Section 7 Technical Assistance

Summary of Indiana Bat Ecology

Background

This document provides a brief summary of the life history and ecology of Indiana bat. The purpose for the document is to provide basic biological information about Indiana bat to assist project proponents with their section 7 reviews.

Indiana Bat Life History

The Indiana bat is a long-lived species with low fecundity, and as such, the fundamental limiting factors to population viability are number of years over which individual bats are able to produce offspring and the survival of young (called pups) to reproductive age. The species' life history strategy is to produce one young each year with high survival rates for both young and adults.

The Indiana bat annual cycle includes 4 major phases: winter hibernation, spring migration, young rearing, and fall migration and swarming. Hibernation begins in mid to late October and extends to the following April. The non-hibernating period, called the active season, extends from mid-April through October. By late April, most bats have migrated to their summer areas. Although varying with latitude, the active period is generally mid-May through July. By early mid-September, most bats begin their migration back to their hibernacula and are hibernating by early November.

Indiana Bat Winter Habitat

Hibernacula are typically caves and mines that provide suitable microclimates for hibernation. Indiana bats form large, single-layer clusters on cave ceilings in densities ranging from 300-499 bats per square foot. Although hibernation is a survival strategy when food is scarce, bats must store sufficient fat to support metabolic processes until spring. Substantial risks are posed by events (e.g., human disturbance) during the winter that interrupt hibernation and increase metabolic rates.

Indiana Bat Summer Habitat - General

During the active season, male Indiana bats roost individually or in small groups and either remain near their winter hibernacula or disperse throughout the range. In contrast, reproductive females form larger groups referred to as maternity colonies, which are often far removed from hibernacula areas.

Maternity colonies usually contain 100 or fewer adult female bats although colonies larger than 300 have been reported. Female Indiana bats primarily roost together to maintain optimal body temperatures of their pups. Females give birth to a single pup between mid June and early July. Pups are altricial at birth and completely depend on their mothers for the first month. Within 25 to 37 days, young bats begin flying and feeding on their own.

Roosting Habitat

Indiana bat maternity areas generally consist of one or more primary maternity roost trees which are used repeatedly by large numbers of bats, and varying numbers of alternate roosts, which may be used

less frequently and by smaller numbers of bats. Primary roost trees are typically large (>9 in dbh) with loose, exfoliating bark and a high-degree of solar exposure. Male bats are much less constrained and may use smaller trees (as small as 2.5 in). Roost trees for both males and females are most often snags (i.e., dead trees) with variable amounts of exfoliating bark, which allow bats to roost between the bark and bole of the tree. However, live trees with peeling bark (especially shagbark hickory *(Carya ovata)*) are also used, as well as, some trees with cavities and crevices. Snags of a wide variety of tree species are used for roosting, including maple (*Acer* spp.), hickory (*Carya* spp.*)*, ash (*Fraxinus* spp.), oak (*Quercus* spp.), elm (*Ulmus* spp.), pine (*Pinus* spp.), hemlock (*Tsuga candensis*), among others.

For reasons discussed below, temperature is an ultimate factor in the fitness of both adults and young, and hence, the roost microclimate is influential in determining the quality of a roost site. Primary maternity roost sites are selected to optimize roost temperatures, consequently, are typically large-diameter dead trees in wooded areas. Alternate roost trees can be smaller and typically their use increases in response to unusually warm or cool temperatures and during periods of precipitation, and hence, may be dead or living trees in open or closed canopy conditions. Suitable habitat must have both suitable primary and alternate roost sites available.

Maintaining optimal body temperatures are critical for prenatal and juvenile growth.

Delays in pre- and postnatal development can affect juvenile and adult female survival. Slowed growth rates during pregnancy and lactation may mean later birth and weaning dates, which limits the time available for maternal recovery and fat accumulation post-weaning. Later weaning dates also leave less time for young to perfect their flying and foraging skills, which in turn, affects their ability to maintain their body condition, store fat, and obtain adequate strength to successfully migrate in the fall. Delays in migration departure could also subject bats (both young and adults) to unfavorable weather conditions along the way.

The strategy for female bats, therefore, is to choose optimal roost sites and to cluster together. Activities that remove potential roosting trees, in particular primary roosting trees, can lower the suitability of an area for roosting. To assist with finding optimal roost sites and colony mates, female bats return to the same summer roosting and foraging areas from year to year. Because Indiana bat roost sites are ephemeral in nature, a continuous supply of currently suitable and future roost trees are needed within a colony's traditional summer area for the colony to persist in the area over time. Loss or significant degradation of their traditional summer habitat forces bats to locate new suitable roosting sites and regain colony cohesion. Inadequate shelter or lack of colony formation can exacerbate thermoregulatory challenges, and if severe enough, lead to reproductive failure, and reduced juvenile and adult survivorship. Loss of roosting trees for males is not likely as consequential as they may roost in smaller trees and do not have the high degree of thermal constraints as maternity colonies.

Indiana bats are active at night. During the day, mothers and their young roost together. As discussed above, these roosting sites are essential for successful recruitment. Studies and anecdotal information suggest that roosting bats are tolerant to transient, low intensity disturbances (e.g., humans walking near roost trees, nearby machinery) and ongoing disturbances (e.g., existing highways, airport traffic, etc.). However, novel, persistent disturbance may lead to bats abandoning their roosts and using lower quality roost trees.

Indiana Bat Foraging Habitat

Indiana bats eat terrestrial and aquatic insects while foraging in forested stream corridors, upland and bottomland forests, forested wetlands, and along wooded edges of agricultural fields, pastures, and impounded bodies of water at night. Pesticides within or near suitable habitat could harm Indiana bats directly (via dermal contact or ingestion) or indirectly by reducing prey availability of foraging bats. Activities that degrade water quality may also lead to direct or indirect harm.

Both the adults and young spend the latter part of the summer foraging to accumulate fat reserves for the fall migration and hibernation. As young are less skilled at foraging, navigating, and escaping predators, survival rates may be much lower at this age than either the pre-weaning and adult stages. Proximity of their foraging area to their day roost when first learning to forage is important for growth and survival of newly volant (flying) bats. Adult or older juvenile Indiana bats may fly many miles to forage, but studies to date indicate that individuals typically forage within 2.5 miles of their diurnal roost sites. Indiana bats tend to avoid vast open spaces, so wooded corridors linking roosting sites with foraging areas are important in areas where forests are fragmented. The intervening habitat between roosting and foraging areas is not always characteristic of suitable roosting or foraging habitat. Although Indiana bats are reluctant to cross open areas, studies show bats using tree-lined fencerows as corridors.

In early to mid-autumn (for some males, departure may be as early as July), Indiana bats migrate back to traditional winter hibernacula. This is the time (called swarming) when most mating occurs. During swarming, bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day (i.e., they continue to use trees near the caves as their day roosts). In addition to mating, bats forage in adjacent forested areas to build up their fat reserves for hibernation. Hence, maintaining sufficient foraging habitat around occupied hibernacula is critical for Indiana bat survival. Radio-telemetry studies document foraging up to 10 miles from a hibernaculum. By late September, many females have entered hibernation, but males may continue feeding and swarming well into October.

Indiana Bat Homerange

The extent of area required to support individual roosting bats or a maternity colony is unknown and likely varies with quality of the habitat and proximity of the essential resources (i.e., roost trees, foraging areas, and water sources) to each other. Based on the life history of the species and studies to date (e.g., reporting average foraging distances and occupied forest patch sizes), we believe it is unlikely that an isolated forest stand of 10 acres or less would provide sufficient resources for an Indiana bat.

Loss or degradation of habitat during the inactive season (hibernation period: November 15 through March 31) could, as explained above, cause reproductive failure if a primary roost tree is removed or a sufficient amount suitable habitat will no longer be available. Although dependent on site specifics (e.g., availability of nearby habitat, quality of remaining habitat, etc.), we believe that a loss of no more than 10 acres or less than 10% of the available habitat in any given forest stand during the **inactive season** is unlikely to lead to detectable adverse effects. Our rationale for this conclusion is as follows. As the stringent roosting requirements are germane to reproductive females and their pups, degradation or loss of a portion of a traditional summer habitat area during the inactive season is not likely to elicit a

negative consequence for male or non-reproductive female Indiana bats. Loss of habitat during the inactive season may be problematic for Indiana bats under the following scenarios:

(1) if such loss eliminates all or a substantial number primary roost trees,

(2) reduces the quality of a roosting or foraging area, or

(3) eliminates an travel corridor that links roosting and foraging areas of a colony.

Provided that sufficient roosting, foraging, and travel habitat is maintained within a colony's traditional homerange, it is unlikely that detectable adverse effects will occur as a result of removal or loss of habitat during the inactive season. As Indiana bat maternity areas contain multiple primary roost trees, it is extremely unlikely that loss of 10 acres or 10% of a forested stand (whichever is smaller) would eliminate all primary roost trees within a traditional homerange of an Indiana bat maternity colony. Similarly, loss of this magnitude is not likely to noticeably degrade the quality of a roosting or foraging area or render a travel corridor unsuitable. For these reasons, we believe it is extremely unlikely that loss of 10 acres or 10% (whichever is smaller) of a forest stand would lead to detectable adverse effects.

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