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Can snag creation benefit a primary cavity nester: Response to an experimental pulse in snag abundance

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ABSTRACT

Thresholds in response by cavity-nesting bird populations to variations in the snag resource are poorly understood. In addition, limited information exists on the value of artificially created snags for cavity-nesting birds. Therefore, uncertainty exists in whether artificially created snags can yield a positive population response among snag-dependent birds. We used an experimental approach to assess the abundance and territory dynamics of a primary cavity nester, the red-headed woodpecker (*Melanerpes erythrocephalus*), in response to three snag density treatments over an 8-year period following treatment installation in 2001. Treatments included snag removal, an unmanipulated control, and a snag pulse (snags experimentally created at 14 times control density). During the first two years post-treatment, abundance of red-headed woodpeckers did not differ among treatments. In 2004, woodpecker abundance in snag pulse plots surpassed that of other treatments and continued to increase until it peaked in 2007 (at nearly 6 times than on control plots), after which it declined but remained greater than on control plots through 2009. Increased woodpecker abundance in high snag density areas was facilitated primarily by a decrease in home range size. Because the red-headed woodpecker is negatively affected by very low snag densities, yet is capable of exploiting pulses in the snag resource by dramatically increasing its abundance, we conclude that snag density regulates populations of this primary cavity nesting species and that snag creation can be an important tool in its conservation.

1. Introduction

Many animal species are dependent on standing dead trees, or snags, for some aspect of their life history. Because the density of snags, particularly those suitable for cavity excavation by large-bodied primary excavators, often is low in managed, short-rotation forests (McComb et al., 1986; Ohmann et al., 1994), interest in the creation of snags by artificial means, variously termed 'morticulture' (Harmon, 2001; Lonsdale et al., 2009) or 'structural enrichment' (Hane et al., 2012; Kroll et al., 2012a) is increasing among forest managers. Snag creation has been suggested as a means to mitigate low snag densities to conserve cavity-dependent birds (Arnett et al., 2010; Brandeis et al., 2002; Bull and Partridge, 1986; Walter and Maguire, 2005). However, because of costs associated with such a program, thorough knowledge of the expected ecosystem response is important (Harmon, 2001). Despite extensive research on cavity nesting birds and snags, many aspects of the relationship between snags and primary cavity excavators remain poorly understood, including thresholds of response to snag densities (Hutto, 2006; Kroll et al., 2012b; Söderström, 2009). Therefore, a better understanding of the response of primary cavity excavators to pulses in snag availability and the manner in which populations of cavity excavators exploit such resources is needed.

The importance of snags to primary cavity nesters, particularly woodpeckers, is self-evident: these species require snags in which to excavate cavities for nesting. This dependence has been well documented not only through knowledge of species' natural history, but also through studies demonstrating low woodpecker abundance when snags were experimentally removed or occurred in very low densities (Dickson et al., 1983; Hutto and Gallo, 2006; Lohr et al., 2002). Thus, because the availability of snags suitable for cavity excavation may be low in some forests, snags are often considered a limiting resource for woodpeckers (Newton, 1994). However, the ability of woodpeckers to respond to a pulse in snag availability, such as those resulting from insect kills, disease outbreaks, fire or storm damage, or morticulture is less clear. Several workers have shown positive relationships between cavity nesters and snag density (Hutto and Gallo, 2006; McComb et al., 1986; Raphael and White, 1984; Schreiber and deCalesta, 1992; Zarnowitz and Manuwal, 1985), but others have failed to detect such relationships (Gunn and Hagan, 2000; Land et al., 1989; Sedgewick and Knopf, 1986; Spiering and Knight, 2005). Kroll et al. (2012a) determined that degree of use of created snags was dependent on landscape context. These findings suggest that snags

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may not always limit woodpecker abundance, even in managed forests. However, no controlled long-term experiment has examined population response of primary cavity nesters to elevated snag density, and the effects of a pulse of artificially created snags on cavity-nesting bird populations are virtually unknown.

Where positive responses of woodpeckers to snag densities have been shown, the mechanisms that permitted those responses have not been investigated. An increase in woodpecker abundance in response to an increase in snag density may simply be a result of immigrants occupying previously unsuitable (and unoccupied) space. Conversely, if most space already was occupied by woodpecker territories prior to the increase in snag availability, more complex explanations may be necessary to explain the increased density. For example, territorial individuals may be required to reduce their home range size to accommodate the additional territories of contenders (Myers et al., 1979; Pons et al., 2008; Stamps, 1990). Alternatively, these territorial birds may be forced to relax their territorial defensiveness and tolerate a greater degree of spatial overlap with neighbors, thus permitting greater territory packing. For example, Hagan et al. (1996) reported that ovenbird density was greater in new forest fragments as displaced individuals packed into remaining habitat, and they suggested that the reduced pairing success they observed may have resulted from an inability of males to defend territory boundaries. Finally, an increased density of woodpeckers in response to a snag pulse may result from the combination of all three of these potential mechanisms acting together.

Our objective was to evaluate the degree to which population size of a primary cavity-nester, the red-headed woodpecker (*Melanerpes erythrocephalus*), is limited by snag availability, and in particular, the response of this species to a pulse in snag availability. We chose the red-headed woodpecker as a focal species because they are among the most abundant breeding woodpeckers in mature loblolly pine (*Pinus taeda*) forests on our study area (Lohr et al., 2002), they respond quickly to dying trees (Smith et al., 2000), and they are a Partners In Flight Watch List species (Rich et al., 2004), having declined in the United States and Canada at a rate of 2.7% per year from 1966 to 2011 (Sauer et al., 2012). We examined the response of red-headed woodpecker abundance to various experimentally manipulated levels of snag density, from no snags (snags removed) to baseline levels (control) to a density equivalent to that occurring after a catastrophic event creates a pulse of snags ten times the baseline level, for eight years following treatment. We predicted that woodpecker abundance in snag pulse treatment areas would increase over time as snags decayed and became more suitable and would decrease as snags fell. We predicted that woodpecker abundance would remain constant in control plots and lowest in snag removal plots. From such an outcome, we could conclude that the availability of snags suitable for nesting, or some factor associated with such snags, represents a limiting resource for this primary cavity nester in late-rotation managed pine forests, and that this species is capable of responding to a pulse in the availability of this resource. We also compared home range size and overlap among treatments during the period of peak response and hypothesized that the mechanism allowing elevated abundance would be either smaller home range size or greater overlap on snag pulse treatments than on controls.

2. Methods

2.1. Study area

Our study was conducted on the US Department of Energy's Savannah River Site (SRS), a 78,000-ha National Environmental Research Park in Aiken and Barnwell counties, South Carolina. The SRS was bounded on the southwest by the Savannah River and was situated in the Upper Coastal Plain and Sandhills physiographic regions. The landscape of the SRS was >90% forested (Fig. 1), with loblolly (*P. taeda*) and longleaf (*Pinus palustris*) pine forests occurring on uplands and deciduous bottomland hardwood forests (dominated by oak, *Quercus* spp., sweetgum, *Liquidambar styraciflua*, red maple, *Acer rubrum*, gum, *Nyssa* spp., and cypress, *Taxodium distichum*) occurring in riparian areas. Our experimental plots were in upland pine forests planted between 1950 and 1953 (48–59 years old during the study) that received prescribed burns at 3–5 year intervals. Forest stands were composed predominantly of loblolly pine, but longleaf pine, slash pine (*Pinus elliottii*), and hardwoods, including oaks, hickories (*Carya* spp.), sweetgum, and black cherry (*Prunus serotina*) also occurred. Midstories were open. Understories were dominated by broomsedge (*Andropogon viginicus*), lespedeza (*Lespedeza* spp.), poison oak (*Toxicodendron pubescens*), blackberry (*Rubus* spp.), and wax myrtle (*Myrica cerifera*). Basal area averaged 12.7 m^2/ha.

2.2. Experimental design

To evaluate red-headed woodpecker response to snag abundance, we used experimental plots created for a larger study of the role of coarse woody debris in the ecology of southern pine forests. Treatments included the following: removal (REM), in which all downed wood and snags ⩾10 cm in diameter were removed; down woody debris pulse (DWD), in which trees were felled to create 5 times the volume of downed wood as occurred in un-manipulated stands; snag pulse (SNAG), in which trees were killed to increase snag volume and density by about 10-fold over levels that occurred in un-manipulated stands; and un-manipulated control (CON). We used a randomized complete block design in which

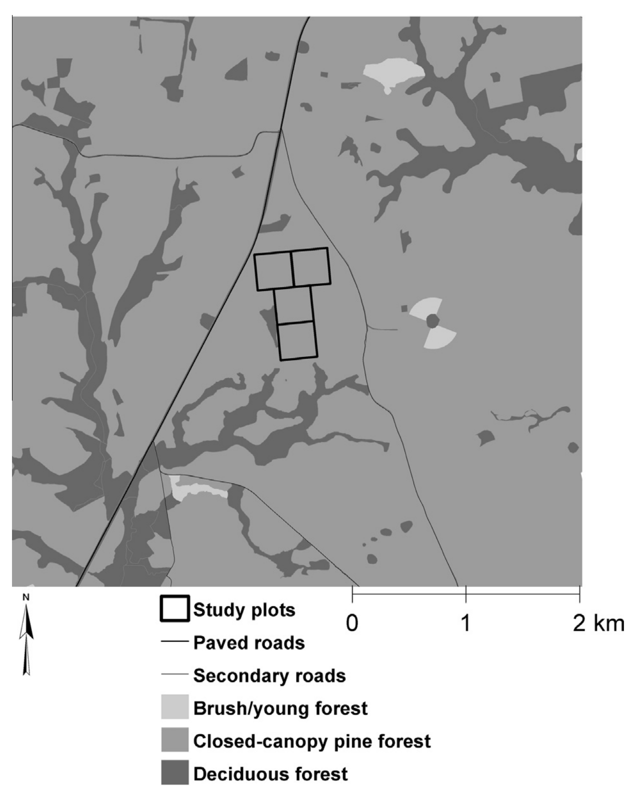

Fig. 1. Land cover map depicting 25 km^2 surrounding a representative experimental block used to investigate the effect of snag density on red-headed woodpeckers on the Savannah River Site, South Carolina.