

Fire and Bats in the Southeast and Mid-Atlantic: More Questions Than Answers?

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Abstract.—The role and impact of fire in Southeastern ecosystems has changed dramatically from pre-European and early settlement times through present day. Regionally, pre-settlement fires were caused either by Native Americans throughout the year or by lighting-caused wildfires during the growing season. Today, much of the prescribed burning for forest and game management purposes occurs during the dormant or winter season in the South, whereas many ecological restoration or maintenance fires are conducted in the late dormant season through the growing season depending on the region and habitat type. Many bat species in the Southeast presumably have evolved in fire-dominated ecosystems with roosting strategies that limit their vulnerability to fire. Moreover, fire in any season that causes overstory tree mortality and creates snags suitable as bat roosts probably provide far more benefit to bats than do the negative impacts from burning. Dormant season burning may render tree/foliage-roosting bats vulnerable to fire in areas of the deep and mid-South where winter temperatures force prolonged periods of inactivity and roosts may be limited in highly fragmented or intensively managed forests. All bats that tree roost can be impacted by growing season burning if non-volant young are present. In the winter, cave-dwelling myotids seem the least vulnerable to negative impacts from wildfire and prescribed burning, although implications from the dramatic increase in late dormant-early growing season prescribed burning in the Appalachians and Interior Highlands to bats are unknown.

Introduction

Little or no research has been conducted on wildfire and prescribed burning impacts to bats and bat populations. Consequently, wildlife managers only can approximate fire effects on these taxa by examining fire impacts to habitat components important to bats. Although fire effects on wildlife and the ecological role of fire in certain Southeastern plant communities such as longleaf pine (*Pinus palustris*) forests are fairly well known (Landers et al. 1989; Landers et al. 1995; Brennan et al. 1998), only recently have wildlife managers started to understand even the most basic aspects of bat ecology and habitat use in the Southeast. For most bats, this

understanding is minimal at best (Wilkins 1987; Watkins 1972; Shump and Shump 1982a; Shump and Shump 1982b; Kunz and Martin R. A. 1982; Kunz 1982; Thomson 1982; Webster et al. 1980; Jones 1977; Fenton 1997; Jones and Manning 1989). Bats are the second most diverse group of mammals in the Southeast and Mid-Atlantic with 18 species occurring north of "tropical" midsection of Florida (Whitaker and Hamilton 1998). To further complicate any assessment of the fire impact on bats, life histories for these 18 different species differ dramatically and each species potentially could be affected in profoundly different ways.

Prescribed burning benefits to bats in the Southeast and Mid-Atlantic are attributed to forest habitat modifications that alter or increase amounts and quality of roosting habitat, modify or improve foraging habitat and increase arthropod prey abundance. Within heavily wooded areas, fires that cause overstory mortality and create canopy gaps may allow bat species such as eastern red bats (*Lasiurus borealis*), big brown bats (*Eptesicus fuscus*), or other edge-open ecotone specialist bats to forage more effectively (Edwards et al. 2000). Also, depending on fire intensity, tree species susceptibility, and tree canopy position, potential roost snags or roosting cavities for big brown bats, northern long-eared bats (*Myotis septentrionalis*), Indiana bats (*Myotis sodalis*) and evening bats (*Nycticeius humeralis*) can be created. However, newly created snags may not be immediately usable by bats. Burning is not an immediate panacea to a paucity of bat roosting substrate because cavity roosts or exfoliating bark roosts can take considerable time to appear and may not be available for one or more seasons depending on forest community composition and regional climate.

Burn Season

Most plausible impacts of growing season burns for bats are poorly documented. Because there are more species of bats using the forest and because parturition occurs for most eastern bats at this time, total mortality could be greater than for dormant season burns. Snags serving as bat roosts could be consumed by burning and during intense fires, roosting bats could be killed. Even without direct mortality, large-scale habitat alteration or habitat destruction could be detrimental to resident bats during a time when females presumably are stressed by the physiological demands of parturition and lactation. The life histories of many bat species have several attributes that could be considered adaptive to growing season fires. During summer months, bats are able to arouse quickly as the difference between the ambient

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temperature and active body temperature of bats is less. Most bats are quick and highly vagile, flying at speeds > 30 kmph (Patterson and Hardin 1969) so that escape and relocation to unburned areas easily can occur. Most bat species utilizing trees and snags have multiple roosts throughout the forest (Sasse and Pekins 1996; Callahan et al. 1997; Menzel et al. 1998; Foster and Kurta 1999, Menzel et al. 2001), providing alternate roosts should the current roost be destroyed by fire. Lastly, most eastern bat species are able to carry their young for some time after they are born (Davis 1970). Conceivably, this would allow females to relocate their young if their nursery roost became endangered by fire.

Although not necessarily true for the deep South, in the mid-Atlantic and mid-South, dormant season burns occur when there are far fewer bats in the forest than in the growing season. Most dormant season burns tend to be controlled prescribed fires with a relative low intensity as currently practiced for pine plantation management or bobwhite quail (*Colinus virginianus*) management. Overstory mortality generally is low and snag creation often is limited. These lower intensity fires also may consume fewer existing snags than would more intense fires at other times in the year. Nonetheless, bats using forests burned during winter months may not be fully adapted to this type of rather “unnatural” disturbance. During winter months, many eastern bats hibernate or enter prolonged periods of inactivity during cold snaps. Bats may take up to 30 minutes to arouse from hibernation (Thomas et al. 1990), making it difficult for those not hibernating in more protected cave or mine refugia to reach a body temperature and activity level sufficient to escape a fire threatening a roost. Dormant season burning is most prevalent in the deep South and the Coastal Plain areas of the mid-Atlantic where winter temperatures generally are warm enough to ensure year-round presence of bats. In upland hardwood forests in the mid-Atlantic states, such as West Virginia and Virginia, burning for ecological restoration efforts to promote oak (*Quercus* spp.) regeneration (Brose et al. 1999) takes place from mid-April to mid-May. During this time, many bat species are finished hibernating and already could be using these upland forests for roosting and foraging.

Solitary Foliage-roosting Guild

Bat species in this guild use the forest exclusively for roosting. Regionally, this includes the eastern red bat, Seminole bats (*Lasiurus seminolus*), and hoary bat (*Lasiurus cinereus*) that roost in tree foliage throughout the year. Eastern pipistrelles (*Pipistrellus subflavus*) roost within tree foliage during the summer (Shump and Shump 1982; Menzel et al. 1998, Veilleux 1999). The northern yellow bat (*Lasiurus intermedius*) generally roosts in Spanish moss (*Tillandsia usneoides*; Webster et al. 1980; Menzel et al. 1999). With the exception of females nursing young, all individuals in this guild roost solitarily. We hypothesize that these roosting habits

translate into few or minimal fire effects on this group as disturbance events probably affect fewer animals at any single time as opposed to colonial-roosting bats. Furthermore, their habit of foliage roosting permits quick perception of surroundings and allows for faster response times. In largely forested landscapes, there are almost infinite amounts of available roosts for alternate use. However, in highly fragmented landscapes, fire and smoke may drive these bats to alternate forest patches as witnessed by Rodrigue et al. (2001), increasing their vulnerability to daytime predation as bats cross non-forested areas.

During winter months, this roosting guild is composed exclusively of Lasiurines, as the eastern pipistrelle retreats to cave or mine hibernacula. Of bats that continue forest roosting throughout winter such as the eastern red bat, some individuals migrate to the deep South and continue similar roosting and activity habits, whereas others individuals staying in the mid-Atlantic and upper South will periodically retreat to the leaf litter on the forest floor to escape cold snaps. Eastern red bats have been observed flying up from the leaf litter in front of dormant season fires (Saughey et al. 1998; Moorman et al. 1998). Whether or not eastern red bats or any other foliage roosting bats experience significant annual mortality from dormant season burning is unknown. An extensive study of the winter roosting habits and the possible effects of fire on this roosting guild has not been conducted.

Bark and Cavity Roosting Guild

This guild uses tree cavities and exfoliating bark for roosts. Generally, these bat species form small roost colonies that render them more susceptible to fire effects than solitary foliage roosting bats. As a result, even a single, localized fire event potentially could impact more individual bats. Cavity roosting bats include the big brown bat, evening bat, Rafinesque’s big-eared bat (*Corynorhinus rafinesquii*), northern long-eared bat, and silver-haired bat (*Lasionycteris noctivagans*). Regionally, evening bats often are found roosting in upland pine forests (Menzel et al., 2001) where both natural and anthropogenic fires are common. Because these bat species roost internally within cavities, their perception and response time necessary for exit and escape may be delayed. Bark roosting species include the endangered Indiana bat, little brown bat (*Myotis lucifugus*), and at times, the northern long-eared bat (Menzel et al. in press). In the northern parts of its distribution, the southeastern bat (*Myotis austroriparius*) will use exfoliating bark and hollow trees, whereas in the southern portion it also utilizes caves, bridges and other structures as roosts (Gardner et al. 1992). The small to medium sized maternity colonies formed under exfoliating bark in trees and snags by this roosting guild are vulnerable to fire disturbance in several ways. Snag roosts, depending on age and condition and fire condition can be highly combustible. However, most of

these species use multiple summer roosts that combined with their ability to carry young in flight might offset this significant liability (Davis 1970). Also, many of these bats often roost in riparian areas where prescribed burning generally is not applicable and where wildfire risks are slight (Gardner et al. 1991; Gardner et al. 1992; Foster and Kurta 1999).

During winter, all the myotids as well as big brown bats and eastern pipistrelles in the foliage roosting guild move to hibernacula in caves, mines, and large rockhouses and cliffines with cave-like characteristics. Silver-haired bats winter from the lower Ohio Valley and mid-Atlantic south into the mid-South where they switch to rock crevice and solitary bark roosting habits. Evening bats migrate to the deep South and coastal regions and continue using tree cavities for roosts. We hypothesize that fire effects on evening bats and silver-haired bats during winter months would be similar to those of the summer months with the added caveat that these animals could be in a prolonged torpor with slower reaction times.

Cavernous Roosting Guild

Of the bats that use caves and mines, few use underground roosts during the summer months. Most use forests (cavities and exfoliating bark) during the summer months. Bats that summer-roost in caves or mines include southeastern bats, gray bats (*Myotis grisescens*) and Townsend's big-eared bats (*Corynorhinus townsendii*). Bachelor colonies of northern long-eared bats and Indiana bats occasionally have been found in caves and mines during the growing season. Although subterranean roosts offer direct protection from flames, fire near occupied underground roosts can impact bats both directly and indirectly. Fire that alters surrounding vegetation such that cave or mine airflow is modified potentially could affect entrance and chamber microclimate (Richter et al. 1993). Additionally, habitat changes around caves or mines may impact foraging bats during pre-hibernation swarming or post-hibernation pre-dispersal, two feeding periods when bats must gain critical fat reserves. Smoke impacts to cavernous roosting bats depend on a cave's airflow characteristics. Depending on the season and air temperature, cave and mine entrances serve as entrances and exits for warm air or cold air (Tuttle and Stevenson 1977). A fire that creates smoke up wind from a "breathing" entrance potentially could fill the cave with smoke. In the late spring and summer, maternity colonies of gray bats or Townsend's big-eared bats that seek warm areas in a cave could be directly influenced by smoke drawn into the portions of a cave serving as a warm air trap or reservoir. During the winter months, the cavernous roosting guild also expands to include the rest of the myotids, eastern pipistrelles, big brown bats and Rafinesque's big-eared bats. Most caves and mines used as hibernacula tend to trap colder air in the winter, so smoke entry into the system probably would be less

likely to occur. Nonetheless, if smoke from a nearby fire is drawn into the hibernaculum, the potential for a catastrophic event affecting large groups of bats is a possibility. Mortality from smoke inhalation or decreased fitness from premature overwinter disturbance and arousal are real possibilities. The increased interest in the use of fire to manage upland hardwood forests in the mid-South and mid-Atlantic where karst topography and cave formation occurs merits expanded fire-ecology research.

Crevice Roosting Guild

Regionally, the myotids, Rafinesque's big-eared bat, and Townsend's big-eared bat occasionally will utilize rock outcrop and cliffines during the growing season for roosting habitat. Also, silver-haired bats have been observed using rock outcrops as winter roosts in Arkansas (D. Saugey, USDA Forest Service, pers. comm.). However, during the summer months, the small-footed bat (*Myotis leibii*) almost exclusively uses cracks and chimneys in large rock outcrops and cliffines (Whitaker and Hamilton 1998). Depending on localized geology, these roosts can be found in a variety of forested habitats and conditions in the region. Within the mountainous portions of the Appalachians in the mid-South and mid-Atlantic, rock outcrops occurring along xeric ridgelines often are covered by dry-site oak communities or fire-adapted pitch pine (*Pinus rigida*)-table mountain pine (*Pinus pungens*) overstories with extremely flammable ericaceous shrub layers. Although regional interest in prescribed burning in these systems to maintain these relictual pine types is increasing (Vose et al. 1997; Welch and Waldrop 2001), the impacts to bats such as the small-footed bat are unknown.

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