# PRESCRIBED FIRE EFFECTS ON SNAGS IN THE SOUTHERN APPALACHIAN MOUNTAINS

by

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ABSTRACT

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Prescribed Fire Effects on Snags in the Southern Appalachian Mountains
(Under the direction of Dr. Andrew Edelman)

Snags, or standing dead trees, are an important structural component of forest ecosystems and provide habitat for a wide variety of wildlife. Many bird and bat species in the southeastern United States are dependent on snags for foraging, protection, or raising of young. Some of these species are also declining due to habitat loss and fragmentation, invasive species, and loss of natural disturbance regimes. Therefore, understanding what processes, both natural and artificial, promote snags with the characteristics important for birds and bats is an important conservation concern. We evaluated the current knowledge on snag requirements of birds and bats of the Southeast and determined what major trends were seen in snag density and characteristics in managed forests. Snag requirements are variable by species and use type but are poorly understood for many species. In addition, the impact of forest management techniques such as repeated prescribed fire and thinning on snags are not clear. As a result, we examined how repeated prescribed fire interval and slope position affected the density and characteristics of snags at 80 sites on the Talladega National Forest, Alabama. We sampled within four different fire intervals including 1–3, >3–8, >8–12, and >12 years in between prescribed fires. The 1–3 year fire interval also experienced mechanical thinning to aid in opening up the canopy. We also sampled 3 different slope positions at each site including the ridge, mid-slope and valley to

account for slope-influenced fire behavior and stressors. Snag density decreased as fire interval increased, with the fewest snags found in the 1–3 year fire interval. Fire interval had no impact on the density of snags with characteristics important for perching and cavity-nesting birds and snag-roosting bats. However, large snags (dbh ≥ 40 cm), were found in greater densities in the 1–3 year fire interval than the >3–8 and >12 fire intervals. Ridges also contained the greatest overall density of snag as well as snags with characteristics suitable for perching birds, cavity-nesting birds, and snag-roosting bats. While repeated frequent fire and thinning reduced the density of snags in the most intensively managed stands, the losses were from the smallest diameter classes which have little value to wildlife. Repeated prescribed fire may also increase the density of large diameter snags that are most valuable to wildlife by increasing mortality in older trees. Open canopies can also reduce competition between living trees, allowing for more growth and thus larger snags. More intense fire and other stressors on ridges may also promote higher densities of snags. Overall land managers can use prescribed fire to accomplish multiple management goals while continuing to produce high quality snags for native wildlife.

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# CHAPTER ONE: SNAGS USED BY BIRDS AND BATS IN THE SOUTHEAST: A REVIEW OF THEIR IMPORTANCE, CHARACTERISTICS, AND MANAGEMENT

## I. INTRODUCTION

Snags, or standing dead trees, can be misinterpreted as indicators of poor forest health, but they are a critical structural component in all types of forest ecosystems. The decaying wood of snags provides shelter and foraging opportunities for a wide range of species, some of which are dependent upon the presence of snags. Their importance to many species has been well documented, especially in birds, with a greater number of snags supporting greater avian diversity (Hagar et al., 1996; Land et al., 1989). Insect larvae, wood-boring arthropods, and bark beetles may be found in abundance on snags and are included in the diets of many woodpeckers and other insectivorous birds (Powell et al., 2002). The soft, decaying wood allows for easy nest-hole excavation by primary cavity-nesting birds and nest-hole widening by secondary cavity-nesting birds (Raphael and White, 1984). Snags are also used for roosting and cover by mammals such as squirrels, bears, racoons, and bats (Arnett and Hayes, 2009; Bull, 2002; Rabe et al., 1998). Snags with sloughing bark are also frequently used by amphibians and reptiles (Bunnell et al., 2002). With their importance to wildlife well documented, creating and maintaining high quality snags is a growing management concern (Morrison et al., 1986). Thus, it is necessary to understand what processes promote snag recruitment and abundance as well as the characteristics most important for wildlife.

Snags are naturally created when live trees are killed by disturbances such as fire, weather, insects, and disease (Morrison and Raphael, 1993; Spies et al., 1988). Wildfires, often

ignited by lightning strikes, can produce many snags through direct tree mortality (Angers et al., 2011). Lightning can also cause individual tree mortality, but on a much smaller scale (Outcalt, 2008). Insects and diseases kill live trees, creating snags often times in patches within a forest. The susceptibility of live trees to infestation and infection are increased by drought, injury, pollution, and normal stand dynamics (Raphael and White, 1984). Once created, snags naturally progress through different stages of decay. The first stage occurs directly after death when the snag is at full height with bark and branches present, and continues to the final, softest stage where the snag is usually a stump with no branches or bark remaining (Cline et al., 1980). A snag typically moves through the decay stages and then falls 5 to 15 years after creation, though this can vary based on diameter, species, climate, and disturbance events (Conner et al., 1994; Keen, 1955).

The effects of human disturbance and forest management on snag dynamics are not yet well understood, though common management techniques such as prescribed fire and forest thinning, the process of selectively removing trees to reduce stand density, have been shown to both increase and decrease snag density in a stand (Cline et al., 1980; Walter and Maguire, 2004). Snags are anthropogenically created when live trees are damaged or killed during harvest or a prescribed fire (Greenberg et al., 2007; Rundel, 1973). Forest thinning and prescribed fire can decrease snag density through direct removal of snags, interrupting natural snag recruitment processes, and exposing remaining snags to strong winds (Cline et al., 1980; Mitchell, 1995). Our understanding of the effects of forest management on snags suffers from a lack of regional-specific data, especially in the southeastern United States, regarding the long-term effects of continued management with prescribed fire and timber removal (Harrod et al., 2009; Zarnoch et al., 2014).

Forest ecosystems of the southeastern United States (here referred to as the Southeast and defined as Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia) are commonly managed with prescribed fire and forest thinning in order to restore and maintain fire-adapted communities (Van Lear and Waldrop, 1989). Historically, fire played a role in controlling understory density and aided in the regeneration of fire-adapted pines and oaks, though this regular disturbance has dwindled due to reduced occurrence of anthropogenic fire, landscape changes, and active fire suppression (Noss et al., 1995; Van Lear et al., 2005; Van Lear and Waldrop, 1989). There has been a subsequent decline in the range of fire-adapted forests such as the *Pinus palustris* (Miller) (Longleaf Pine), *Pinus echinata* (Miller) (Shortleaf Pine), and oak-hickory forests (Stewart et al., 2015; Van Lear et al., 2005). However, since the late 20th century, fire has been reintroduced to many public and private lands in the Southeast to assist in restoring fire-adapted ecosystems and their associated flora and fauna (Simberloff, 1993). Forest thinning is also commonly used in conjunction with prescribed fire to restore open canopies associated with fire-adapted forests (Van Lear et al., 2005).



Due to the loss of natural disturbances, urbanization, agricultural development, and the conversion of more natural forests to timber plantations, the Southeast has also seen an overall decline in snags and snag-using wildlife such as birds and bats (O'Keefe and Loeb, 2017; Raphael and White, 1984; Rodhouse et al., 2015). Several bat species that rely on snags for roosting and reproduction are experiencing significant population declines (Silvis et al., 2016). Increasing density of suitable snags in managed forests through various methods may support these declining native wildlife (Harlow and Guynn, 1983; Land et al., 1989; Moorman et al., 1999). Forest managers are including target densities of snags in their management plans, but

these quotas are often not met or even monitored due to time and financial constraints (Smith et al., 2008; Styskel, 1983). These management plans also fail to acknowledge that snags vary in quality, and though a landscape may have a high density of snags, they may not have the needed characteristics to support the most species (Fassnacht and Steele, 2016; Zack et al., 2002). There is also a lack of scientific literature which can help guide and support snag management objectives (Butler et al., 1999). To best manage for snags and the species which use them, there is a need to understand exactly what characteristics of snags are the most important for target species, and how current management efforts are affecting these snags.

Wildlife and plant species composition as well as management techniques and goals vary widely based on forest type and geography. Regional specific data on the effect of forest management on snags is needed, especially in the Southeast (Ganey, 2016; McComb et al., 1986). To manage for the highest quality wildlife snags, species-specific knowledge is required to understand what snag characteristics are suitable for different groups of birds and bats (Lanham and Guynn, 1993; O'Keefe and Loeb, 2017). This review summarizes existing knowledge on snag-using birds and bats in the Southeast, their preferred snag characteristics, and the effect of common management practices on snags. This information will assist land managers and scientists in selecting management practices that produce snags for targeted wildlife species.