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Time-since-fire and stand seral stage affect habitat selection of eastern wild turkeys in a managed longleaf pine ecosystem

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ABSTRACT

Longleaf pine (*Pinus palustris*) forests rely on prescribed fire to limit encroachment of hardwoods and maintain early successional understory communities. However, prescribed fire may alter habitat availability while female eastern wild turkeys (*Meleagris gallopavo silvestris*) are reproductively active. In addition, the vigor of vegetation regrowth post-fire is impacted by both midstory and overstory stand-conditions which can be a function of stand age. Therefore, the degree to which prescribed fire affects habitat availability and selection of wild turkeys may be a function of both time-since-fire and the age of the stand fire was applied to. We assessed habitat selection of female wild turkeys during their reproductive cycle in a longleaf pine forest managed with frequent prescribed fire. We captured 63 female wild turkeys during 2015 and 2016 on a longleaf pine-dominated landscape in southwestern Georgia, USA, that was managed with 1–3 year fire-return intervals applied to relatively small burn blocks (mean size of burn = 26.02 ha in 2015; 19.84 ha in 2016) on pine stands of varying age-classes. We attached Global Positioning Systems units to individuals and collected hourly locations from 1 March to 15 August. We then used distance-based analyses to estimate daily selection or avoidance of vegetation communities relative to the known reproductive phenology of individual females. Females selected hardwood stands during pre-nesting and post-nesting phases, but avoided them during the incubation phase. Females used open vegetation communities during all phases of reproduction following pre-nesting. Turkeys selected areas burned ≤ 2 years prior but used different seral stages of pine during different reproductive phases. Specifically, females selected for recently burned mature pine stands during incubation but then selected for recently burned young pine stands, mature pine stands burned 2 years earlier, and open vegetation communities during brooding. Our findings demonstrate that time-since-fire and stand seral age interact to affect how turkeys use pyric landscapes. In general, pine stands providing ample understory vegetation are favored while females are reproductively active. Our data suggests practitioners should try to manage a landscape containing both young and mature pine stands and use prescribed fire to create understory conditions selected by turkeys across all reproductive phases.

1. Introduction

Longleaf pine (*Pinus palustris*) forests historically covered ≥ 36 million ha in the southeastern United States (Landers et al., 1995; Brockway et al., 2005a; Van Lear et al., 2005). Through intensive logging and conversion of sites to agriculture or faster growing species (i.e. loblolly pine [*P. taeda*] and slash pine [*P. elliottii*]), many longleaf pine forests were lost (Landers et al., 1995; Brockway et al., 2005a; Van Lear et al., 2005; Oswalt et al., 2012). Currently, longleaf pine forests occupy < 5% of their historic range. However, restoring and reestablishing longleaf pine forests has become a management priority throughout the southeastern United States (Alavalapati et al., 2002). Mature longleaf pine forests are characterized by open, park-like conditions with extensive herbaceous understories that result from frequent fire (Kirkman et al., 2004; Outcalt, 2008). Restoration efforts are primarily centered on reintroducing fire to stands where it has been excluded, and reestablishment of longleaf pine which necessitates mechanical removal of overstory trees, and replanting longleaf pine seedlings (Brockway et al., 2005a,b; Van Lear et al., 2005).

Management and restoration of longleaf pine forests relies on

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frequent application of prescribed fire (e.g. 1–3 years) to mimic natural and historic burn frequencies (Brockway et al., 2005a; Oswalt et al., 2012). Frequent fire-return interval reduces fuel loads, limits midstory encroachment of hardwoods, and promotes early successional vegetation communities (Waldrop et al., 1992; Brockway and Lewis, 1997; Glitzenstein et al., 2012). The degree of change immediately after fire disturbance can be heterogeneous across a burned area as vegetation responses are affected by differences in fire intensity, fuel loading, and timing of application (Thaxton and Platt, 2006; Ellair and Platt, 2013; Wiggers et al., 2013). Differences in vegetation response lead to increased understory diversity and structural heterogeneity (Thaxton and Platt, 2006; Grady and Hoffmann, 2012). However, as time-since-fire increases, understory diversity decreases due to successful encroachment and establishment of woody species (Grady and Hoffmann, 2012; Robertson and Hmielowski, 2014).

Reestablishment of longleaf pine forests can result in a mosaic of pine seral stages across the landscape. After mechanical removal of the overstory, managers sometimes apply prescribed fire to remove logging slash to prep sites for planting (Brockway et al., 2005a,b). In areas trying to restore longleaf pine forests, managers first plant longleaf pine seedlings wherever conditions are appropriate and plant loblolly pine in sites less conducive to longleaf pine survival and growth. After replanting sites in longleaf pine seedlings, understory vegetation is dominated by herbaceous plants, grasses, and hardwood shrubs, with no midstory or overstory vegetation (Kirkman et al., 2004). Longleaf pine seedlings spend time in a grass stage devoting resources to root growth and when conditions are right, grow quickly thus outcompeting other understory vegetation and escaping harm from fire (Platt et al., 1988). Although planting density affects how long after planting young longleaf pines reach the period of stem exclusion (i.e. canopy closure), the resulting understory vegetation at canopy closure is sparse, and similar to conditions in southern pine plantations (Harrington, 2006). After thinning, understory communities respond to reduced canopy cover, coupled with applications of prescribed fire or herbicide, and plant diversity increases (Harrington and Edwards, 1999; Harrington, 2006). These communities are dominated by grasses and herbaceous vegetation that with the application of frequent fire are maintained indefinitely (Kirkman et al., 2004). If attempting to mimic natural disturbance, mature pines are then managed by occasional single tree selection cuts designed to create canopy gaps that facilitate natural regeneration (McGuire et al., 2001; Pecot et al., 2007; Outcalt, 2008).

Because prescribed fire immediately alters vegetation communities and is applied during winter, spring, and summer, which coincides with the reproductive period of eastern wild turkeys (*Meleagris gallopavo silvestris*; hereafter: turkeys), it has potential to alter habitat selection of reproductively active females (Little et al., 2016a; Yeldell et al., 2017b). Prescribed fire shifts the spatial arrangement of resources, affecting how individuals partition their time and space use (Streich et al., 2015; Little et al., 2016b; Yeldell et al., 2017a). For example, turkeys may be attracted to recent burns because of forage availability (Glover and Bailey, 1949; Exum et al., 1987) as insects are found in similar abundance immediately before and after fire (Chitwood et al., 2017) but may be more accessible due to reduced litter cover (Addington et al., 2015). The response of vegetation post-fire is affected by pine stand conditions as well; vigor in understory growth post-fire is diminished in stands with denser midstory and overstory conditions (Wiggers et al., 2013; Addington et al., 2015). Regenerating clear-cuts replanted with longleaf pine provide early successional communities with resources similar to open areas (Dalke et al., 1942; Kennamer et al., 1980). As longleaf pine stands age, high-density plantings inhibit development of the understory though shading, competition, and heavy litter (Dagley et al., 2002; Battaglia et al., 2003; Harrington et al., 2003), reducing forage availability. When stands are selectively thinned, the resulting low-density overstories create suitable conditions for understory growth of herbaceous plants (Kirkman and Mitchell, 2006) that turkeys feed on (Exum et al., 1987). Hardwood stands in pine-dominated landscapes can play an important role by providing roosting cover and forage during seasons when herbaceous plants are sparse (Miller et al., 1999; Jones et al., 2005); however, these areas are also preferred by species known to prey on turkeys and their nests (e.g. bobcats [*Lynx rufus*], raccoons [*Procyon lotor*]; Chamberlain et al., 2002,2003; Godbois et al., 2003).

In landscapes managed with frequent fire, turkeys may change selection of vegetation communities during different reproductive phases (Yeldell et al., 2017b). Similarly, habitat selection may be influenced by pine seral stage. For example, in managed pine stands in Mississippi, females were more likely to select stands that were thinned and burned (Miller and Conner, 2007). These stands resulted in open, herbaceous understories preferred by turkeys. Similarly, in pine-dominated forests in Louisiana, females selected mature pine stands burned during the previous 5 months during laying, but not during any other reproductive period, probably because of foraging opportunities which met the physiological demands associated with egg laying (Yeldell et al., 2017b). In southwestern Georgia, females avoided mature pine stands during nesting, in favor of shrub/scrub communities (Streich et al., 2015), whereas females used young pine stands in Mississippi burned on 2–3 year rotations during brood-rearing (Jones et al., 2005). Therefore, both pine seral stage and time-since-fire may interact to influence turkey vegetation community selection throughout their reproductive season, but the extent of this interaction is unknown.

Our objective was to determine how time-since-fire affected selection of different seral stages of pine by female turkeys during their reproductive cycle. We hypothesized that females would not select any pine-dominated stands during pre-nesting, but instead select hardwood stands as these stands provide roosting structure and hard mast. Females require substantial nutrient uptake due to the high physiological demand during egg laying and brood-rearing, therefore we hypothesized females would select mature pine stands more recently burned (i.e. < 6 months previous) due to increased foraging opportunities for protein-rich invertebrates (Lemon, 1949; Wiggers et al., 2013; New, 2014; Chitwood et al., 2017), and avoid young pine stands regardless of time-since-fire, during laying and brood-rearing. We hypothesized that females would select pine stands farther along in their burn rotation (i.e. ≥ 2 growing seasons post-burn), regardless of pine seral stage, during incubation due to increased vegetation density and nest concealment. Lastly, during post-nesting, we hypothesized that females would select vegetation communities similar to selection during pre-nesting.

2. Materials and methods

2.1. Study area

We conducted research on the Silver Lake Wildlife Management Area (hereafter, SLWMA) and surrounding private lands in southwestern Georgia. The SLWMA was managed by the Georgia Department of Natural Resources-Wildlife Resources Division (GADNR) for hunting and other outdoor recreation activities. The SLWMA encompassed approximately 3900-ha, of which 3392 ha (88%) was dominated by pine (*Pinus* spp.) forests. Of these, 83% (2814.77 ha) were mature pine forests (≥ 20 years old), and 14% (478.21 ha) were young pine plantations (4–19 years old). Although we classify stands hereafter young or mature stands, we recognize that longleaf pine only 20 years post-planting is still relatively young (see Addington et al., 2015); nonetheless, our classifications represent important changes in stand conditions on our site. Stands that we classify as young pine stands were characterized by increased stocking levels and diameter at breast height (DBH) classes ≤ 20.3 cm. Mature pine stands were characterized by lower stocking levels, DBH classes > 20.3 cm, and more open, park-like conditions. Other plant communities included clear-cuts planted in pine, hardwood forests, agricultural fields, and wildlife openings scattered throughout. The SLWMA is managed by GADNR as a northern bobwhite (*Colinus*