Biological Opinion

Bat Conservation Strategy for the State of Arkansas 2025

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BIOLOGICAL OPINION

1. INTRODUCTION

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

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

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

This BO addresses the effects of the Service's implementation of the Bat Conservation Strategy for the State of Arkansas (Strategy) on the federally endangered Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) (the covered species). The Strategy becomes effective as of the signature date of this BO. For this intra-Service consultation, the Service's Arkansas Ecological Services Field Office (AFO) is the federal action agency, and the Kentucky Field Office is the consulting office. The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat.

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

The Service has determined that the proposed Action may result in the incidental take of the Indiana bat and northern long-eared bat. Incidental take for this Action would be exceeded when over 4,000 acres of suitable Indiana or northern long-eared bat habitat were cleared during a single year or over 40,000 acres of suitable habitat were cleared over the 10-year duration of this BO. Any incidental take occurring as a result of this Action is exempted from the prohibitions of Section 9 of the ESA, provided the non-discretionary measures and conservation measures detailed in the ITS become binding conditions of any permit, contract, or grant issued for implementing the Action.

2. PROPOSED ACTION

The Action is the AFO's implementation of the Strategy for an indefinite number of projects with Federal and non-Federal entities that may affect one or both covered species through removal of suitable forested habitat (tree removal). The Strategy offers voluntary ESA compliance options that allow entities to ensure their actions: (1) do not jeopardize the continued existence of a covered species; and (2) obtain an exemption for take prohibitions, as provided in Section 8 of this BO, for a covered species that is incidental to their actions. The AFO participates in the Strategy and is responsible for determining if a specific project meets the requirements for voluntary participation, as well as implementing certain, predetermined conservation measures associated with the Strategy. Implementation of the Strategy provides recovery-focused conservation benefits for the covered species as mitigation for the removal of up to 40,000 acres of suitable forested habitat over a 10-year period.

Additional coordination with the AFO will be required for any action expected to result in impacts to a covered species that were not evaluated in this BO, including any action expected to result in impacts to designated critical habitat of a covered species.

The AFO chose to exclude projects that could impact known or potential hibernacula due to their importance for conservation of the covered species and the difficulty in analyzing effects related to potential hibernaculum impacts. Additionally, project-specific review by the AFO will be required for the categories of projects listed below to determine if use of the Strategy is appropriate or if another ESA compliance option should be used:

- Individual projects resulting in the loss of more than 250 acres of forested habitat for any of the covered species.
- Projects occurring within one mile of Priority 1 (P1) or Priority 2 (P2) Indiana bat hibernacula.[1]
- Projects occurring within ½ mile of Priority 3 (P3) or Priority 4 (P4) Indiana bat hibernacula or active northern long-eared bat hibernacula.[1]
- Clearing of greater than 100 acres of forested habitat during the pup season (May 15 to July 31).
- Projects occurring within 2 miles of primary or secondary Indiana bat or northern long-eared bat maternity tree record.
- Projects that may result in adverse effects to the covered species from post-construction and/or operational activities other than loss of forested habitat (e.g., permanent lighting, noise and vibrations above pre-construction levels, prescribed fire).

2.1. Removal of Suitable Forested Habitat (Tree Removal)

Removal of suitable forested habitat involves the removal of trees that provide suitable habitat to the Indiana or northern long-eared bats. For the purposes of this document, suitable forested habitat may be live trees and/or snags ≥5 inches diameter at breast height (dbh) that have

[1] Priority 1 (P1) hibernacula have a current or historical winter population of ≥10,000 Indiana bats; Priority 2 (P2) have 1,000-9,999 bats; Priority 3 (P3) have 50-999 bats; and Priority 4 (P4) have <50 bats (Service 2007).

exfoliating bark, cracks, crevices, and/or hollows for Indiana bat, live trees and/or snags ≥3 inches dbh that have exfoliating bark, cracks, crevices, and/or cavities for northern long-eared bat. The Service acknowledges that not all trees meeting these requirements will provide suitable habitat due to tree structure or other habitat factors but utilizes this definition in order to quantify potential habitat removal for the purposes of this BO.

Removal of suitable forested habitat may be completed for any project, including, but not limited to linear projects such as transmission lines, fire lines and roads and non-linear projects such as subdivisions, transmission towers, timber sales and bridge construction. Tree removal will be conducted utilizing chainsaws and/or heavy equipment such as bulldozers, skid steers or feller bunchers. In order to remove trees, it may be necessary to construct roads, log landings or bridges as part of the activity. Removal of suitable habitat may occur while bats are likely to be present (occupied) or during the hibernation period when bats are not expected to be present (unoccupied). Impacts may occur in areas where Indiana and/or northern long-eared bats have been documented (known habitat) or where the presence of one or more of these species is assumed (potential habitat). Furthermore, known habitat may include fall/spring swarming habitats around known hibernacula, and known summer habitats. However, tree removal during the pup season (May 15 – July 31st) will be limited to 100 acres per project during that season. The determination of potential to have maternity colonies of federally listed tree bats will be informed by survey records in the surrounding area and habitat conditions.

2.2. 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 AFO 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.

2.3. Action Area

For purposes of consultation under ESA §7, the "Action Area" is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The Action Area for this consultation includes all lands within the geo-political boundaries of Arkansas and those portions of Missouri, Oklahoma, Texas, Louisiana, Mississippi and Tennessee that occur within 20 miles of the Arkansas state line (74,582 square miles). Execution of multi-state projects utilizing the Strategy that are implemented by the AFO will require advance, written approval of the Service Field Office(s) involved.

This Action Area corresponds with the scope of the Strategy and recognizes that projects associated with the Strategy: (a) are likely to occur at scattered and undeterminable locations across Arkansas; (b) may cross into adjacent states; and (c) will vary in size and distribution on the landscape.

2.4. Conservation Measures

Conservation measures are proposed actions that will be undertaken by project proponents as part of the Action to benefit, promote the recovery of, and/or minimize effects to species affected by the Action.

- Projects implemented in association with the Strategy will clear no more than a cumulative total of 40,000 acres (not to exceed 4,000 acres annually) of known and/or potential Indiana bat forested habitat and/or northern long-eared bat forested habitat.
- Projects implemented in association with the Strategy will clear no more than 100 acres per project of suitable forested habitat during the pup season (May 15-July 31).
- Suitable forested habitat removed by the project will be minimized as feasible.
- Suitable forested habitat removed during the pup season (May 15 – July 31) will be minimized as feasible.
- Best Management Practices (BMPs) for sediment and erosion control will be implemented in accordance with state permits, program requirements, and regulations during tree removal and construction.

2.5. Compensation Measures

The Strategy identifies compensatory mitigation options that project proponents may implement or fund to assist in the conservation and/or recovery of the covered species within the Action Area. Voluntary use of the Strategy becomes part of the project proponent’s proposed action and requires that at least one of the compensatory mitigation options listed below is implemented as part of their proposed action:

a) protection of unprotected known habitat with a demonstrated significance to the covered species;
b) contribution of funds to the Arkansas Bat Fund (ABF) sufficient to offset the identified impacts when other measures are impractical or have limited value to the covered species’ conservation and/or recovery;
c) purchase credits from an approved species conservation bank;
d) other activities that provide a tangible conservation benefit to the covered bat species proposed to the AFO for case-by-case evaluation.

2.6. Conservation Benefits

As described in the Strategy, the AFO has identified conservation goals for the covered species based on recovery plans, published guidance, literature, and/or the best available scientific information. Proponents incorporating the Strategy will provide mitigation for impacts from their project to the covered species being impacted. This mitigation is anticipated to exceed (at a programmatic scale) what is needed to compensate for impacts to the species, yielding a net conservation benefit or gain. Conservation benefits, as well as impacts, are tracked by acres and the habitat type (e.g., staging/swarming, maternity), as is the loss of suitable forested habitat that drives the adverse effects evaluated in this BO.

Conservation benefits may be achieved directly through a project proponent's specific actions or indirectly through the ABF or a conservation bank. Regardless of the mechanism used, all conservation benefits will be aligned with the goals identified in the Strategy. These goals have been established to maximize the benefits to the species by targeting actions that help protect and manage important habitat components for the covered species, especially during the most sensitive life-stages.

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.

The Service is not currently aware of any quantifiable information regarding non-federal actions that may occur within the action area and must be considered in formulating our opinion for this action. Additional discussion of cumulative effects is provided in Section 7.3.

4. INDIANA BAT

This section summarizes the best available data about the biology and current condition of the Indiana bat throughout its range that are relevant to formulating an opinion about the Action.

4.1. Status of Indiana Bat

The Service published its decision to list the Indiana bat as endangered on March 11, 1967 (Federal Register 32[48]:4001) under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U.S.C. 668aa[c]). The ESA of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) subsequently extended full legal protection from unauthorized take to the species. Critical habitat was designated for the species on September 24, 1976 (41 FR 14914). Thirteen hibernacula, including 11 caves and two mines in six states, were listed as critical habitat.

4.2. Species Description

The Indiana bat 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 wingspan 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 Indiana bat closely resembles the little brown bat and northern long-eared bat. It is distinguished from these species by its foot structure and fur color. The Indiana Bat Draft Recovery Plan (Service 2007) provides a comprehensive summary of the description of the species and is incorporated by reference.

4.3. Life History

Indiana bat hibernates in caves and mines in the winter (typically October through April) and migrates to forested summer habitat. When arriving at their traditional hibernacula from August to September, Indiana bats "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 is a critical part of the life cycle when Indiana bats converge at hibernacula, mate, and forage to store sufficient fat reserves to sustain them through winter (Service 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 (Service 2007). Females may mate their first autumn, whereas males may not mature until the second year (Service 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 (Service 2007). Hibernation facilitates survival during winter when insect prey is unavailable. Hibernating Indiana bats cluster on cave ceilings in densities of approximately 300-484 bats/square feet (ft), from approximately October through April. Clusters may protect individuals from temperature changes and reduce sensitivity to disturbance. Like other cave bats, the Indiana bat 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 (Service 2007).

Spring emergence occurs when outside temperatures increase and insects (prey) are more abundant (Richter et al. 1993). Most Indiana bats 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 (Service 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 Indiana bat, 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 Indiana bats migrate north for the summer maternity season (Service 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 may roost near their hibernacula or migrate long distances to their summer habitat (Kurta and Rice 2002).

Female Indiana bats give birth to one young each year (Mumford and Calvert 1960; Humphrey et al. 1977; Thomson 1982). The proportion of female Indiana bats that produce young is not well documented. At a colony in Indiana, 23 of 25 female Indiana bats 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 Indiana bats 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 and Cope 1977).

Indiana bats feed on aquatic and terrestrial invertebrates. Diet varies seasonally and among different ages, sexes, and reproductive status (Service 1999). Numerous foraging habitat studies have found that Indiana bats forage in closed to semi-open forested habitats and forest edges located in floodplains, riparian areas, lowlands, and uplands. Old fields and agricultural fields are also used (Service 2007; Sparks et al. 2005). Indiana bats frequently forage along riparian corridors and obtain water from streams, ponds, and water-filled road ruts in forest uplands.

The average life span of the Indiana bat is 5 to 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, Humphrey and Cope (1977) estimated annual survival. Female survivorship in an

Indiana population was 76% for ages 1 to 6 years and 66% for ages 6 to 10 years. Male survivorship was 70% for ages 1 to 6 years and 36% for ages 6 to 10 years. Following 10 years, the survival rate for females dropped to 4% (Humphrey and Cope 1977).

4.4. Habitat Characteristics of the Indiana Bat

Winter Habitat

Indiana bats roost in caves or mines with configurations that provide a suitable temperature and humidity microclimate (Brack et al. 2003; Service 2007). Requirements for hibernacula are discussed in the draft Recovery Plan for the species (Service 2007).

Summer Habitat

During summer, Indiana bats (males and females) use forested habitat for roosting, foraging, and commuting. Indiana bats are often associated with floodplain or riparian forests with large trees, scattered canopy gaps, and open understories (Service 2007). Research has showed adaptability in habitats used, including upland forests, forests altered by grazing, swine feedlots, row-crops, hay fields, residences, clear-cut harvests, and shelterwood cuts (Garner and Gardner 1992; Service 1999).

Suitability of a roost tree is determined by its condition (dead or alive), suitability of loose bark, solar exposure, spatial relationship to other trees, and its spatial relationship to water sources and foraging areas. Potentially suitable roost trees can be trees of any species with bark separating from the tree after the tree dies, senesces, or is injured. Live trees that exhibit peeling or shaggy bark, such as hickories (*Carya* spp.) and large white oaks (*Quercus alba*), may also be suitable roost trees. Many maternity colonies have been associated with oak-hickory and elm-ash-cottonwood forest types. Tree cavities, hollow portions of tree boles or limbs, and crevices and splits from broken tops occasionally have been used as roosts, usually by individual bats. Roost longevity is variable due to many factors, such as the rate at which bark sloughs off or the tree falls down. Some roosts may only be habitable for one to two years while species with good bark retention, such as slippery elm (*Ulmus rubra*), cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), and various oaks (*Quercus* spp.) and hickories (*Carya* spp.) may provide habitat for four to eight years (Service 1999).

Trees over 40 cm (15.7 in) in diameter at breast height (dbh) are optimal for maternity colonies, while trees in excess of 22 cm (8.6 in) in dbh serve as alternate roosts (Service 2002). Females have been documented using roost trees as small as 5.5 inches in dbh (Kurta 2005). The average size of a male roost is typically smaller than that of female maternity colonies; for example, one male was observed in a roost tree measuring only 2.5 inches in dbh (Gumbert et al. 2002).

Maternity colonies have been documented to use eight to 34 roost trees per season (Callahan et al. 1997; Kurta et al. 2002; Roby pers comm 2024). The extent and configuration of the roosting area is probably determined by availability of suitable roost trees in a given area. Distances between roosts can be from less than 10 feet to a couple miles (Kurta et al. 1996; 2002). Primary roosts are generally larger in diameter and located in openings or at the edge of forest stands, while alternate roosts can either be in openings or the interior of the forest stand. Maternity colony movements among multiple roosts seem to depend on micro-climate changes, particularly solar radiation (Humphrey et al. 1977). Cool temperatures can delay fetal development and growth of juveniles; therefore, selection of maternity roost sites may be critical to reproductive success. Kurta et al. (1993) suggest movement between roosts may be the way that bats deal with the ephemeral nature of roost trees. It is not known how many alternate roosts must be available to ensure retention of a colony within a particular area, but large, nearby forest tracts would improve the potential for an area to provide adequate roosting habitat (Callahan 1993; Callahan et al. 1997).

Information to date indicates that Indiana bats predominately forage, roost, and travel within wooded habitats or along their edges (Cope et al. 1974; Humphrey et. al., 1977; LaVal et al., 1977; LaVal and LaVal 1980; Gardner et. al., 1991; Hobson and Holland 1995; Kiser and Elliot 1996; Butchkosi and Hassigner 2002; Rommé et al. 2002; Murray and Kurta 2004; Menzel et al. 2005; Sparks et al., 2005). Use of other habitat types appear to be infrequent relative to availability (Garner and Gardner 1992; Menzel et al., 2005; Sparks et al. 2005). The observations of Murray and Kurta (2004) indicate that Indiana bats will avoid traveling in open areas; of the 34 transmitter nights (= a single bat monitored through one night), no bats were detected crossing open areas but rather predictably, over 5 years, used a single tree-lined corridor to move from their roosting to foraging areas. Avoiding these open areas increased the distance bats needed to fly by up to 55 percent (=656 to 11,154 feet extra distance flown) more than if they had taken a straight-line flight from their day roosts to their foraging areas. Similarly, investigators in Missouri (Ecology and Environment, Inc. 2009) found that the areas of activity for five radio-tagged bats were in heavily forested areas and along riparian corridors and forest edges. No bats were recorded in the open areas interspersed throughout the research area.

Conversely, research has shown that Indiana bats will cross open areas to travel between roosting and foraging habitat (Brack and Sparks, pers. comm. 2011). Adult females and volant juveniles from multiple maternity colonies in Kentucky have been documented flying back and forth across the Ohio River to forage and roost (Seiter et al 2022). The Ohio River's average width in these areas is approximately 1,500 feet. Whitaker et al. (2006) documented a maternity roost in an isolated 1.7-acre woodlot where the closest woody habitat was a brushy fencerow of small trees 525 feet away. Similarly, three years of radiotelemetry study on a maternity colony of Indiana bats in an agricultural landscape of Ohio documented Indiana bats often crossing open areas greater than 0.62 miles in length (Kniowski 2011).

Given this information, it is reasonable to assume that Indiana bats may use edge habitat and seemingly isolated tracts near occupied habitat but will rarely fly over large open areas. The distance from the forest edge (i.e., the area of non-wooded habitat) that Indiana bats are likely to travel through is unknown. We are aware of few studies that provide specific data on "capture distances from the forest edge." Data garnered thus far by Stantec et al. (2010) show that of the 1,124 foraging telemetry points from 21 radio-tagged Indiana bats, the vast majority (75 percent) of points were within 400 feet of a forest edge and 97 percent were within 1000 feet of forest edge. Drawing from all existing data, it is reasonable to conclude that Indiana bats are unlikely to occur within project areas located more than 1000 feet from wooded areas.

Home range size estimates for Indiana bat vary greatly among studies. Home range size may vary between seasons, sexes, and reproductive status of the females (Lacki et al. 2007).

MacGregor et al. (1999) found that males that choose to remain near their hibernacula ranged from 25-1,404 acres. Other studies using radio telemetry tagging and various analysis methods (i.e., mean convex polygons, 95% adaptive kernel, 95% fixed kernel) have estimated average individual Indiana bat summer home range sizes of 205–828 acres (Menzel et al. 2005; Sparks et al. 2005; Watrous et al. 2006; Jachowski et al. 2014; Kniowski and Gehrt 2014). Jachowski et al. (2014) found home range size averaged 249 acres for four males and 358 acres for eight females. Menzel et al. (2005) found no significant difference in male and female home range size in Illinois. Womack et al. (2013) found Missouri home ranges averaged 2,809 acres and lactating and pregnant females did not significantly differ in home range. Bergeson et al. (2013) analyzed a mean of 927 acres and 704 acres foraging range for females in Illinois using two different analysis techniques. Watrous et al. (2006) calculated a mean home range of 205 acres for 14 female Indiana bats in Vermont. Without site-specific data, the Service generally considers the potential home range for an Indiana bat to include all suitable habitat within 2.5 miles of documented roost(s) (Service 2011), recognizing the area of actual use may be just a portion of that area.

Indiana bats show a high degree of fidelity to roost trees, roosting areas, and foraging areas (Gardner et al. 1991; Humphrey et al. 1977; Kurta et al. 1996, 2002; Kurta and Murray 2002; Gumbert et al. 2002). Bats using familiar foraging and roosting areas are thought to benefit from decreased susceptibility to predators, increased foraging efficiency, and the ability to switch roosts in case of emergencies or alterations surrounding the original roost (Gumbert et al. 2002).

<u>Spring and Fall Habitat</u>
In the spring and fall, Indiana bats usually roost, forage, and commute in habitats like those selected during the summer. These areas are most typically within 10 miles of a P1/P2 hibernaculum and five miles of a P3/P4 hibernaculum; however, use of habitat areas that are farther from hibernacula have been documented (Kiser and Elliot 1996; MacGregor et al. 1999; Rommé et al. 2002; Hawkins et al. 2005).

4.5. Numbers, Reproduction, and Distribution

Indiana bat occurs throughout most of the eastern United States. Winter surveys in 2024 found hibernating Indiana bats dispersed across 15 states. However, over 95% of the estimated range-wide population hibernated in four states – Missouri (37.6%), Indiana (37.1%), Illinois (13.2%), and Kentucky (7.9%) (Service 2024a). Summer distribution of the Indiana bat 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. However, many summer maternity colonies have been found in the northeastern states of Pennsylvania, Vermont, New Jersey, New York, West Virginia, and Maryland. Maternity colonies have also been found in the south, including southern Arkansas, Georgia, Alabama, Mississippi Copperhead 2017; Copperhead pers. comm. 2014), southwestern North Carolina (Britzke et al. 2003; Service 2007). Non-reproductive summer records for the Indiana bat have also been documented in eastern Oklahoma, northern Mississippi, Alabama, and Georgia.

The data regarding Indiana bat abundance prior to federal listing are limited, but the available information, summarized in the draft Recovery Plan (Service 2007), suggests that Indiana bats were once far more abundant than they were in the 1960s. When the Indiana bat was originally listed as endangered in 1967, there were an estimated 883,300 bats, and most of these hibernated in a small number of hibernacula (Clawson 2002). Since the species was listed, its population numbers continued to decline through approximately 2001, with large population declines observed at hibernacula in Kentucky and Missouri. The range wide population estimate dropped approximately 57% from 1965 to 2001 (Service 2007). The range-wide, biennial population estimates increased from 2001 to 2007, indicating that the species' long-term decline had been arrested and likely reversed (Service 2024a). However, the arrival of white-nose syndrome (or "WNS"; see discussion below) is the probable cause of the decline observed since 2007. The Service estimated the 2024 range-wide population at 631,786 bats (Figure 4.1) occurring in 194 hibernacula in 15 states, with the three most populous states being Missouri (237,733), Indiana (234,657), and Illinois (83,304). This represents a 2.8% decrease from the range-wide population estimate of 664,637 in 2007 (when WNS began). However, there has been an 8.3% increase since the 2022 survey.

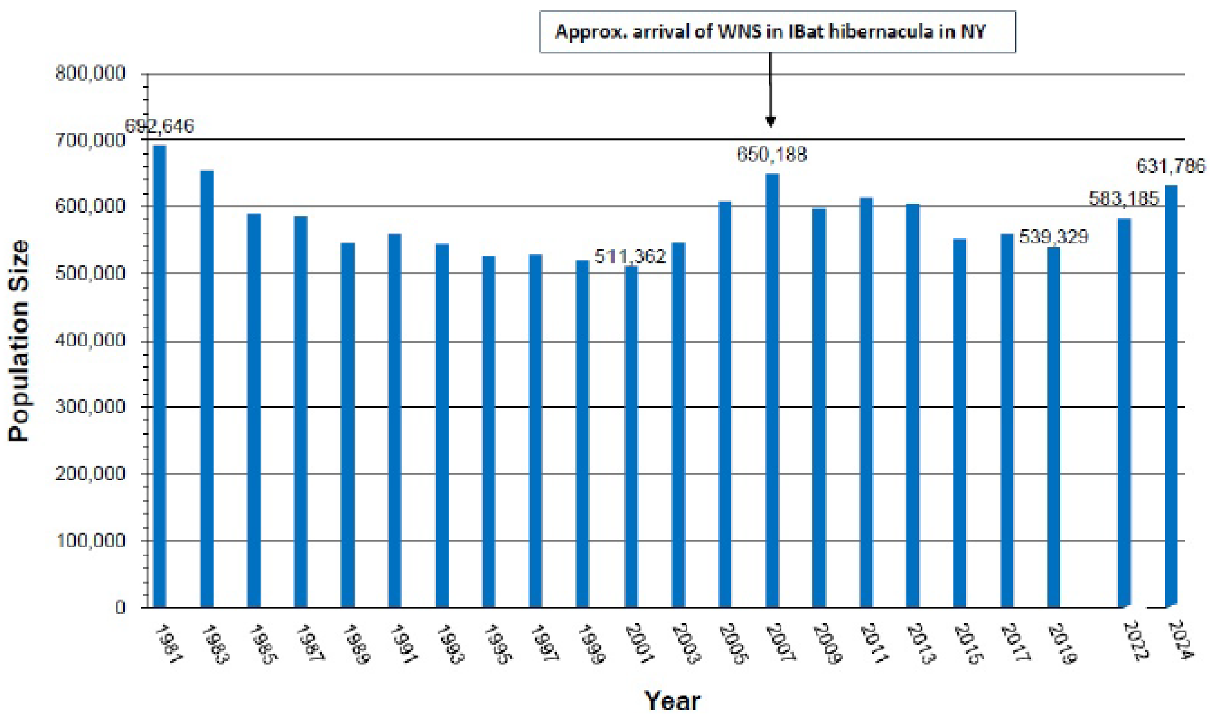

Figure 4.1. Indiana bat range-wide population estimates from 1981-2024.

4.6. Conservation Needs and Threats

Destruction/Degradation of Hibernacula
There are well-documented examples of modifications to Indiana bat hibernacula that affected the thermal regime of caves and, thus, the ability to support hibernating Indiana bats as summarized in the draft revised Recovery Plan (Service 2007). Generally, threats to the integrity of hibernacula decreased since the listing of Indiana bats 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).

<u>Loss/Degradation of Forested Habitat</u>
Loss of forest cover and degradation of forested habitats contributed to the decline of Indiana bats (Service 1983; Garner and Gardner 1992; Drobney and Clawson 1995; Whitaker and Brack 2002). Throughout the Indiana bat, 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 Indiana bat, 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 Indiana bat 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 Indiana bat.

Urbanization and development are currently the greatest contributor to forested habitat loss within the Indiana bat range (Wear and Greis 2002; USFS 2005, 2006). At a study site in central Indiana, Indiana bats 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 Indiana bat, 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 Indiana bat maternity colonies will be found 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 Indiana bats, with increasing forest cover suggesting at least the potential for improved habitat conditions. Conversely, in areas where almost all forest land has been lost, the absence of woodlands on the landscape certainly equates to less habitat than in prehistoric and early historic periods.

Throughout the Indiana bat 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 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 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.

<u>Disturbance of Hibernating Bats</u>
The original recovery plan stated that human disturbance of hibernating Indiana bats was one of the primary threats (Service 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 Indiana bats, but the threat still occurs. Biologists throughout the range of the Indiana bat were asked to identify the primary threat at specific hibernacula, and "human disturbance" was identified as the primary threat at 41% of P1, P2 and P3 hibernacula combined.

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 Indiana bat. White-nose syndrome is responsible for unprecedented mortality of insectivorous bats in eastern North America (Blehert et al. 2009; Turner et al. 2011). 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 little brown bat) 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. 2013; 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 Indiana bats between 2007 and 2015. At the time dead bats were first observed in the winter of 2006-2007, it is not known how long the (previously unidentified) fungus, Pd, had been present in affected sites. 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% and continues to decline. 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. However, populations in the Midwest and Ozark-Central Recovery Units have increased by 10.2 and 16.9%, respectively, since 2015. As of 2016, WNS or Pd was confirmed in all states within the species' range. Further declines in Indiana bat populations from the disease may occur 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 the Indiana bat. 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 the Indiana bat are 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 the Indiana bat. Service (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 Indiana bat, are limited. During winter, only a small proportion of caves provide the right conditions for hibernating Indiana bats. 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 Indiana bat summer maternity range within the United States due to climate change.

Wind Turbines

There is growing concern that Indiana bat (and other bat species) may be threatened by the recent surge in construction and operation of wind turbines across the species' range. Eight Indiana bat mortalities occurred at wind turbines; five of those were during the fall migration period (Service 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 Indiana bat mortality occurred at these facilities and at other wind facilities throughout the range of the species.

5. NORTHERN LONG-EARED BAT

This section summarizes the best available data about the biology and current condition of the northern long-eared bat throughout its range that are relevant to formulating an opinion about the Action.

5.1. Status of Northern Long-eared Bat

The Service published its decision to list the northern long-eared bat as endangered on November 29, 2022 (87 FR 73488). No critical habitat has been designated for this species.

5.2. Species Description

The northern long-eared bat is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. Adult body weight averages five to eight grams (0.2 to 0.3 ounces), with females tending to be slightly larger than males (Caceres and Pybus 1997, p. 3). Average body length ranges from 3.0 to 3.7 inches. (Barbour and Davis 1969, p. 76; Caceres and Barclay 2000, p. 1). The fur is medium to dark brown on the dorsal side and tawny to pale brown on the ventral side, with dark brown (but not black) ears and wing membranes (Nagorsen and Brigham 1993, p. 87; Whitaker and Mumford 2009, p. 207). As indicated by its common name, the northern long-eared bat is distinguished from other *Myotis* species by its relatively long ears (average 0.7 inches; Whitaker and Mumford 2009, p. 207) that, when laid forward, extend beyond the nose up to 0.2 inches (Caceres and Barclay 2000, p. 1). The tragus (i.e., projection of skin in front of the external ear) is long (average 0.4 inches; Whitaker and Mumford 2009, p. 207), pointed, and symmetrical (Nagorsen and Brigham 1993, p. 87; Whitaker and Mumford 2009, p. 207). Within its range, the species can be confused with the little brown bat or the western long-eared myotis (*Myotis evotis*). The northern long-eared bat can be distinguished from the little brown bat by its longer ears, tapered and symmetrical tragus, slightly longer tail, and less glossy pelage (Caceres and Barclay 2000, p. 1; Kurta 2013, in litt.). The northern long-eared bat can be distinguished from the western long-eared myotis by its darker pelage and paler membranes (Caceres and Barclay 2000, p. 1).

5.3. Life History

The northern long-eared bat hibernates in caves and mines in the winter (typically October through April) and migrates to forested summer habitat. The swarming season occurs between the summer and winter seasons (Lowe 2012, p. 50), and the purpose of swarming behavior may include: introduction of juveniles to potential hibernacula, copulation, and stopping over sites on migratory pathways between summer and winter regions (Kurta et al. 1997, p. 479; Parsons et al. 2003, p. 64; Lowe 2012, p. 51; Randall and Broders 2014, pp. 109–110). During this period, heightened activity and congregation of transient bats around caves and mines is observed, followed later by increased sexual activity and bouts of torpor prior to winter hibernation (Davis and Hitchcock 1965, pp. 304–306; Fenton 1969, p. 601; Parsons et al. 2003, pp. 63–64).

The swarming period may occur between July and early October, depending on latitude within the species' range (Hall and Brenner 1968, p. 780; Fenton 1969, p. 598; Caire et al. 1979, p. 405; Kurta et al. 1997, p. 479; Lowe 2012, p. 86;). Individuals may investigate several cave or mine openings during the transient portion of the swarming period, and some individuals may use these areas as temporary daytime roosts or may roost in forest habitat adjacent to these sites (Kurta et al. 1997, pp. 479, 483; Lowe 2012, p. 51). Many of the caves and mines associated with swarming are also used as hibernacula for several other species of bats (Fenton 1969, p. 599; Whitaker and Rissler 1992, p. 132; Kurta et al. 1997, p. 484; Glover and Altringham 2008, p. 1498; Randall and Broders 2014, p. 109).

While northern long-eared bats are thought to predominantly overwinter in caves and abandoned mines, the species has also been observed overwintering in other types of habitats that offer similar conditions (e.g., temperature, humidity levels, air flow). The species may use these alternate hibernacula in areas where caves or mines are not present (Griffin 1945, p. 22). Further, Grider et al. (2016, p. 11) found northern long-eared bats to be present and active year-round on the coastal plain of North Carolina, where there is no known non-cavernicolous (cave- like) hibernacula; therefore, it is likely this population was not (traditionally) hibernating. Also, in coastal North Carolina, northern long-eared bats were observed to be active most of the winter. Although torpor was observed, time spent in torpor was very short, with the longest torpor bout (i.e., hibernation period) for each bat averaging 6.8 days (Jordan 2020, p. 672). Similarly, the species has been recently documented as active during the hibernation season in other southern states (e.g., Alabama, Mississippi, and Louisiana). In those areas, it appears the species enters temporary periods of torpor and will roost in trees and culverts while in torpor. However, Arkansas is within the hibernating portion of the species' range.

Spring staging is the time between winter hibernation and spring migration to summer habitat (Whitaker and Hamilton 1998, p. 80). During this time, bats begin to gradually emerge from hibernation, exit the hibernacula to feed, but re-enter the same or alternative hibernacula to resume daily bouts of torpor (Whitaker and Hamilton 1998, p. 80). The staging period is likely short in duration (Caire et al. 1979, p. 405; Whitaker and Hamilton 1998, p. 80). In Missouri, Caire et al. (1979, p. 405) found that northern long-eared bats moved into the staging period in mid-March through early May. Sasse et al. (2014, p. 172) found pregnant females using a mine in late April and May in Arkansas. In Michigan, Kurta et al. (1997, p. 478) determined that by early May, two-thirds of the *Myotis* species, including the northern long-eared bat, had dispersed to summer habitat. Variation in timing (onset and duration) of staging for Indiana bats (*Myotis sodalis*) was based on latitude and weather (Service 2007, pp. 39–40, 42); similarly, timing of staging for northern long-eared bats is likely based on these same factors.

Migratory movements between seasonal habitats (summer roosts and winter hibernacula) of 35 miles to 55 miles have been documented (Griffin 1940, pp. 235, 236; Caire et al. 1979, p. 404; Nagorsen and Brigham 1993 p. 88). The spring migration period typically runs from mid-March to mid-May (Easterla 1968, p. 770; Caire et al. 1979, p. 404; Whitaker and Mumford 2009, p. 207); fall migration typically occurs between mid-August and mid-October.

In the summer, reproductive females form maternity colonies and give birth to pups. Maternity colonies are generally small, numbering from about 30 (Whitaker and Mumford 2009, p. 212) to 60 individuals (Caceres and Barclay 2000, p. 3); however, larger colonies of up to 100 adult females have been observed (Whitaker and Mumford 2009, p. 212). Most studies have found that the number of individuals roosting together in a given roost typically decreases from pregnancy to post-lactation (Foster and Kurta 1999, p. 667; Lacki and Schwierjohann 2001, p. 485; Garroway and Broders 2007, p. 962; Perry and Thill 2007, p. 224; Johnson et al. 2012, p. 227). Northern long-eared bats exhibit fission-fusion behavior (Garroway and Broders 2007, p. 961), where members frequently coalesce to form a group (fusion), but composition of the group is in flux, with individuals frequently departing to be solitary or to form smaller groups (fission) before returning to the main spatially discrete unit or network (Barclay and Kurta 2007, p. 44). As part of this behavior, northern long-eared bats switch tree roosts often (Sasse and Pekins 1996, p. 95), typically every two to three days (Foster and Kurta 1999, p. 665; Owen et al. 2002, p. 2; Carter and Feldhamer 2005, p. 261; Timpone et al. 2010, p. 119). Patriquin et al. (2016, p. 55) found that roost switching and use varies regionally in response to differences in ambient conditions (e.g., precipitation, temperature).

Adult females give birth to a single pup (Barbour and Davis 1969, p. 104). Birthing within the colony tends to be synchronous, with most births occurring around the same time (Krochmal and Sparks 2007, p. 654). Parturition (birth) may occur as early as late May or early June (Easterla 1968, p. 770; Caire et al. 1979, p. 406; Whitaker and Mumford 2009, p. 213) and may occur as late as mid-July (Whitaker and Mumford 2009, p. 213). Juvenile flight capability often occurs by 21 days after birth (Kunz 1971, p. 480; Krochmal and Sparks 2007, p. 651) and has been documented as early as 18 days after birth (Krochmal and Sparks 2007, p. 651).

Northern long-eared bats are nocturnal foragers and use hawking (i.e., catching insects in flight) and gleaning (i.e., picking invertebrates from surfaces) behaviors in conjunction with passive acoustic cues (Nagorsen and Brigham 1993, p. 88; Ratcliffe and Dawson 2003, p. 851). The species has a diverse diet including moths, flies, leafhoppers, caddisflies, and beetles (Griffith and Gates 1985, p. 452; Nagorsen and Brigham 1993, p. 88; Brack and Whitaker 2001, p. 207), with diet composition differing geographically and seasonally (Brack and Whitaker 2001, p. 208). The most common invertebrates found in the diets of northern long-eared bats are lepidopterans (moths) and coleopterans (beetles) (Brack and Whitaker 2001, p. 207; Lee and McCracken 2004, pp. 595–596; Feldhamer et al. 2009, p. 45; Dodd et al. 2012, p. 1122), with arachnids also being a common prey item (Feldhamer et al. 2009, p. 45).

Foraging patterns indicate a peak activity period within five hours after sunset followed by a secondary peak within eight hours after sunset (Kunz 1973, pp. 18–19). Brack and Whitaker (2001, p. 207) did not find significant differences in the overall diet of northern long-eared bats between morning (3 a.m. to dawn) and evening (dusk to midnight) feedings; however, there were some differences in the consumption of particular prey orders between morning and evening feedings. Additionally, no significant differences existed in dietary diversity values between age classes or sex groups (Brack and Whitaker 2001, p. 208).

5.4. Habitat Characteristics of the Northern Long-eared Bat

Winter Habitat

Northern long-eared bats are thought to predominantly overwinter in hibernacula that include caves and abandoned mines. These hibernacula have relatively constant, cooler temperatures (0 to 9 degrees Celsius or 32 to 48 degrees Fahrenheit) (Raesly and Gates 1987, p. 18; Caceres and Pybus 1997, p. 2; Brack 2007, p. 744), with high humidity and no strong currents (Fitch and Shump 1979, p. 2; van Zyll de Jong 1985, p. 94; Raesly and Gates 1987, p. 118; Caceres and Pybus 1997, p. 2). Bats are typically found roosting singly or in small numbers in cave or mine walls or ceilings, often in small crevices or cracks, sometimes with only the nose and ears visible, and thus are easily overlooked during surveys (Griffin 1940a, pp. 181–182; Barbour and Davis 1969, p. 77; Caire et al. 1979, p. 405; van Zyll de Jong 1985, p. 9; Caceres and Pybus 1997, p. 2; Whitaker and Mumford 2009, pp. 209–210).

This species has also been observed overwintering in other types of habitats that have similar conditions (e.g., temperature, humidity levels, air flow) to cave or mine hibernacula. The species may use these alternate hibernacula in areas where caves or mines are not present (Griffin 1945, p. 22). Individuals have been found using the following alternative hibernacula: abandoned railroad tunnels (Service 2015, p. 17977), the entrance of a storm sewer in central Minnesota (Goehring 1954, p. 435), a hydroelectric dam facility in Michigan (Kurta et al. 1997, p. 478), an aqueduct in Massachusetts (Massachusetts Department of Fish and Game 2012, unpublished data), and a dry well in Massachusetts (Griffin 1945, p. 22). More recently, northern long-eared bats were found in a crawl space within a dwelling in Massachusetts (Dowling and O'Dell 2018, p. 376) and a rock crevice in Nebraska (White et al. 2020, p. 114).

Summer Habitat

Northern long-eared bats typically roost singly or in maternity colonies underneath bark or, more often, in cavities or crevices of both live trees and snags (Sasse and Pekins 1996, p. 95; Foster and Kurta 1999, p. 662; Owen et al. 2002, p. 2; Carter and Feldhamer 2005, p. 262; Perry and Thill 2007, p. 222; Timpone et al. 2010, p. 119). The species is flexible in tree species selection and, while they may select for certain tree species regionally, are likely not dependent on certain species of trees for roosts throughout their range; rather, many tree species that form suitable cavities or retain bark will be used by the bats opportunistically (Foster and Kurta 1999, p. 668; Silvis et al. 2016, p. 12; Hyzy 2020, p. 62). Carter and Feldhamer (2005, p. 265) hypothesized that structural complexity of habitat or available roosting resources are more important factors than the actual tree species. Further, Silvis et al. (2012, p. 7) found forest successional patterns, stand, and tree structure to be more crucial than tree species in creating and maintaining suitable long-term roosting opportunities.

Males and non-reproductive females may also roost in cooler locations in the summer, such as caves and mines (Barbour and Davis 1969, p. 77; Amelon and Burhans 2006, p. 72). To a lesser extent, individuals have also been observed roosting in colonies in human-made structures, such as in buildings, in barns, on utility poles, behind window shutters, in bridges, and in bat houses (Mumford and Cope 1964, p. 72; Barbour and Davis 1969, p. 77; Cope and Humphrey 1972, p. 9; Burke 1999, pp. 77–78; Sparks et al. 2004, p. 94; Amelon and Burhans 2006, p. 72; Whitaker and Mumford 2009, p. 209; Timpone et al. 2010, p. 119; Bohrman and Fecske 2013, pp. 37, 74; Feldhamer et al. 2003, p. 109; Sasse et al. 2014, p. 172; Service 2015, p. 17984; Dowling and O'Dell 2018, p. 376). It has been hypothesized that use of human-made structures may occur in areas with fewer suitable roost trees (Henderson and Broders 2008, p. 960; Dowling and O'Dell 2018, p. 376). In north-central West Virginia, individuals were found to use artificial roosts more readily as distance from large forests [greater than 200 hectares (494 acres)] increased, suggesting that artificial roosts are less likely to be selected when there is greater availability of suitable roost trees (De La Cruz et al. 2018, p. 496).

Studies of northern long-eared bat home range are highly variable, and it is uncertain if male northern long-eared bat summer home range size are larger or smaller than females. Foster and Kurta (1999) studied Indiana bats at a site also occupied by northern long-eared bats and found that northern long-eared bats moved greater distances (anywhere from 20 feet to 6,562 feet) between roosts. Timpone et al. (2010) reported the mean distance between capture sites and roosts was 5,577 feet. Fill et al. (2021) recorded a male traveled 8,858 feet and a female traveled 984 feet between capture site and roost. Another study found foraging areas can be larger for females than males (Broders et al. 2006) with males traveling approximately 1,640 feet for foraging and roosting and females traveling 6,562 feet; these distances were centered around roosting and foraging areas.

From data reported by Broders et al. (2006), we estimate home ranges for males as approximately 14 ha (35 ac) and 54 ha (134 ac) for females. Henderson and Broders (2008) estimated the distance moved for foraging females was 3,609 feet, whereas the total roost area covered was 77 ac. Owen et al. (2003) determined a mean maternity home range size of 161 aces, and Gorman et al. (2022) estimated a minimum roosting area for a maternity colony at 88.4 218 ac. The Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities from Take Prohibitions (Service 2016) indicates 1,000 ac as the area a northern long-eared bat colony utilizes. The Service assumed a 325-ac home range size for northern long-eared bat based on the average from reported studies (Service 2024b); however, the Service did not provide sources for its information.

Most foraging occurs above the understory one to three meters (three to 10 feet) above the ground but under the canopy (Nagorsen and Brigham 1993, p. 88) on forested hillsides and ridges, rather than along riparian areas (LaVal et al. 1977, p. 594; Brack and Whitaker 2001, p. 207). This coincides with data indicating that mature forests are an important habitat type for foraging (Caceres and Pybus 1997, p. 2; White et al. 2017, p. 8). Foraging also takes place over small forest clearings, water, and along roads (van Zyll de Jong 1985, p. 94). Northern long-eared bats seem to prefer intact mixed-type forests with small gaps (i.e., forest trails, small roads, or forest-covered creeks) in forest with sparse or medium vegetation for forage and travel rather than fragmented habitat or areas that have been clear cut (Service 2015, p. 17992).

5.5. Numbers, Reproduction, and Distribution

The northern long-eared bat 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 most 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 northern long-eared bat) 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 northern long-eared bats must be described and understood within the context of the impacts of WNS. Before the onset of WNS, the best available information on the species came primarily from summer surveys (primarily focused on the Indiana bat or other bat species) and some targeted research projects. In those efforts, the northern long-eared bat was frequently encountered and was considered the most common myotis bat in many areas. Overall, the species was considered to be widespread and plentiful throughout its historic range (Caceres and Barclay 2000).

5.6. Conservation Needs and Threats

<u>White-nose Syndrome</u>
For over a decade, WNS has been the primary stressor on the northern long-eared bat. WNS is a disease of bats that is caused by the fungal pathogen *Pseudogymnoascus destructans* (Pd) (Blehert et al. 2009; Turner and Reeder 2009; Lorch et al, 2011; Coleman and Reichard 2014; Frick et al. 2017; Bernard et al. 2019; Hoyt et al. 2021). The effects of WNS have been severe, with most summer and winter colonies experiencing significant declines following its arrival. Just four years after the discovery of WNS, Turner et al. (2011, pp. 18–19) estimated a 98% decline in winter counts across 42 sites in Vermont, New York, and Pennsylvania. Similarly, Frick et al. (2015, p. 5) estimated the arrival of WNS led to a tenfold decrease in northern long-eared bat colony size. Most recently, Cheng et al. (2021) used data from 27 states and two provinces to conclude that WNS caused estimated population declines of 97–100% across 79% of the species' range. Although variation exists among sites, an overwhelming majority of hibernating colonies have developed WNS and experienced serious impacts within two to three years after its arrival (Cheng et al. 2021; Wiens et al. 2022, pp. 231–247). To date, there are no proven measures to reduce the severity of impacts from WNS.

<u>Wind Related Mortality</u>
Wind related mortality, while overshadowed by the disproportionate impacts to tree bats and by the enormity of WNS, is also a significant stressor for northern long-eared bats. There is notable spatial overlap between northern long-eared bat occurrences and wind facilities, and mortality has been documented at wind turbines. Analyses using data from Wiens et al. (2022, pp. 236–247) and Whitby et al. (2022, entire) suggest that the impact of wind related mortality is discernible in the ongoing decline of the species. "Feathering" (i.e., pitch turbine blades parallel with the prevailing wind direction to slow rotation speeds) has been used to reduce bat fatalities; however, the effectiveness of this method in reducing fatality rates for the northern long-eared bat has not been documented.

<u>Climate Change</u>
While the risk of exposure to climatic changes exists range-wide for the northern long-eared bat, the magnitude, direction, and seasonality of those changes are expected to vary across its range. Although there may be some benefits to the species from a changing climate, overall, negative impacts are anticipated. Species-specific observations for the northern long-eared bat are lacking; however, observed impacts on the little brown bat include reduced reproduction during drought conditions (Adams 2010, pp. 2440–2442) and decreased adult survival during dry years in the Northeast (Frick et al. 2010, pp. 131–133). While sufficient moisture is important, excessive precipitation during the spring can negatively affect insectivorous bats. Heavier precipitation

events may lead to decreased insect availability and reduced echolocation ability (Geipel et al. 2019, p. 4), resulting in lower foraging success. Precipitation also wets bat fur, reducing its insulating value (Webb and King 1984, p. 190; Burles et al. 2009, p. 132) and increasing a bat's metabolic rate (Voigt et al. 2011, pp. 794–795). Bats are likely to reduce their foraging bouts during heavy rain events, and reduced reproduction has been observed during cooler, wetter springs in the Northwest (Grindal et al. 1992, pp. 342–343; Burles et al. 2009, p. 136). Responses to climate change by the northern long-eared bat will vary throughout its range based on the extent of annual temperature rise in the future.

Habitat Loss

As previously discussed, northern long-eared bats require suitable roosting, foraging, and commuting habitat during the spring, summer, and fall. Any loss of these habitats is likely to influence the survival and reproductive success of the species. Data from the National Land Cover Database shows that deciduous forest landcover decreased across all northern long-eared bat representation units (RPUs) (e.g., Southeast, Eastern Hardwoods, Subarctic, Midwest, and East Coast) by 1.4 million acres from 2006 to 2016, for an average loss of 140,000 acres per year. Other cover types that provide foraging opportunities, such as emergent wetland cover types, also decreased by an additional 1.4 million acres across all RPUs. Changes in suitable habitat availability may be linked to losses of roosting or foraging habitat, longer flights between suitable roosting and foraging areas due to habitat fragmentation, fragmentation of maternity colony networks, and direct injury or mortality. Impacts from forest habitat removal may range from minor (e.g., removal of a small portion of foraging habitat in unfragmented forested area with a robust population) to significant (e.g., removal of roosting habitat in highly fragmented landscapes with a small, disconnected population). Adverse impacts are more likely in areas with little forest or highly fragmented forests (e.g., western U.S. and central Midwestern states), as there is a higher probability of removing roosts or losing connectivity between roosting and foraging habitats.

The complete loss of or modification of winter roosts (rendering the site unsuitable) can impact both individual bats and populations. Additionally, disturbances within hibernacula can make a site unsuitable or harm individuals using it. Modifications to bat hibernacula can alter the ability of bats to access the site (Spanjer and Fenton 2005, p. 1110) and affect the airflow and microclimate of the subterranean habitat, affecting the ability of the cave or mine to support hibernating bats. Furthermore, bats present during any excavation or filling could be crushed or suffocated. Human entry or other disturbances to hibernating bats results in additional arousals from hibernation, increasing total energy expenditure at a time when bats rely on fat reserves. This is of particular importance for sites impacted by WNS, as more frequent arousals from torpor increases the probability of mortality in bats with limited fat stores (Willis and et al. 2012, p. 96).

6. ENVIRONMENTAL BASELINE

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

6.1. Indiana Bat

6.1.1 Action Area Numbers, Reproduction and Distribution

The Action Area's surface land coverage within the Indiana bat range is approximately 32,087 square miles. The occupied range of the species (i.e., the collective home ranges of all individuals) within the total range and Action Area is unknown but is expected to be considerably smaller due to presence of unsuitable habitats and unoccupied suitable habitats.

The Action Area lies at the southwest corner of the species' range and numerous records of the species occupying summer and winter habitat exist within it. Occurrences of the species are clearly tied to the availability of suitable summer and winter habitat. Potential winter habitat is static (assuming no anthropogenic alterations occur) in the landscape, because the caves and other underground features the species relies on for winter habitat do not change locations. However, the species will move from one winter habitat area to another to take advantage of better conditions in hibernacula, to take advantage of new hibernacula (e.g., mines), or to abandoned hibernacula that humans or other factors have altered or disturbed.

Within Arkansas there are 55 known hibernacula. Four of these are identified as Priority 2 hibernacula (have a current or observed historical population between 1,000 and 10,000 and an appropriate microclimate) and 12 are identified as Priority 3 hibernacula (have current or observed historical population of 50-1,000 bats; Service 2007). No sites in Arkansas are designated as critical habitat (Service 2007). The 55 known hibernacula in Arkansas contained 7,350 Indiana bats in 2024 (Figure 6.1), which represents 1.2 % of the total estimated population. Surveyors in Arkansas recently documented a large number of Indiana bats hibernating in sections of two different caves that have not been routinely surveyed. It is unknown if those individuals are new additions to the States population or if they were previously overlooked during survey efforts of the sites. The addition of those individuals has caused a significant increase in the population estimate for the State of Arkansas as shown in Figure 6.1.

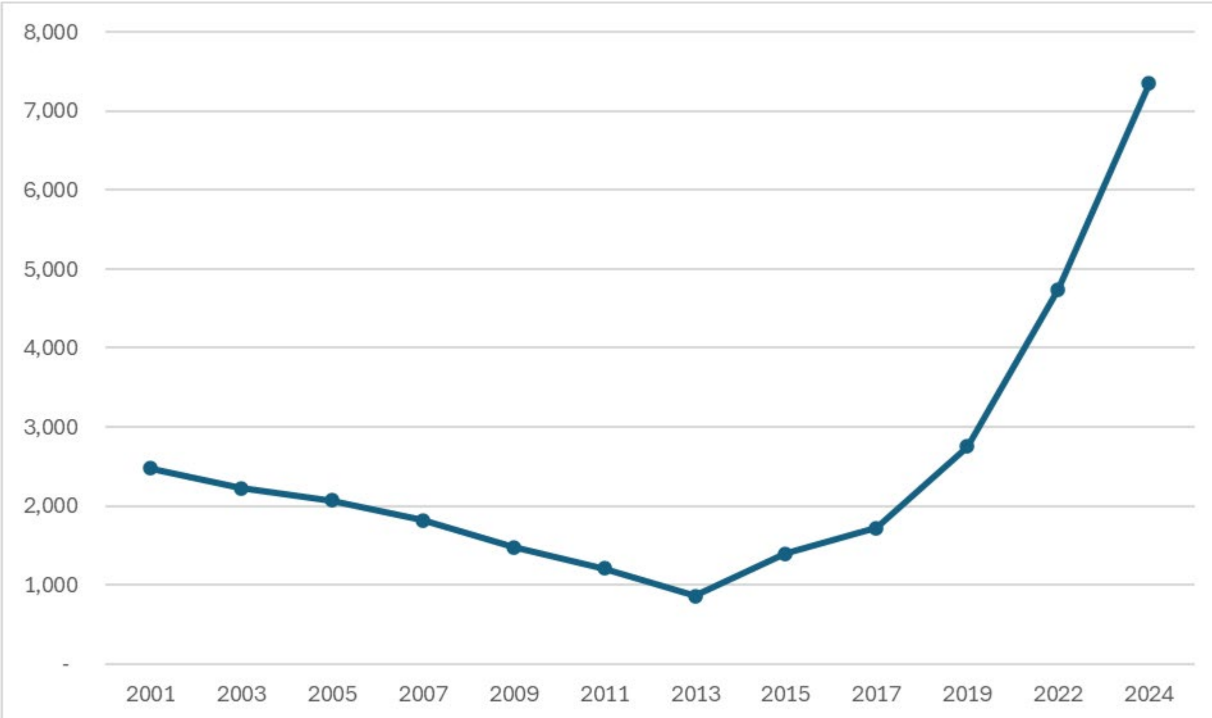

Figure 6.1. Indiana bat population estimate in Arkansas based on winter cave counts (Sasse, 2022).

Until recently, summer records for Indiana bat were limited to the Ozark Highlands and Crowley's Ridge. Starting in 2018 work was conducted to improve our understanding of the migratory patterns and maternity colony locations of female Indiana bats that hibernate in caves of the Ozark Plateau of Arkansas (Roby *et al*., 2021; Custer 2021). Female bats were tracked from hibernacula until signals were lost or a maternity colony was identified. Bats often used 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 began, the bats used stop over roost trees for one or more nights/days during their migration (Roby *et al*., 2021). Female bats migrated north, south, and east from hibernacula in Newton and Stone counties, Arkansas, suggesting that there may be maternity colonies throughout Arkansas. One female bat was tracked to a maternity colony in bottomland hardwood forests in the Black River area (Custer, 2021). Further mist netting efforts on the Ozark-St. Francis National Forest also resulted in the capture of multiple female Indiana bats and identification of the first Indiana bat maternity colony in the Boston Mountains near Deer, Arkansas, in 2021. A third maternity colony was historically documented at Dave Donaldson Black River WMA in Eastern Arkansas, but efforts to confirm that the maternity colony is still active have not been successful. No other maternity colonies are documented in the state.

Summer records of male Indiana bats in Arkansas are still limited to the Ozark Highlands and Crowley's Ridge Regions, but some male Indiana bats are expected to be distributed more broadly. Several male Indiana bats have been captured on the Ozark-St. Francis National Forest. Most of those captured since 2013 have been tracked with radio telemetry to roost trees. Male bats have primarily roosted 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, Indiana bat has been found to roost in larger than average trees and in moderate to large canopy gaps (Silvis et. al. 2016). Similarly, most of the roost trees used on the Ozark-St. Francis National Forest have been snags that are in advanced decay stages and located in areas of solar exposure.

6.1.2 Action Area Conservation Needs and Threats

Because the Action Area has been defined as the State of Arkansas and all portions of adjoining states that occur within 20 miles of the Arkansas border it is difficult to identify specific factors affecting the Indiana bat's environment within the Action Area. However, there are number of current and long-term land uses, environmental conditions and demographic trends that are expected to affect Indiana bats within the Action Area, which we discussed in the species status Section of the BO.

6.2. Northern Long-eared Bat

6.2.1 Action Area Numbers, Reproduction, and Distribution

The northern long-eared bat has been physically documented in 37 of 75 counties in Arkansas. Its abundance in the summer is variable across the State and is likely related to the presence of suitable forest habitat and fidelity to historical summer areas. There are 96 known northern long-eared bat hibernacula that are concentrated in the karst landscapes of the Ozarks and in mines in the Ouachita Mountains. The northern long-eared bat is difficult to find in Arkansas caves and thus is rarely found in large numbers (Sasse et al 2014). The species was one of the most common and abundant forest bats in the karst region of Arkansas prior to the detection of WNS in Arkansas during the winter of 2011-2012. Between 2013 and 2018, there was a 99% decline in the number of northern long-eared bats caught during mist-netting efforts on the Ozark National Forest (Figure 6.2, Edmonds 2020). Mist-netting data for most areas of Arkansas is not available, but northern long-eared bat abundance is believed to follow the same trend throughout the State. Observations of northern long-eared bats in Arkansas caves have similarly declined by over 99% with only two being observed in the past five years. No other current population data exists on Northern long-eared bats in the State of Arkansas.

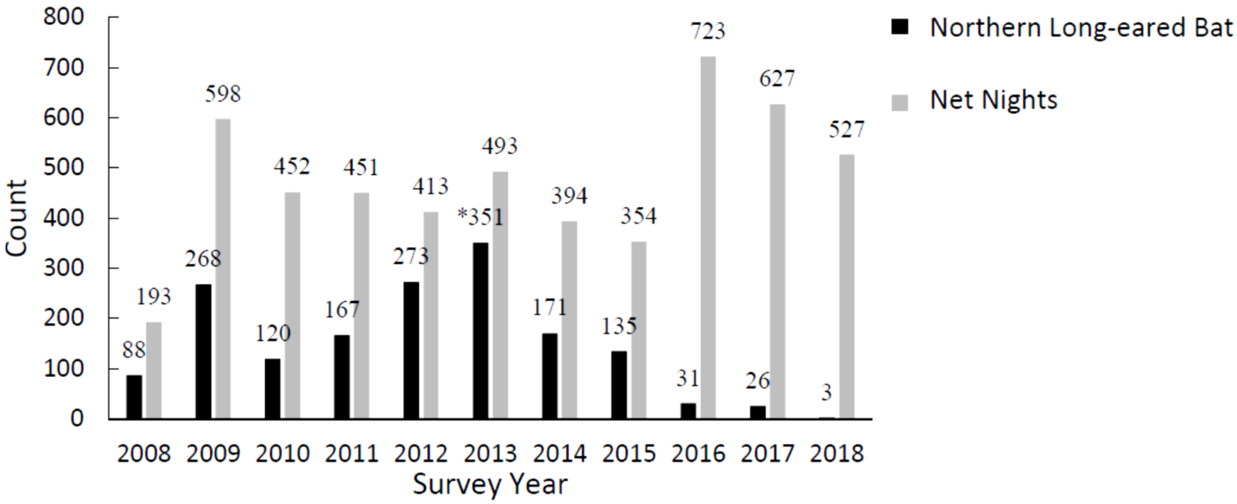

Figure 6.2 Number of summer net-nights (gray) compared to number of northern long-eared bat captures (black) across the Ozark National Forest by year (2008–2018; asterisk denotes year WNS was detected in Arkansas – From Edmonds, 2020).

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 northern long-eared bats in Arkansas, 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 northern long-eared bats and the historic abundance of the species, suitable foraging habitat is available in abundance in most of the species' range.

Studies on the roosting habits of northern long-eared bats 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 Ozark National Forest found that female northern long-eared bats 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.

6.2.2 Action Area Conservation Needs and Threats

Because the Action Area has been defined as the State of Arkansas and all portions of adjoining states that occur within 20 miles of the Arkansas border it is difficult to identify specific factors affecting the northern long-eared bat's environment within the Action Area. However, there are number of current and long-term land uses, environmental conditions and demographic trends that are expected to affect northern long-eared bats within the Action Area, which we discussed in the species status Section of the BO.

7. EFFECTS OF THE ACTION

This section addresses the direct and indirect effects of the Action on the covered species, including the effects of consequences of the proposed action. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action but are later in time and reasonably certain to occur. The Service believes the covered species are likely to experience similar impacts from removal of forested habitat due to similarities in species biology and life history and has decided to combine our analysis into one analysis for both species. When appropriate, we identify where applicable science may apply to a particular species; however, we expect the effects on the species from the stressors to be similar and have reflected this in our analysis.

The types of impacts to covered species that are addressed in this BO and associated with the Strategy are limited to those adverse effects caused by the removal or alteration of suitable forested habitats. Because the Action is programmatic and involves a variety of project types, we did not identify specific project components of the Action to be analyzed. Rather, we have identified four stressors associated with tree removal (i.e., the alteration of the environment that is relevant to the species) to the covered species that are reasonably certain to result from the Action: noise and vibration associated with tree removal, loss of roosts, forest loss and fragmentation, and aquatic resource degradation. All these stressors are associated with the removal or alteration of suitable forested habitats that likely occur during the implementation or construction timeframe of a project that is incorporated as a consequence of the proposed Action.

Below we discuss the best available science relevant to each stressor, then describe the Stressor-Exposure-Response 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 the covered species). Finally, we identify and consider how proposed conservation measures may reduce the severity of the stressor or the probability of an individual bat's exposure for each pathway.

7.1. Removal of Suitable Forested Habitat (Tree Removal)

The Service expects removal of suitable forested habitat (up to 4,000 acres annually) to occur in Indiana and northern long-eared bat habitat anywhere within the 74,582 square miles within the Action Area. Removal of suitable forested habitat will occur for a variety of activities including, but not limited to, linear projects such as transmission lines and roads and non-linear projects such as subdivisions, transmission towers, timber sales and bridge construction. The Service expects the activity to result in the following stressors: (1) noise/vibration, (2) loss of roosts, (3) forest loss and fragmentation, and (4) aquatic resource degradation. We evaluate the applicable science and Stressor-Exposure Response pathways for removal of suitable forested habitat below.

7.1.1. Stressor: Noise/Vibration (Tree Removal)

The people, chainsaws, and heavy equipment involved in removal of suitable forested habitat activities as described above generate noise and/or vibrations that could disturb Indiana and northern long-eared bats. During the active season, this disturbance could cause volant bats to temporarily flee or permanently abandon roosts during the day.

Applicable Science

Bats may be less likely to roost in areas of regular sound disturbances (Bennett and Zurcher, 2013; Garner and Gardner, 1992). Disturbance to bats in and around the Action Area may occur due to engine sounds, track noise, back-up warnings, or activities such as excavation, tree falling and blading during tree clearing. Noise disturbance could also occur due to chainsaws or other small equipment. Bats enter torpor during the active season (Besler and Broders 2019, Henshaw 1970) and have been shown to come partially out of torpor when stimulated by noise (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 (Luo et al., 2014). 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 falling.

Gardner et al. (1991) found that Indiana bats continue 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 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 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 (Service 2002).

Finch et al. 2020 demonstrated noise effects on bats up to 65.6 feet away from the source. Using an online noise attenuator calculator (https://www.omnicalculator.com/physics/distance-attenuation) and assuming normal conditions and terrain, traffic noise, that the study found to have a peak of 86 decibels (dB) at 10 feet, would attenuate over 66 feet to 69 dB. Using this study, we have evidence that noise around 69.5 dB has significant effects on feeding behavior and overall activity on *Pipistrellus* species of bats. Construction equipment noise usually ranges from 100-120 dB and the same equipment or equipment with similar noise production is used in tree clearing activities. Using the same online noise attenuation calculator, noise of 120 dB would attenuate down to 65 dB in approximately 560 feet.

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* and *Perimyotis* belong, 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: Indiana Bat and Northern Long-eared Bat

Activity: Noise and vibration associated with operation of equipment during tree removal.	
Stressor: –New chronic and intense ongoing anthropogenic noise above 65 dB and vibration in suitable forested habitat.	
Exposure (time)	March 15 – November 15 of each year.
Exposure (space)	Up to 4,000 acres of tree removal annually for the duration of this BO (10 years).
Resource affected	Individuals (juveniles, adults), males and females
Individual response	The stressor is expected to cause a variety of potential responses by affected individuals, especially if noise and vibration exceed normal, ambient levels for the Action Area where forested habitat removal is occurring. These include responses that are unlikely to result in significant effects to bats while roosting, such as arousing during daylight hours, shifting within the roost, and increasing vocalizations, as well as minor shifts in use of foraging and commuting habitats while active at night. The covered species are also likely to experience the following potentially significant effects if the stressor causes bats to flush from their roosts: • Extra energy expenditure that may reduce the fitness of individuals and result in reduced survival and/or reproductive success, especially for females and juveniles. • Increased chance of predation of individuals, especially if individuals flush during daylight hours when noise and vibration are most likely to occur during forest habitat removal operations.
Conservation Measures	To avoid and minimize impacts of tree removal projects will implement the following conservation measures: • Minimize the amount of suitable forested habitat removed by the project. • Minimize removal of suitable forested habitat during the pup season (May 15 – July 31).
Interpretation	The effects of increased noise and vibrations will be greatest during removal or alteration of the forested habitat when bats may be roosting in trees immediately adjacent to noise- and/or vibration-producing activities and are more likely to flush from their roosts or alter their behavior. Forested habitat removal activities that require heavy equipment and associated vehicles, personnel, and tools will be used at this time and are likely to produce noise and vibrations in the Action Area above ambient levels. The noise and vibrations associated with these activities may affect the covered species by causing individuals to alter their behaviors, which may be temporary or permanent. Significant changes in noise levels or significant increases in vibrations above ambient levels are more likely to result in altered behaviors, such as flushing from roosts and avoiding habitat areas in close proximity to the source of noise or vibrations. The novelty of the noise or vibrations and the relative level of those

Effects Pathway 1: Indiana Bat and Northern Long-eared Bat

Activity: Noise and vibration associated with operation of equipment during tree removal.	
Stressor: –New chronic and intense ongoing anthropogenic noise above 65 dB and vibration in suitable forested habitat.	
	disturbances will also likely dictate the range of responses from individuals or colonies of a covered species. Flushing from roosts is expected to cause: (a) extra energy expenditure that may reduce the fitness of individuals and result in reduced survival and/or reproductive success, especially for females and juveniles; (b) an increased chance of predation of individuals, especially if individuals flush during daylight hours when noise and vibration are most likely to occur during the construction of a project; and (c) increase in probability that adult females may abandon roosts and/or non-volant young if the event occurs during the pup season. These are adverse effects that are likely to result in harm to the covered species, including injury or mortality of individuals. Individuals roosting, foraging, and/or commuting in other portions of the project vicinity outside of the project's disturbance footprint will be exposed to this stressor at variable levels that would decrease with distance from the disturbance footprint. Specifically, noise and vibration levels within portions of the project vicinity outside the disturbance footprint are expected to be highest at locations closer to the point of origin and diminish with increasing distance from the point of origin, due to the diminished effects of noise and vibrations with distance from the source (i.e., the noise or vibrations will be absorbed and typically become less loud or noticeable). Therefore, individuals of a covered species within the project vicinity and outside of the disturbance footprint are more likely to be affected if they are closer to the noise and vibrations point of origin and if the noise or vibrations are significantly different than ambient levels (i.e., loud, repetitive, novel, etc.). Conversely, individuals of a covered species would be less likely to be affected by noise and vibrations the farther they are from the disturbance footprint and the noise and vibrations' point of origin. However, the likelihood that adverse effects will not occur cannot be discounted, because flushing from a roost may still occur and result in the same adverse effects noted in the previous paragraph. Noise and vibration disturbances from personnel and vehicles within the project vicinity during certain aspects of the forested habitat removal that do not involve heavy equipment (e.g., land surveying) are expected to be similar to ambient levels within the project area and covered species present are likely habituated to such noise and vibration. Based on these factors, effects to the covered species from noise and vibrations associated with removal or alteration of suitable

Effects Pathway 1: Indiana Bat and Northern Long-eared Bat	
Activity: Noise and vibration associated with operation of equipment during tree removal.	
Stressor: –New chronic and intense ongoing anthropogenic noise above 65 dB and vibration in suitable forested habitat.	
	forested habitat that do not involve heavy equipment are unlikely to occur or result in effects outside of the disturbance footprint and are considered discountable.
Effect	The effect of this stressor is Harm to affected covered species, which can include physical injury to individuals and/or mortality of individuals.

7.1.2. Stressor: Loss of Roosts

The Action would result in the removal and loss of up to 4,000 cumulative acres of forested habitat per year and no more than 250 acres of habitat per project. The majority of this removal of forested habitats would occur during implementation of projects that use the Strategy for ESA compliance. Trees removed during the March 15– November 15 timeframe may be occupied by the covered species when they are removed. Whereas trees removed during the November 16 – March 14 timeframe are unlikely to be occupied by the covered species.

7.1.2.1. Loss of Occupied Roosts

Applicable Science

Risk of injury or death from being crushed when a tree is felled is most likely to affect 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). Bats are 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 (May 15 to July 31) could potentially have nursing young bats that have not yet developed the ability to fly. Indiana bats often have larger maternity colonies in a single tree, it is not uncommon to find 50 or more mother and pup pairs in a single tree. Northern long-eared bat maternity colonies have been reported in groups of up to 42 individuals (Foster and Kurta 1999). 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 (Lane 1946). If a mother can leave the roost before or while it is being fell, 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 Indiana bat 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 Indiana bat maternity roost tree felled, a dead elm in Wayne County, Indiana. The original account stated that eight bats were "captured and identified as Indiana bats," and that about 50 bats flew from the tree. Although, the original account did not specify how the eight bats were captured, J. Whitaker (Indiana State

University, pers. comm., 2005, as cited in the draft revised Indiana bat 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 Indiana bats were retrieved (by people) when their roost was felled in Knox County, Indiana (J. Whitaker, pers. comm., 2005, as cited in the draft revised Indiana bat recovery plan).

Effects Pathway 2: Indiana Bat and Northern Long-eared Bat

Activity: Removal of suitable forested habitat (active season tree removal)

Stressor: Loss of occupied roost trees

Exposure (time)	March 15 – November 15 of each year.
Exposure (space)	Up to 4,000 acres of tree removal annually for the duration of this BO (10 years).
Resource affected	Adults and juveniles of both sexes.
Individual response	The stressor is expected to cause a variety of potential responses by affected individuals of the covered species. These include responses that are unlikely to result in significant effects to bats, such as arousing during daylight hours, shifting within the roost, increasing vocalizations, and minor shifts in use of foraging and commuting habitats while active at night. However, the covered species are also likely to experience the following potentially significant effects from the stressor: • Bats struck by equipment or crushed by a felled tree will be injured or killed. • Colony fragmentation could decrease thermoregulation and foraging efficiency that may reduce fitness and result in reduced survival/reproductive success. • Extra energy expenditure that may reduce the fitness of individuals and result in reduced survival and/or reproductive success, especially for females and juveniles. • Increased chance of predation of individuals, especially if individuals flush during daylight hours when roost tree removal and removal of summer habitat are most likely to occur.
Conservation Measures	To avoid and minimize impacts of tree removal projects will implement the following conservation measures: • Minimize the amount of suitable forested habitat removed by the project. • Minimize removal of suitable forested habitat during the pup season (May 15 – July 31).
Interpretation	Tree removal during the summer occupancy timeframe could result in death or injury to roosting individuals that are crushed by a felled tree, especially non-volant juveniles. Those bats that survive or flush from felled trees will be exposed to increased levels of predation and

Effects Pathway 2: Indiana Bat and Northern Long-eared Bat	
Activity: Removal of suitable forested habitat (active season tree removal)	
Stressor: Loss of occupied roost trees	
	expend extra energy to find another suitable roost. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes during the summer timeframe (e.g., migration, pregnancy, lactation) or other stressors (e.g., WNS), is likely to reduce fitness and subsequently reduce survival and reproductive success for individuals of the covered species. The implementation of conservation measures outlined in the Strategy will minimize but not eliminate adverse effects to non-volant pups and pregnant or lactating females.
Effect	The effect of this stressor is Harm to affected covered species, which can include physical injury to individuals and/or mortality of individuals.

7.1.2.2. Loss of Unoccupied Roosts

Applicable Science

The potential for adverse effects to Indiana bats from tree removal during the hibernation timeframe is rooted in the well-documented knowledge that Indiana bats exhibit strong fidelity to their summer roosting areas and foraging habitat (Kurta et al. 2002; Garner and Gardner 1992; Service 2007). Adverse effects to Indiana bats associated with the removal of forested habitats occur through several pathways that lead to a reduction in individual fitness as a result of increased energy expenditure. This evaluation is supported by numerous bat researchers, including Kurta and Rice (2002), who commented:

> "*The U.S. Fish and Wildlife Service often allows potential roost trees to be cut after Indiana bats leave for hibernation in order to make way for developments such as new bridges, highways, and housing projects. This policy understandably is intended to allow human developments to proceed while preventing direct "take" of Indiana bats. This practice, however, should be limited, because it destroys potential roost trees without establishing whether they actually are used by Indiana bats, which may leave the bats with no shelter when they return in spring in an energetically stressed condition. Upon returning, the bats have just completed 6-7 months of hibernation and an extensive migration, and they arrive already pregnant and at a time when air temperatures are low and food (flying insects) is scarce. Excessive precipitation and/or colder-than-average temperatures drastically reduce reproductive success of temperate bats (Grindal et al. 1992; Lewis 1993), and such negative effects likely would occur even during normal weather if Indiana bats do not have adequate shelter.*"

Northern long-eared bat colonies retain their colony identity and exhibit high site fidelity between years (Silvis et al. 2015). A colony's use of the same general roosting area from one year to the next may occur due to the return of at least some individuals from the prior year – either juveniles (e.g., Silvis et al. 2015, p. 11) or adults. Northern long-eared bat females have been shown to roost together for multiple summers in the same location, and individual females have been captured returning to the same small area for at least five consecutive summers (Foster and Kurta 1999, p. 665; Patriquin et al. 2010; Perry 2011).

To evaluate the effects of roost removal on the northern long-eared bat, Silvis et al. (2015, p. 5) removed a primary roost and five secondary roosts, respectively, from the roosting area of two colonies in a heavily forested area of Kentucky. No roosts were removed from the roosting area of a third colony. In the year after roost removal, individuals persisted in each area and did not appear to change their colony roosting areas (Silvis et al. 2015, p. 10). Despite the 'consistent patterns of space use between years' by the colonies, few individuals were recaptured in the second year. "Colony identity" remained intact, although turnover among the individuals that comprised each colony was high (Olivera-Hyde et al. 2019, p. 724). The return of juveniles from the first year may have been key in retention of the colonies' identities despite the high colony turnover (Silvis et al. 2015, p. 10-11). Females "exhibit fidelity to a general geographic area", but they may not settle into the same areas as in previous years (Olivera-Hyde et al. 2019, p. 724). Although the identity of each colony persisted, Silvis et al. (2015b, p. 12) detected signs of a "segmented roost network" in the colony from which five secondary roosts were removed. Those five roosts constituted 24% of the roosts identified during radio-tracking of colony members. This was consistent with a previous simulation in which removal of about 20% of roosts resulted in a 50% chance of colony fragmentation (Silvis et al. 2014b, p. 287).

Forested habitat loss or alteration during the hibernation timeframe (i.e., while the bats are not present) harms all covered species by requiring them to increase energy use to respond to the habitat loss or alteration when they return to summer habitats. This is likely to impair essential behavior patterns associated with sheltering (roosting), breeding, and/or feeding (foraging). This impairment, in turn, results in reduced survival and/or reproduction of the affected individuals. These effects are compounded because most of the returning bats are coming from hibernacula infected with WNS. Individuals surviving WNS have additional energetic demands. For example, when emerging from hibernation, WNS-affected bats have lower levels of fat reserves than non-WNS-affected bats (Reeder et al. 2012; Warnecke et al. 2012). Many may also have wing damage (Reichard and Kunz 2009; Meteyer et al. 2009) that makes migration and foraging more challenging. Females that survive migrating 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 3: Indiana Bat and Northern Long-eared Bat

Activity: Removal of suitable forested habitat (inactive season tree removal)	
Stressor: Loss of unoccupied roost trees	
Exposure (time)	November 16 – March 14
Exposure (space)	Up to 4,000 acres of tree removal annually for the duration of this BO (10 years).
Resource affected	Adults and juveniles of both sexes.
Individual response	The stressor is expected to cause a variety of potential responses by individuals from the loss of summer habitat in areas where removal or alteration of forested habitat previously occurred as part of a project.

Effects Pathway 3: Indiana Bat and Northern Long-eared Bat

Activity: Removal of suitable forested habitat (inactive season tree removal)

Stressor: Loss of unoccupied roost trees

	These include responses that are unlikely to result in significant effects to bats, such as minor shifts in use of foraging and commuting habitats while active at night. However, the covered species are also likely to experience the following potentially significant effects from the stressor upon return to their historical roosts: • Extra energy expenditure to find new suitable roosts may reduce the fitness of individuals and result in reduced survival and/or reproductive success, especially for females and juveniles. • Colony fragmentation could decrease thermoregulation and foraging efficiency that may reduce fitness and result in reduced survival/reproductive success. Colony fragmentation will increase the chance of predation for individuals.
Conservation Measures	To avoid and minimize impacts of tree removal projects will implement the following conservation measures: • Minimize the amount of suitable forested habitat removed by the project.
Interpretation	Adults from the covered species are expected to experience adverse effects after they arrive at summer habitat in the first year after tree removal occurs. The extra energy to find new roosting habitat is in addition to what is already necessary for foraging, pup rearing, social interactions, or other activities. The use of additional energy in response to habitat loss, especially when combined with the energy needs associated with normal life cycle processes during the summer timeframe (e.g., migration, pregnancy, lactation) or other stressors (e.g., WNS), is likely to result in adverse effects to adults and juveniles. However, the covered species are expected to adapt to this stressor in subsequent years after new suitable roosting habitat is found.
Effect	The effect of this stressor is Harm to affected individuals of a covered species, which can include physical injury and/or mortality of individuals.

7.1.3. Stressor: Forest Loss and Fragmentation

Activities proposed in the Strategy include removal of suitable forested habitat (tree removal) on up to 4,000 acres annually. In addition to removal of roosting habitat, tree removal often results in the loss and fragmentation of forested habitats and may result in degradation of the covered species foraging and commuting habitat.

Applicable Science

In a fragmented landscape, Indiana bats may have to fly across less suitable or unsuitable habitat, which could pose a greater risk from predators (e.g., raptors) (Mikula et al. 2016). As a result, Indiana bats consistently follow tree-lined paths rather than crossing large open areas (Gardner et al. 1991; Murray and Kurta 2004). Murray and Kurta (2004) found that Indiana bats increased their commuting distances by 55% to follow these paths rather than flying over large agricultural fields. However, if these corridors are not available, Indiana bats may be forced over open areas. For example, Kniowski and Gehrt (2014) observed Indiana bats flying across open expanses of cropland >1 km (0.6 mile) to reach remote, isolated woodlots or riparian corridors.

Indiana and northern long-eared bat maternity colonies in Illinois, Indiana, Michigan, and Kentucky have been shown to use the same roosting and foraging areas during subsequent years (Gardner et al. 1991; Humphrey et al. 1977; Kurta and Murray 2002; Kurta et al. 1996; Kurta et al. 2002). Bats using familiar roosting and foraging areas are thought to benefit from decreased susceptibility to predators, increased foraging efficiency, and the ability to switch roosts in case of emergencies or alterations surrounding the original roost (Gumbert et al. 2002). Conversely, bats that must use new or inferior habitats after a loss or alteration of their normal forested habitat would not have these same benefits. In addition, movement distances, foraging areas, and roosting areas used by female northern long-eared bats may be smaller in fragmented forest landscapes than in landscapes with larger amounts of suitable forest cover (Henderson and Broders 2008, p. 959). In these areas, the extent of available forest patches may constrict northern long-eared bat foraging areas and could even increase use of alternative roosts (e.g., buildings, Henderson and Broders 2008 p. 959-960).

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). In their southern Illinois study, Carter et al. (2002) found Indiana bat roosts in a highly fragmented landscape, although both the number of patches and mean patch size were higher in the area surrounding roosts than around randomly selected points. Kniowski and Gehrt (2014) suggest, to obtain similar resources, longer or more frequent commuting flights will be required by Indiana bats in highly fragmented landscapes with smaller, more distant suitable habitat patches when compared to landscapes with larger, more abundant habitat patches.

Effects Pathway 4: Indiana Bat and Northern Long-eared Bat

Activity: Removal or alteration of suitable forested habitat	
Stressor: Forest loss and fragmentation	
Exposure (time)	Tree removal will be a one-time occurrence but may occur any time of year. The covered species may be exposed to this stressor while present between March 15 and November 15 or during the first summer bats return if tree removal occurs in the unoccupied time.
Exposure (space)	Up to 4,000 acres of tree removal annually for the duration of this BO (10 years).

Effects Pathway 4: Indiana Bat and Northern Long-eared Bat

Activity: Removal or alteration of suitable forested habitat	
Stressor: Forest loss and fragmentation	
Resource affected	The stressor is expected to affect summer habitat (i.e., foraging and commuting habitat) and individual bats, including adults and juveniles of both sexes.
Individual response	The stressor is expected to cause a variety of potential responses by affected individuals from the loss and fragmentation of summer habitat in the Action Area where loss and fragmentation of forested habitats has occurred as the result of a project. These include responses that are unlikely to result in significant effects to bats, such as minor shifts in use of foraging and commuting habitats while active at night. However, the covered species are also likely to experience the following potentially significant effects depending on the timing, location, and size of forest loss and fragmentation: • Extra energy expenditure that may reduce the fitness of individuals and result in reduced survival and/or reproductive success, especially for females and juveniles.
Conservation Measures	To avoid and minimize impacts of tree removal, projects will implement the following conservation measures: • Minimize the amount of suitable forested habitat removed by the project.
Interpretation	Tree removal will create gaps within larger forested blocks and along linear forested corridors or expand gaps along the edges of larger forest blocks. Projects that remove small amounts of forested habitat within an already diverse landscape of forest blocks, tree lines, and open areas are anticipated to have an insignificant effect on the covered species. These types of gaps are not expected to make access to other forested habitat more difficult, require additional energy expenditure, or limit access to habitat because the covered species currently foraging and commuting in these types of areas are presumably unaffected by these gaps. Additionally, the gap may provide new or additional forest edge habitat that the covered species could use for foraging and commuting habitat. However, projects that remove large areas of forested habitat and/or fragment other areas of habitat to the extent it significantly alters a bats' behavior (i.e., foraging and commuting) are likely to adversely affect the covered species. These adverse effects may cause extra energy expenditure, reducing the fitness of individuals, especially for females and juveniles.
Effect	The effect of this stressor is Harm to affected individuals of a covered species, which can include physical injury and/or mortality of individuals.

7.1.4. Stressor: Aquatic Resource Degradation

Aquatic resource degradation may occur indirectly as a result of tree removal associated with a project. In addition, the placement of culverts in streams and drainage ditches during construction of access roads and construction entrances could disturb sediment and negatively affect water quality. Trenching at stream crossings will also result in sediment disturbance in the streams, and soil that is exposed during excavation and vegetation removal could enter streams through stormwater runoff. Spills and leaks of petroleum-based products and other contaminants from vehicles and heavy equipment could also enter streams and degrade water quality. Activities that reduce the quantity or alter the quality of aquatic resources could affect a covered species, even if conducted while individuals are not present. However, project proponents are required to use BMPs in accordance with applicable state permits, program requirements, and regulations to minimize the potential for aquatic resource degradation. Implementation of these practices is anticipated to avoid some potential water quality impacts and minimize others.

Applicable Science

Drinking water is essential, especially when bats are actively foraging. The covered species will utilize a variety of water sources including streams, ponds, and water-filled road ruts in upland forest. Numerous foraging habitat studies have found that Indiana bats often forage in closed to semi-open forested habitats and forest edges located in floodplains, riparian areas, lowlands, and uplands; old fields and agricultural fields are also used (Service 2007). Northern long-eared bats typically forage under the canopy on forested hillsides and ridges rather than along riparian areas (LaVal et al. 1977, p. 594; Brack and Whitaker 2001, p. 207). However, forest-covered streams may also be used by the northern long-eared bats during foraging and travel (Service 2015, p. 17992).

The covered species collectively feed on a variety of aquatic and terrestrial insects. Indiana bat diets vary seasonally and among different ages, sexes, and reproductive status (Service 1999). Four orders of insects contribute most to the diet of the species: Coleoptera, Diptera, Lepidoptera, and Trichoptera (Belwood 1979; Lee 1993; Kiser and Elliot 1996; Murray and Kurta 2002). Various reports differ considerably in which of these orders is most important. Consistent use of moths, flies, beetles, and caddisflies throughout the year at various colonies suggests that Indiana bats are selective predators to a certain degree, but incorporation of other insects into the diet also indicate these bats can be opportunistic (Murray and Kurta 2002). Brack and LaVal (1985) and Murray and Kurta (2002) suggested that the Indiana bat may best be described as a “selective opportunist.” The northern long-eared bat has a diverse diet that includes aquatic insects such as caddisflies (Griffith and Gates 1985, p. 452; Nagorsen and Brigham 1993, p. 88; Brack and Whitaker 2001, p. 207).

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

Effects Pathway 5: Indiana Bat and Northern Long-eared Bat

Activity: Removal or alteration of suitable forested habitat	
Stressor: Aquatic resource degradation (sediment)	
Exposure (time)	March 15 – November 15, annually
Exposure (space)	Up to 4,000 acres of tree removal annually for the duration of this BO (10 years).
Resource affected	The stressor is expected to affect foraging habitat, prey abundance (aquatic insects), and individual bats, including adults and/or juveniles of both sexes.
Individual response	The stressor is expected to cause a variety of potential responses by affected covered species, especially if water quality is degraded in a project area where tree removal is occurring. These include responses that are unlikely to result in significant effects to bats, such as minor shifts in use of drinking water sources and foraging habitat while active at night. The Service has no data that would suggest that these minor behavioral shifts would require extra energy expenditures or reduce foraging efficiency that would reduce fitness and/or result in reduced survival and/or reproductive success of individuals.
Conservation Measures	The conservation measure that would most directly apply and minimize effects related to this stressor is: • Use BMPs for sediment and erosion control in accordance with state permits, program requirements, and regulations during tree removal and construction.
Interpretation	The Service has no information that would clearly indicate that potential aquatic resource degradation during tree removal is likely to result in significant adverse effects on the covered species. The effects of sedimentation on aquatic resources are expected to be minimal due to the temporary nature of activities and implementation of the conservation measures. Drinking water sources and aquatic insect prey are not expected to be eliminated, and the covered species have shown they can use a variety of drinking water and prey sources and do not forage exclusively on aquatic insect prey.
Effect	This stressor is expected to have an insignificant effect on the covered species. No physical injury to individuals and/or mortality of individuals is expected to result from this stressor.

7.2. Summary of Effects

The Action may occur within suitable staging/swarming habitat and/or suitable summer maternity roosting, foraging, and commuting habitat for the covered species. Impacts to the covered species will occur due to the removal or alteration of suitable forested habitat. Impacts to habitat could occur at any time of year, including May 15 to July 31 when non-volant pups may be present, although this has been restricted under the Action to only 100 acres per project. The stressors and adverse effects associated with each activity are summarized in Table 7.1.

Table 7.1. Summary of effects of the Action on the Covered Species

Stressor: Activity	Adverse Effect	Insignificant/Discountable
Noise and vibration: removal or alteration of suitable forested habitat	Harm	
Loss of occupied roosts: removal or alteration of suitable forested habitat	Harm	
Loss of unoccupied roosts: removal or alteration of suitable forested habitat	Harm	
Forest loss and fragmentation: removal or alteration of suitable forested habitat	Harm	
Aquatic resource degradation: removal or alteration of suitable forested habitat		Insignificant

7.3. Cumulative Effects

For purposes of consultation under ESA §7, cumulative effects are the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under §7 of the ESA.

Land use activities that may affect the covered species and that are likely to occur within the Action Area include: timber harvest, recreational use of caves, and development associated with road, residential, industrial, and agricultural development, and other related activities that are not a direct consequence of the Action. These private actions are likely to occur within the Action Area, but the Service is unaware of any quantifiable information about the extent of private timber harvests within the Action Area, the amount of use of off-highway vehicles within the Action Area, or the amount of recreational use of caves within the Action Area. Similarly, the Service does not have any information on the amount or types of residential, industrial, or agricultural development that will occur within the Action Area that may require removal of forested habitat without a mandate to consult with the Service. Therefore, the Service is unable to make any determinations or conduct any meaningful analysis of how these actions may or may not adversely and/or beneficially affect the covered species. It is possible that these activities will have cumulative effects on the covered species and their habitat in certain situations (e.g., a private timber harvest during summer months within an unknown maternity colony may cause adverse effects to that maternity colony). We can only speculate as to the extent or severity of those effects, but these actions have been occurring for decades and are considered part of the environmental baseline for the status of species.

7.4. Conclusion

In this section, we summarize and interpret the findings of the previous sections for the covered species (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to jeopardize the continued existence of the species. We have considered the status of each species across its range, the status of each species within the Action Area, and the effects of the Action to each of the covered bat species. In our effects analysis, we identified how the covered species would be adversely affected by the Action. We anticipate that individuals from each of the covered species who utilize summer and staging/swarming habitat within the Action Area are likely to be adversely affected by the removal of forested habitat and will experience harm as a result of the Action. However, we do not anticipate that all individuals from the covered species that are adversely affected will experience harm based on the following reasons:

- Injury and/or mortality of adult and juvenile bats will be reduced if some or all of the habitat removal occurs during the hibernation timeframe (November 16 – March 14) when all of the covered bat species are not present in the Action Area.
- Injury and/or mortality of non-volant pups will be reduced if some or all of the habitat removal occurs outside the pup season (May 15 – July 31).
- The minimal amount of summer habitat removed each year from the Action Area versus the total availability of habitat within the Action Area.
- The removal of habitat throughout the Action Area will be random and spread across the variety of habitat types (e.g., known summer, known staging/swarming, suitable summer), and additional habitat will periodically become available independent of the Action.
- Limiting the size of each area where habitat can be removed by a single project will limit the scale of impacts and reduce the potential for loss of large, forested blocks or significant fragmentation of remaining forested habitat.

After reviewing the status of each covered species, the environmental baseline for the Action Area, the effects of the Action, and the inclusion of any cumulative effects in the environmental baseline, it is the Service’s biological opinion that the Action is not likely to jeopardize the continued existence of the Indiana bat or the northern long-eared bat. We reached this determination using the best available commercial and scientific information as described in the effects analysis of this BO while considering how those effects relate to the survival and recovery potential (i.e., resiliency, redundancy, and representation) of the Indiana bat and northern long-eared bat, as described below:

Resiliency
Resiliency describes the ability of a species to withstand stochastic disturbance (arising from random factors). Resiliency is positively related to population size, growth rate, and fecundity and may be influenced by connectivity among populations. Generally, populations need enough individuals within habitats of adequate area and quality to maintain survival and reproduction in spite of disturbance. Resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of anthropogenic activities.

Indiana Bat

The recovery goals for the species include obtaining a minimum overall population estimate of 457,000 and demonstrating a positive population growth rate. The total population of Indiana bats in Arkansas is believed to be 7,350 bats. The total Arkansas population represent only 1.2% of the 2024 range-wide estimate of Indiana bats (631,786) and less than 1% of potential Indiana bat habitat in Arkansas is expected to be impacted by the Action. Therefore, the Action is expected to adversely affect only a small proportion of Indiana bats in Arkansas and an even smaller proportion of the range-wide species' population. For these reasons, the Action will not reduce the resiliency of the Indiana bat.

Northern Long-eared Bat

The range of the northern long-eared bat includes 37 states and the District of Columbia in the eastern and north-central United States and portions of eight Canadian provinces. An estimate of the number of northern long-eared bats in Arkansas is not available, but we anticipate approximately 0.2% of northern long-eared bat habitat in Arkansas to be adversely affected by the Action and only part of that habitat to be occupied by northern long-eared bats. Therefore, the Action would only adversely affect a small proportion of the Arkansas population and a much smaller percent of the range-wide species' population. In addition, the habitat losses associated with the Action are not expected to cause significant or meaningful reductions in habitat connectivity or habitat quality that would lead to negative population-level effects. For these reasons, the Action will not reduce the resiliency of the northern long-eared bat.

Redundancy
Redundancy describes the ability of a species to withstand catastrophic events (a rare destructive natural event or episode involving many populations). It "guards against irreplaceable loss of representation" (Redford et al. 2011, p. 42) and minimizes the effect of localized extirpation on the range-wide persistence of a species. Redundancy is best achieved by having multiple, resilient (connected) populations widely distributed across the species' range. Having multiple populations reduces the likelihood that all populations are affected simultaneously, while having widely distributed populations reduces the likelihood of populations possessing similar vulnerabilities to a catastrophic event. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Therefore, as redundancy increases, species viability also increases.

Indiana Bat and Northern Long-eared Bat

If habitat removal occurs from May 15 to July 31, non-volant pups from the covered species may be impacted, and mortality would be higher than at other times of the year. However, implementation of the Strategy limits clearing of habitat during this time of year to only 100 acres per project, thus minimizing the number of maternity colonies affected by the proposed Action. Additionally, impacts are expected to be widely distributed across the Action Area and are unlikely to cause a reduction in any of the covered species' redundancy, as the likelihood of a catastrophic event (or large effect) would be reduced. This represents a very small proportion of the range-wide population for each of the covered species, and thus, the widely distributed impacts are unlikely to cause a reduction in redundancy of the Indiana bat or northern long-eared bat as the likelihood of a catastrophic event (or large effect) would be reduced.

Representation

Representation describes the ability of a species to adapt to changing environmental conditions over time and is characterized by the breadth of genetic and environmental diversity within and among populations. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of habitat characteristics across the geographical range and other factors as appropriate.

Indiana Bat and Northern Long-eared Bat

The 40,000 acres of suitable habitat that will be removed for the Action represents only 0.2% of the total habitat available in the Action Area. Additionally, no reduction in the distribution of Indiana bats or northern long-eared bats is expected because the Action Area will continue to support suitable habitat, and both species are expected to continue to occupy the Action Area. For these reasons, we do not expect the representation of the Indiana bat or northern long-eared bat to be reduced by the Action.

Further, implementation of the Strategy is expected to promote the survival and recovery of the covered species through protection and management of:

1) existing forested habitat that supports known maternity populations, particularly those that would expand existing conservation ownerships;
2) known priority hibernacula;
3) additional conservation lands that contain potential habitat for the species, particularly those that would expand existing conservation ownerships; and
4) additional conservation benefits from the avoidance and minimization that the Strategy inherently encourages (e.g., protection of known habitats, protection of non-volant pups, protection of staging/swarming bats).

Based on this analysis of resiliency, redundancy, and representation, we conclude that the effects of the Action will not appreciably reduce the likelihood of both the survival and recovery of the Indiana bat or northern long-eared bat.

8. 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:

- "harass" is defined as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding feeding or sheltering." (50 C.F.R. § 17.3);

- "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 Service must undertake the non-discretionary measures described in this ITS and the conservation measures detailed in this BO, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. The Service has a continuing duty to monitor the activity covered by this ITS. The protective coverage of §7(o)(2) may lapse if the Service fails to (a) assume and implement the terms and conditions; or (b) 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. To monitor the impact of incidental take, the project proponent must report the progress of the specific action and its impact on the covered species to the Service as specified in the respective sections of this ITS.

8.1. 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.

The Service anticipates that the Action is reasonably certain to cause incidental take of individual Indiana and northern long-eared bats consistent with the definition of harm resulting from removal of suitable forested habitat (tree removal; see Section 7, Effects of the Action). The

Service expects incidental take of individual Indiana and northern long-eared bats will be difficult to quantify for the following reasons:

- The individuals are small, mostly nocturnal, and when not hibernating, occupy forested habitats where they are difficult to find, capture, or observe;
- The Indiana bat forms maternity colonies under loose bark or in the cavities of trees, and males and non-reproductive females may roost individually, which makes finding roost trees difficult;
- Finding dead or injured specimens during or following project implementation is unlikely; and
- Some incidental take is in the form of non-lethal harm and not directly observable.

Although we cannot estimate the number of individual Indiana or northern long-eared bats that will be incidentally taken, the Service is providing a mechanism to quantify take levels and define when take would be exceeded. For purposes of this BO, the Service defines incidental take in terms of the extent of suitable Indiana and/or northern long-eared bat habitat, in acres, that is expected to be affected by the proposed action. The Service used estimates provided in the Strategy and supporting documents, as explained in this BO, information exchange between Service staff and a review of publicly available information and scientific literature to determine the extent of habitat expected to be taken. Based on these calculations, the Service anticipates that incidental take of Indiana and northern long-eared bats may occur, in the form of harm from up to 4,000 acres of tree removal on lands in the Action Area, annually. Therefore, the amount of annual incidental take authorized for Indiana and northern long-eared bats by this BO includes all individuals occurring within up to 4,000 acres of tree removal annually in suitable habitat in the Action Area. Over the ten-year period of this BO, the amount of incidental take for Indiana and northern long-eared bat authorized by this BO includes all individuals within up to 40,000 acres of tree removal in the Action Area. The Service acknowledges that this is likely an overestimate due to the fact that some amount of the proposed activities is likely to occur in unoccupied habitat.

8.1.1 Surrogate Measures for Monitoring

For the Indiana and northern long-eared bat, 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:

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

We have identified surrogate measures in our analyses of effects (Section 7) and Incidental take Statement (Section 8) that satisfy these criteria for monitoring take of the species named above during Action implementation. Table 8.1 lists the species, life stage, surrogate measure, and the section of the BO that explains the causal link between the surrogate and the anticipated taking. We describe procedures for this monitoring in Section 8.4.

Table 8.1. Estimates of the annual amount of take caused by the Action, by species, life stage, and form of take, collated from the effects analyses.

Common Name	Life Stage	Surrogate Units	Form of Take	Effects Analysis Section
Indiana bat	Juvenile, adult	4,000 acres of tree removal annually	Harm	7.1.1, 7.1.2, 7.1.3
Northern long-eared bat	Juvenile, adult	4,000 acres of tree removal annually	Harm	7.1.1, 7.1.2, 7.1.3

8.2. Reasonable and Prudent Measures

The Action includes conservation measures, discussed previously, to minimize impacts to the covered species. Based on appropriate implementation of these measures, the Service believes that no additional "reasonable and prudent measures" will be necessary to minimize incidental take of the covered species caused by the Action.

8.3. 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.

8.4. Monitoring and Reporting Requirements

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. Below we identify the M&R responsibilities of the AFO.

1.) The AFO shall keep records of the levels of incidental take exempted under this BO that are applied to projects that have agreed to voluntarily implement the Strategy. These records shall track the acres and the seasonality of habitat affected under each project and specify whether the affected habitat is known summer or staging/swarming habitat or potential summer or staging/swarming habitat.

2.) The AFO shall periodically audit projects implemented by cooperators to verify compliance with the Strategy. The selection of projects for these audits is at the AFO's discretion.

3.) The AFO, its cooperators, and any of their contractors must take care when handling dead or injured species covered by this BO or any other federally listed species that are found at project sites in order to preserve biological material in the best possible state and to protect the handler from exposure to diseases, such as rabies. Project cooperators are responsible for ensuring that evidence for determining the cause of death or injury is not unnecessarily disturbed. Reporting the discovery of dead or injured listed species is required in all cases to enable the Service to determine whether the level of incidental take exempted by this BO is exceeded and to ensure that the terms and conditions are appropriate and effective. Parties finding a dead, injured, or sick specimen of any endangered or threatened species, must promptly notify the Service's Division of Law Enforcement at 1875 Century Blvd., Suite 380, Atlanta, Georgia 30345 (Telephone: 404/679-7057) and the KFO at 330 West Broadway, Room 265, Frankfort, Kentucky 40601 (Telephone: 502/695-0468). The AFO is then responsible for notifying the RO Ecological Services program office at 1875 Century Boulevard, Suite 200, Atlanta, Georgia 30345 (Telephone 404/679-7085).

9. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the Act by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to minimize or avoid the adverse effects of a proposed action, implement recovery plans, or develop information useful for the conservation of listed species. The Service offers the following conservation recommendations:

1. The AFO should keep records of the amount of habitat purchased, managed, and protected and the amount of funding contributed to the Fund. The AFO should use these records, and other information about conservation benefits to bats resulting from the Strategy, to inform an analysis of its overall effect in determining whether to renew and modify the program as the duration of the current program draws to a close.

2. The AFO should continue to work with partners to survey for and track Indiana and northern long-eared to identify additional maternity colony locations.

3. The AFO should create and maintain a geographic data base and query tool that allows cooperators to identify when proposed projects are located within known habitats for the covered species. The AFO will also maintain current pdf maps of the covered species known habitats for any cooperators who may not have access the geographic database.

10. REINITIATION NOTICE

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the Service 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.

For this BO, the exempted incidental take would be exceeded when the take surpasses 4,000 acres of Indiana bat habitat removal or 4,000 acres of northern long-eared bat habitat removal in any year. The total amount of incidental take, as measured by the habitat surrogate, covered for this period is 40,000 acres for each species. These are the amounts of habitat removal that are exempted from the prohibitions of section 9 of the Act by this BO.

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

11. LITERATURE CITED

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