribution, Conservation and Current Status of the Little Brown Bat (Myotis lucifugus) in Arkansas. *Journal of the Arkansas Academy of Science*, *65*(1), 180-182.

Scesny, A. A., & Robbins, L. W. 2006. Detection of fire by eastern red bats (Lasiurus borealis): arousal from torpor (Doctoral dissertation, Missouri State University). Sealander and Young 1955

Sealander, J.A., and G.A. Heidt. 1990. Arkansas Mammals. The University of Arkansas Press, Fayetteville, Arkansas. 308 pp.

Siemann, E., Haarstad, J., & Tilman, D. 1997. Short-term and long-term effects of burning on oak savanna arthropods. *American Midland Naturalist*, 349-361.

Silliman, B.S., Jr., J.D. Dana, and W. Gibbs. 1851. On the Mammoth Cave of Kentucky. American Journal of Science and Arts (Second Series) 11:332-339.

Silvis A., W.M. Ford, and E.R. Britzke. 2015. Effects of Hierarchical Roost Removal on Northern Long-Eared Bat (*Myotis septentrionalis*) Maternity Colonies. PLoS ONE 10(1):e0116356. doi:10.1371/journal.pone.0116356

Silvis, A., Perry, R., & Ford, W. M. 2016. Relationships of three species of bats impacted by white-nose syndrome to Forest condition and management. Gen. Tech. Rep. SRS–214. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station, 214, 1-48.

Slider, R.M. and A. Kurta. 2011. Surge tunnels in quarries as potential hibernacula for bats. Northeastern Naturalist 18(3):378–381.

Smith, W.B., P.D. Miles, J.S. Vissage, and S.A. Pugh. 2003. Forest resources of the United States, 2002. U.S. Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN. General Technical Report NC-241. 137 pp.

Sparks, D.W., J.O. Whitaker, Jr., and C.M. Ritzi. 2005. Foraging ecology of the endangered Indiana bat. Pp. 15-27 *in* K.C. Vories and A. Harrington (eds.), The Proceedings of the Indiana bat and coal mining: a technical interactive forum. Office of Surface Mining, U.S. Department of the Interior, Alton, IL.

Starbuck, C. A., Amelon, S. K., & Thompson III, F. R. 2015. Relationships between bat occupancy and habitat and landscape structure along a savanna, woodland, forest gradient in the Missouri Ozarks. *Wildlife Society Bulletin*, *39*(1), 20-30.

Summerville, K.S. and T.O. Crist. 2002. Effects of timber harvest on forest lepidoptera: community, guild, and species responses. Ecological Applications 12:820-835.

Tate, M. E. 2020. Investigating the ecology and behavior of the Indiana bat and tricolored bat during fall s warming and spring staging. Master's Thesis, University of Tennessee, 2020.

Thames, D.B. 2020. Summer Foraging Range and Diurnal Roost Selection of Tri-colored bats, *Perimyotis subflavus*. Master's Thesis University of Tennessee Knoxville.

Thomson, C.E. 1982. *Myotis sodalis*. Mammalian Species. 163:1-5.

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

Toomey, R.S., III, M.L. Colburn, and R.A. Olson. 2002. Paleontological evaluation of use of caves: a tool for restoration of roosts. Pp. 79-85 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

Tormanen, A. P., & Garrie, J. 2021. Responses of bat-prey to prescribed burns and mechanical thinning. *Forest Ecology and Management*, *491*, 119162.

Turner, G.G., D.M. Reeder, and J.T.H. Coleman. 2011. A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a look to the future. Bat Research News 52(2): 13-27.

Tuttle, M.D. 1997. A mammoth discovery. Bats 15:3-5.

Tuttle, M.D. 1999. Former home of more than a million endangered Indiana bats protected. Bats 17(3):8-9.

Udell, B.J., B.R. Straw, J. Szymanski, M. Seymour, J. Wong, A.M. Wiens, B.E. Reichert, J.E. Diffendorfer, L. Kramer, and Z. Ancona. 2022. Spatially explicit method of predicting bat wind take at wind facilities and allocating it among winter hibernacula populations. Appendix E-1 in Straw, B.R., J.A. Martin, J.D. Reichard, and B.E. Reichert, editors. Analytical Assessments in Support of the U.S. Fish and Wildlife Service 3-Bat Species Status Assessment. Cooperator Report prepared in cooperation with the U.S. Geological Survey, United States Fish and Wildlife Service and Bat Conservation International. https://doi.org/10.7944/P9B4RWEU.

U.S. Army Garrison Fort Drum. 2011. Biological Assessment on the proposed activities on the Fort Drum Military Installation, Fort Drum, New York (2012-2014) for the Federally-endangered Indiana bat (*Myotis sodalis*).

U.S. Forest Service (USFS). 2005. A snapshot of the northeastern Forests. U.S. Department of Agriculture, Forest Service, Northeastern Area, State and Private Forestry. Newton Square, PA. NA-IN-01-06. 23 pp.

U.S. Forest Service (USFS). 2006. NCRS–the changing Midwest assessment. U.S. Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN.

U.S. Forest Service (USFS). 2012. 2010 Resources Planning Act Assessment. Gen. Tech. Rep. WO-87. Washington, D.C., 198pp

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

U. S. Fish and Wildlife Service (USFWS). 2002. Final biological opinion on the application for an incidental take permit for the federally endangered Indiana bat (*Myotis sodalis*) for the Six Points Road interchange and associated development. USFWS Bloomington Field Office, Bloomington, IN. 36 pp.

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

U.S. Fish and Wildlife Service (USFWS). 2014. Indiana Bat Fatalities at Wind Energy Facilities. https://www.fws.gov/midwest/wind/wildlifeimpacts/inbafatalities.html#Table1.

U.S. Fish and Wildlife Service TNFO (USFWS). 2018. Biological Opinion Programmatic Strategy for Routine Actions that may affect Endangered or Threatened Bats. https://ecos.fws.gov/tails/pub/document/12943431.

U.S. Fish and Wildlife Service (USFWS). 2019. Indiana bat Rangewide Population Estimates. https://www.fws.gov/midwest/endangered/mammals/inba/pdf/2019_IBat_Pop_Estimate_6_27_2019a.pdf

U.S. Fish and Wildlife Service (USFWS). 2021. Species Status Assessment Report for the Tricolored Bat (*Perimyotis subflavus*), Version 1.1. December 2021. Hadley, MA.

Van Lear, D.H., and R.F. Harlow. 2002. Fire in the eastern United States: influence on wildlife habitat. In: Ford, W.M., K.R. Russell, and C.E. Moorman., eds. The role of fire in nongame wildlife management and community restoration: traditional uses and new directions. Gen. Tech. Rep. NE-288. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 2-10.

Veilleux, J. P., Whitaker, J. O., & Veilleux, S. L. 2003. Tree-roosting ecology of reproductive female eastern pipistrelles, Pipistrellus subflavus, in Indiana. *Journal of Mammalogy*, *84*(3), 1068-1075.

Veilleux, J.P. and S.L. Veilleux. 2004. Intra-annual and interannual fidelity to summer roost areas by female eastern pipistrelles, *Pipistrellus subflavus*. The American Midland Naturalist 152(1):196–200.

Vincent, E.A. and J.O. Whitaker. 2007. Hibernation of the eastern pipistrelle *Perimyotis subflavus*, in an abandoned mine in Vermillion County, Indiana, with some information on *Myotis lucifugus*. Proceedings of the Indiana Academy of Science 116(1):58–65.

Warnecke, L., J.M. Turner, T.K. Bollinger, J.M. Lorch, V. Misra, P.M. Cryan, G. Wibbelt, D.S.Blehert, and C.K.R. Willis. 2012. Inoculation of bats with European *Geomyces destructans* supports the novel pathogen hypothesis for the origin of white-nose syndrome. PNAS 109(18):6999-7003.

Wear, D.N. and J.G. Greis (eds.). 2002. Southern Forest resource assessment. U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC. General Technical Report SRS-53. 635 pp.

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

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

Wiens, A.M., J. Szymanski, B.J. Udell, and W. E. Thogmartin. 2022. Winter Colony Count Data Assessment and Future Scenarios for the Little Brown, Northern Long-eared, and Tricolored Bat Species Status Assessment. Chapter E in Straw, B.R, J. A. Martin, J.D. Reichard, and B.E. Reichert, editors. Analytical Assessments in Support of the U.S. Fish and Wildlife Service 3-Bat Species Status Assessment. Cooperator Report prepared in cooperation with the U.S. Geological Survey, United States Fish and Wildlife Service and Bat Conservation International. https://doi.org/10.7944/P9B4RWEU.

Willis C. K. R, A. K. Menzies, J. G. Boyles, and M. S. Wojciechowski. 2011. Evaporative water loss is a plausible explanation for mortality of bats from white-nose syndrome. Integrated and Comparative Biology 51:364–373.

Winhold, L. and A. Kurta. 2006. Aspects of Migration by the Endangered Indiana Bat, *Myotis sodalis*. Bat Research News 47:1-11.

APPENDIX A

Threatened, Endangered, and Sensitive Species

Priorities

- Provide diverse habitats that will support viable populations of all native and desirable nonnative species.
- Work with the U.S. Fish and Wildlife Service (USFWS) to develop recovery plans for federally listed species. Implement Forest Service actions as recommended in recovery plans for federally listed species. In the absence of an approved recovery plan, implement interim Forest Service objectives.
- Manage habitat to move species toward recovery and de-listing. Prevent the listing of proposed and sensitive species. Coordinate with partners to implement measures to resolve conflicts with all threatened and endangered species and habitats.
- Develop monitoring plans to evaluate the effectiveness of canopy density control treatments in primary and secondary Indiana bat zones. Use adaptive management in making adjustments based on results of monitoring.
- When opportunities arise in the secondary Indiana bat zones to thin inclusions or stand size areas where shagbark hickory is the dominant species, the objectives of this thinning will be to enhance health and longevity of the residual trees. The target residual basal area for these areas is site index minus 10. Designated leave trees should be the largest stems with the greatest potential for crown development and longevity.
- Encourage reintroduction of extirpated or declining native species when technologically feasible. Develop partnerships with universities, groups, and other agencies to facilitate reintroduction of native species.

Forest Wide Standards and Guidelines

FW 15 Catalog, inventory, and classify wild caves as they are discovered according to the Cave Resources Protection Act (CRPA) guidelines and determine significance using established protocols. Management direction of cave resources will be made following the CRPA guidelines and will allow for input from interested outside agencies and the public. Known or suspected threatened or endangered species occupancy and/or use is adequate to define a cave or mine as significant.

FW 16 Districts will be responsible for maintaining inventory records for caves on their district. Districts that permit wild cave use will maintain permit records to be used to document visitor use and aid in the safety of permitted cave users. Master copies of inventory and permit records will be kept at the Supervisor's Office.

FW 17 Manage cave significance and public use on the basis of the Cave Resources Protection Act (CRPA) guidelines as either:

- Permitted open with year-round use
- Permitted seasonally
- Open with interpretation
- Closed year-round

FW18 Mature forest cover is maintained within 100 feet slope distance from the top of bluffs and 200 feet slope distance from the base to provide wildlife habitat associated with unique landform. Within this zone, activities are limited to those needed to ensure public safety or to maintain and improve habitat for federally listed species or other species whose viability is at risk.

FW28 No herbicide is ground broadcast within 60 feet of any known threatened, endangered, proposed, or sensitive species except for endangered bats. Selective applications may be done closer than 60 feet, but only when supported by a site-specific analysis. Selective herbicide treatments using a non-soil active herbicide may be used closer than 60 feet to protect TES plants from encroachment by invasive plants.

FW32 Herbicide will not be used within the appropriate SMZs or within 300 feet of any public or domestic water intake. Selective treatments may occur within SMZs only when a site-specific analysis of actions to prevent significant environmental damage such as noxious weed infestations supports a "Finding of No Significant Impact" (FONSI), and then using only herbicides labeled for both terrestrial and aquatic use within these areas.

FW33 Maintain the following average standing dead, existing, and potential hollow den and loose bark trees per acre forest wide:

- Primary and Secondary Indiana Bat Zones – 9 snags per acre
- All other areas:
    - 2 snags per acre greater than 12” dbh; plus
    - 4 snags per acre

    Total 6 snags per acre

Unless necessary for insect/disease control or to provide for public safety, standing dead and den trees will not be cut during salvage operations.

Snags will be left from the largest size classes and maybe clumped.

FW 42 Karst features will be recognized and documented when they are found to occur across the landscape; these features include caves, springs, sinkholes, and losing streams.

FW 43 Karst management zones (KMZs) will be applied in a manner similar to that of streamside management zones (SMZs). Where karst features are identified, the boundaries of the KMZs will be delineated according to significance of karst features or potential risks. For karst features that are of significance or where the potential risks to water resources are great, a KMZ of 100 feet will be applied. For karst features that are less significant or where minimal potential risks to water resources exist, a KMZ of 50 feet will be applied. Karst management zones are mitigation measures primarily for the protection and conservation of groundwater resources and cave dependent species. These buffer designations are minimums and can be increased as necessary to provide appropriate mitigation measures as deemed necessary. Activities prohibited within these areas include:

- Use of motorized wheeled or tracked equipment (except on existing roads and trails).
- Mechanical site preparation.
- Recreational site construction.
- Tractor constructed fire lines for prescribed fire.
- Herbicide application.
- Construction of new roads, skid trails, and log landings.
- Slash disposal.

FW 44 Management activities within KMZs will be planned to use practices that result in minimal surface disturbance; this will be measured as less than five percent soil disturbance over the entire KMZ within the project area

FW 45 Within KMZs, there will be no mechanical entry during management activities; low impact vegetation management is appropriate.

FW 46 Exceptions to established KMZ guidelines can be made through site specific analysis and consultation with the US Fish & Wildlife Service (USFWS).

FW 47 Optimal overstory density within the primary zone around Indiana bat hibernacula is a range of 60 to 80 percent canopy closure. Use timber harvest, non-commercial thinning and prescribed fire to regulate and maintain this optimal density.

During normal order of entry, for compartments within Indiana bat primary conservation zones, do landscape scale analysis of existing forest stand conditions. This analysis should be used to determine commercial and non-commercial treatments needed to shift percent canopy closure towards the optimal overstory density. The long term goal of treatments is to adjust canopy closure so that 80 to 90 percent of the primary conservation zone is within the 60 to 80 percent canopy closure range. This will not be fully accomplished during this planning period. Annually report canopy cover adjustments accomplished with commercial and non-commercial treatments within Indiana bat conservation zones to the Arkansas Field Office, USFWS.

When designating trees to be cut to regulate overstory density, two approaches are recommended for equating canopy density to target leave basal area. A simple rule of thumb is to use site index plus 10 as the target leave basal area. Another option is the use of canopy density/ basal area conversion charts defined by tree diameter classes.

FW 48 Optimal overstory density within the secondary zone around Indiana bat hibernacula is a range of 50 to 70 percent canopy closure. Use timber harvest, non-commercial thinning, and prescribed fire as needed to regulate and maintain this optimal density.

During normal order of entry for compartments within Indiana bat secondary conservation zones, do landscape scale analysis of existing forest stand conditions. This analysis should be used to determine commercial and non- commercial treatments needed to shift percent canopy closure toward the optimal overstory density. The long-term goal of treatments is to adjust canopy closure so that 80 to 90 percent of the secondary conservation zone is within the 50 to 70 percent canopy closure range. This will not be fully accomplished during this planning period. Annually report canopy cover adjustments accomplished with commercial and non-commercial treatments within Indiana bat conservation zones to the Arkansas Field Office, USFWS.

When designating trees to be cut to regulate overstory density, two approaches are recommended for equating canopy density to target leave basal area. A simple rule of thumb is to use site index minus 10 as the target leave basal area. Another option is the use of canopy density/basal area conversion charts defined by tree diameter classes.

FW 52 Prescribed burn plans for areas containing caves or for areas near significant caves or mines will identify these sites as smoke sensitive targets. The prescribed burn plans will be written to *minimize* active combustion and smoldering phase smoke from entering these sites when bats are present.

FW 53 No commercial timber harvest may be used in KMZs up to 200 feet from cave entrances except for habitat protection or enhancement for threatened and endangered species.

FW 54 Prohibit camping and campfires within 200 feet from the entrance to caves, mines, and rock shelters used by TES species.

FW 55 Close or restrict access to caves where disturbance or vandalism of critical resources may occur.

FW 57 Identify caves or abandoned mines that contain significant populations of TES species as smoke-sensitive targets.

FW 58 If significant bat roosting is found, these structures will be maintained, or alternative roosts suitable for the species and colony size will be provided prior to adverse modification or destruction.

FW 59 Do not issue permits for the collection of TES species except for approved scientific purposes. Permits are also required from U.S. Fish and Wildlife Service and Arkansas Game and Fish Commission.

FW 60 The use of caves for disposal sites or the alteration of cave entrances is prohibited except for the construction of cave gates or similar structures to ensure closure.

FW 61 Before old buildings, wells, cisterns, and other man-made structures are structurally modified or demolished, they are surveyed for bats. If significant bat roosting is found (a TES species), these structures will be maintained, or alternative roosts suitable for the species and colony size will be provided prior to adverse modification or destruction.

FW 62 Watershed boundaries and recognizable landmarks such as roads streams, and bluff lines are used to identify primary and secondary conservation zones that extend out 0.25 (1/4) mile and 5 miles, respectively, surrounding Indiana bat hibernacula.

FW 63 All known Indiana bat hibernacula should be evaluated for gates. If additional hibernacula are found, the caves should be evaluated for gating to protect Indiana bats during the critical hibernation period.

FW 64 All activities proposed within primary Indiana bat management zones will be coordinated with the USFWS and conservation and recovery of Indiana bat will be the management priority for those actions.

FW 65 In the primary conservation zone for the Indiana bat, the following new improvements and treatments are not permitted: permanent road construction, trails, grazing or hay allotments, wildlife openings, special uses, and integrated pest management using biological or species-specific controls. Other activities that create permanent openings are prohibited within the primary conservation zone.

FW 66 Cutting of potential Indiana bat roost trees (trees of three inches or greater diameter at breast height) is restricted in primary Indiana bat management zones and in Indiana bat priority roosting zones for caves with fall swarming Indiana bats from August 15 to November 30. Cutting of potential Indiana bat roost trees as described above is also restricted in the primary Indiana bat management zones for caves with hibernating Indiana bats from March 1 to April 30. Indiana bat priority roosting zones are mapped in coordination with USFWS based on habitat quality and bat use patterns around caves with the intent of protecting core use areas encompassing a minimum of 100 acres per Indiana bat hibernacula. Management activities within the priority roosting zones would emphasize Indiana bat roosting habitat and ensure a continual supply of quality roosting trees.

FW 68 In the secondary zone buffer around Indiana bat hibernacula, a minimum of 60 percent of all forested acreage is maintained in nine inch or greater size classes. Of this total, about 40 percent will be trees in a mature condition. The 0-10 age class does not exceed 10 percent of the forested acreage of the secondary buffer at any time.

FW 69 Live trees, snags, buildings, and other structures known to have been used as roosts by Indiana bats and female northern long-eared bats are protected from cutting and/or intentional modification until they are no longer suitable as a roosting structure (trees no longer standing) unless their cutting or modification is needed to protect public or employee safety. Where roost tree cutting or modification is deemed necessary, it must be coordinated with the USFWS. Prescribed burns may proceed without special protection for roost trees except for active Indiana bat maternity trees.

FW 70 Shagbark hickory, because of its high value as roost/maternity sites, should receive special attention during sale layout and cultural treatments. In areas where shagbark hickory is uncommon, retain all shagbark hickory over six inches dbh (6" dbh) except those that are immediate hazards. If multiple 6- inch or greater stems are encountered, which are competing for moisture, nutrients, and growing space, thin to retain the largest shagbark trees with potential for crown development and longevity. Where shagbark hickory is common within the treatment stand and the surrounding landscape, retain the largest individual shagbark stems in the treatment stand as part of the 20 basal area (overstory) and allow smaller stems, which might be in excess of six inches dbh (6" dbh) to be removed during regeneration treatments.

FW 71 Protections are established around gray bat maternity and hibernation colony sites and Ozark big-eared bat maternity sites, bachelor sites, and winter colony sites. Cutting of overstory vegetation is prohibited within a 200-foot buffer around these sites. Within ¼ mile of the sites, there will be no new permanent development, such as construction of roads, trails, wildlife openings, pastures or special use right of ways unless required to access private property. Exceptions may be made where coordination with USFWS determines these activities to be compatible with recovery of these species.

FW 163 If Indiana bat maternity trees are discovered within the Forests, those trees and other trees used by the colony would be protected. No tree falling would occur within 150 feet of known maternity trees unless their cutting or modification is needed to protect public or employee safety. Where tree cutting or modification is deemed necessary within this area, it must be coordinated with the USFWS. Prior to prescribed fire, fuels would be removed from around known maternity trees to prevent damage during the burn. During the maternity period (April 1st to August 15th), activities that may disturb the colonies, such as timber harvest, use of heavy equipment, and prescribed fire would be prohibited in an area approximately ¼ mile from known maternity roost trees. Variation in the buffer distance would be coordinated with USFWS and may include type of activity or topography that would shield the maternity site from the disturbance. Efforts would be made to determine the location of roost trees used by the colony prior to proceeding with forest management in the vicinity of the colony. If it is determined with USFWS that the colony has abandoned the site, the protections are no longer required except to maintain known roost trees as per revised FW69.

Monitoring (Forest Plan Appendix I; Table I-2) Threatened, Endangered, and Sensitive bat populations and habitat utilization are monitored. Long-term population trends, species distributions and habitat use patterns are monitored to inform management strategies.

Measurement frequency: Annual

Reporting frequency: 2 years

Precision and reliability: High