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Timber Volume and Bobwhite Abundance

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Mature pine (*Pinus* spp.) ecosystems maintained with frequent prescribed fire are the primary habitat of northern bobwhites (*Colinus virginianus*) in the Red Hills region of northern Florida and southern Georgia. Timber volume is thought to be negatively related to bobwhite abundance; however, this relationship has not been quantified. We related mean basal area of mature trees (>15cm dbh) to autumn covey call count indices at 23 locations on 6 study areas with varying timber volume, but similar bobwhite management practices, 2002 - 2004. Bobwhite abundance was inversely related to timber volume ($r = -0.61$, $P = 0.002$). Adjusted covey counts averaged 11.3 coveys below, and 6.4 coveys above, 9.2 m^2/ha (40 ft^2/ac) of basal area ($F_{1,21} = 19.4$, $P < 0.001$). Where maintaining high densities of bobwhites is a priority, we recommend pine basal areas be <10 m^2/ha. However, our data also suggested that bobwhites can be maintained at a bobwhite/0.4 ha at basal areas up to 14 m^2/ha assuming sound management is applied.

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Introduction

In much of the southeastern USA, coastal plain upland-pine forests have historically been the most important habitat type for bobwhites (Stoddard 1931, Rosene 1969). Changes in pine silviculture and a reduction of prescribed fire have lowered the suitability of pine forests as habitat for bobwhites (Brennan et al. 1998, Palmer et al. 2004). A decline of early-successional habitats through conversion of open agricultural lands to closed-canopied pine forests over recent decades has further increased the significance of forested habitats for bobwhite conservation in the Southeast (Fies et al. 1992).

It has been recommended that forested landscapes be maintained with 30-50% canopy closure and less than 9.18 m^2/ha (40 ft^2/ac) of timber basal area (Rosene 1969, Brennan 1999, Burger 2001). These relatively open timber canopies, along with frequent prescribed fire, are necessary for maintaining the mix of herbaceous and woody ground cover needed to meet the life history requirements of bobwhites. It has long been thought that timber volume mediates groundstory suitability for bobwhites and is generally negatively correlated with bobwhite abundance (Stoddard 1931, Rosene 1969, Moser and Palmer 1997, Brennan 1999). While the relationship between timber density and bobwhite abundance is generally understood no effort has been made to quantify the relationship.

On southeastern bobwhite hunting plantations, bobwhite management actions and general groundstory habitat conditions in upland pine forests are relatively consistent across property ownership (Moser et al. 2002). Maintenance of groundstory vegetation suitable for sustaining high density bobwhite populations is accomplished with biennial burning in conjunction with mechanical treatments. Pine silviculture dominates the upland areas with limited midstory and/or pine regeneration (Moser et al. 2002). Unlike groundstory management, however, timber volume does vary significantly both within and across land ownerships. The similarities

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in landscape conditions among hunting plantations create an opportunity to investigate the relationship between timber density and bobwhite abundance. The trade-off between timber density and bobwhite management has important financial and biological consideration for managers (Moser and Palmer 1997, Engstrom and Palmer 2003). The objective of this study was to quantify the relationship between timber density and autumn bobwhite abundance on southeastern hunting properties managed for bobwhites.

Study Area

We selected 6 properties in the Red Hill Region of north Florida and south Georgia, including Tall Timbers Research Station (TT), Pebble Hill Plantation (PH), and 4 private plantations, DE, LL, SH, SW. Four properties (TT, PH, SW and SH) were comprised mainly of second growth loblolly and shortleaf pine uplands located on old fields (formerly agricultural fields), with <10% of overstory in longleaf pine. Two plantations were predominantly longleaf pine; 93% of timber at DE and 75% of timber at LL was longleaf pine.

The primary management objective of these plantations is to maintain high density bobwhite populations with secondary objectives including other game wildlife species, and/or timber production. Management includes use of low intensity biennial prescribed fires, roller drum chopping, and mowing to produce groundstory conditions favorable for bobwhites. In the past, timber density and composition varied among and within each plantation due to differing land uses and the interest of each owner in generating revenue from timber sales. Timber was managed using the Stoddard-Neel system, or variations of it, resulting in a mature canopy of pines over most of the uplands (Moser et al. 2002).

Methods

Research and Sampling Design

Our objective was to relate covey abundance to timber volume. We estimated bobwhite abundance using covey call point counts. The bobwhite covey call can be heard up to distances up to approximately 500 m (Wellendorf and Palmer 2005). Therefore, we chose listening points to sample covey calling and then quantified the basal area of the stand within the surrounding 500 m. We located all the possible listening points on a property such that a 500 m radius fit within the property, was composed of >75% upland pine forested habitats and contained minimal hardwood bottomland forest habitats. Among the plantations, DE, LL and PH each contained 4 survey points, SH and SW had 3 survey points and TT had 5 survey points.

Bobwhite Covey Abundance

We estimated bobwhite abundance by conducting covey call point counts during October - November, 2002 - 2004, using trained observers (Wellendorf and Palmer 2005). We counted coveys calling from 45 minutes before sunrise to sunrise (DeMaso et al. 1991, Seiler et al. 2002, Wellendorf et al. 2004). We adjusted raw counts by an estimate of the predicted calling rate to give an estimate of the number of coveys within the listening radius of the point and used this value as index of bobwhite abundance (Wellendorf et al. 2004). We conducted covey call counts at each point 1 to 3 times during each autumn, 2002 - 2004. When multiple counts were made at a point during a single autumn, the maximum covey count recorded at that point was used in analyses. To avoid temporal psuedoreplication, we then averaged corrected counts for each point across all years and used this average covey abundance in our analyses.

Estimates of Timber Density

We estimated timber basal area within the 500-m radius surrounding each survey point (78.5 ha). Sampling points were evenly spaced over the 78.5 ha area by overlaying a 2.5 ha grid in ArcView GIS 3.2. Using GPS receivers, technicians located sub-sample points at the intersection of grid lines and determined total tree basal areas using a 10-factor prism (Avery 1967). Basal area, the total estimated cross-sectional area of timber (conifer and hardwood) in a stand at breast height (approx. 1.35m), expressed in m^2/ha, was measured at each point. We generated a

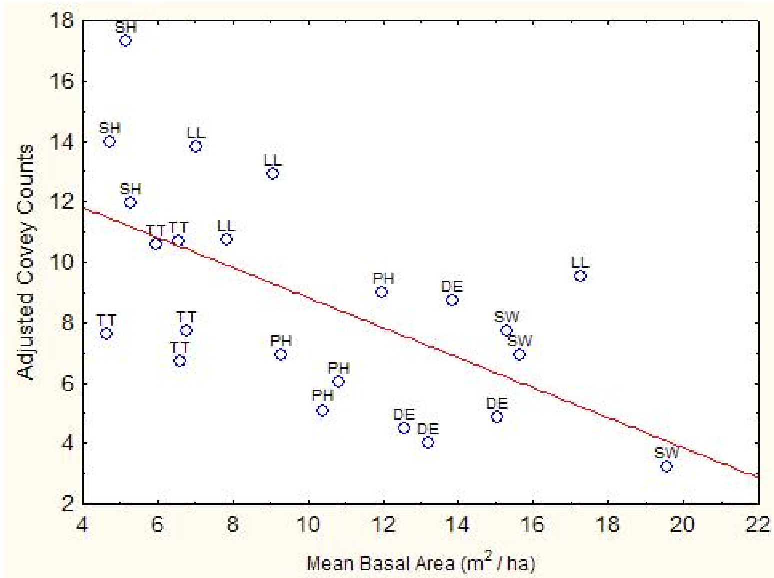

Figure 1: Relationship between mean basal area of timber (m^2/ha) within a 500-m radius surrounding northern bobwhite (*Colinus virginianus*) covey call point counts and the 3-year average of covey counts (adjusted for predicted calling rates) on 6 sites (DK, LL, PH, SH, SW, TT), Thomas and Grady counties, Georgia and Leon County, Florida, 2002 - 2004.

mean basal area from all subsample points.

We related bobwhite abundance to timber density in 3 ways. First we correlated mean basal area/point and the average number of coveys counted. However, it is unlikely that a linear model would be the logical underlying model for the affect of timber volume on bobwhite abundance. Therefore, we also considered simple curvilinear models. We hypothesized that bobwhite abundance would not be affected by timber density below some threshold but would be above this threshold. Given our limited data set and range of basal areas on our study areas, we chose to conduct a simple piecewise linear regression to determine if a breakpoint occurred in the relationship of interest. We used the Quasi-Newton estimation method to determine the best fit for our data. We then compared mean abundance of bobwhites below and above the breakpoint to provide a general effect size for timber volume on bobwhite abundance within the ranges tested in this study (Stat Soft Inc. 2003).

Results

Basal Area and Bobwhite Abundance

We surveyed bobwhite abundance at 23 locations, of which 20 points were visited each year of the study and 3 points were only visited in 2004. Our mean adjusted covey count was 8.72 (Range 3.21 - 17.29) coveys per point over the 3 year study. Basal area of timber in the 500 m surrounding each point averaged 10.2 m^2/ha (Range 4.62 - 19.56 m^2/ha or 20.1 - 85.2 ft^2/ac).

Timber densities and bobwhite abundance varied within and among the 6 study sites (Figure 1). Bobwhite abundance was inversely related to timber volume ($R^2 = 0.37$, $r = -0.61$, $P = 0.002$; Figure 1). Piecewise regression estimated a breakpoint existed in the regression line at 8.72 m^2/ha, we compared mean bobwhite abundance above and below 9.18 m^2/ha (40 ft^2/ac) to assess effect size. Bobwhite abundance was significantly higher when basal areas were below 40 ft^2/ac than above 40 ft^2/ac ($F_{1,21} = 19.4$, $P < 0.001$). Adjusted covey counts averaged 11.3 coveys below, and 6.4 coveys

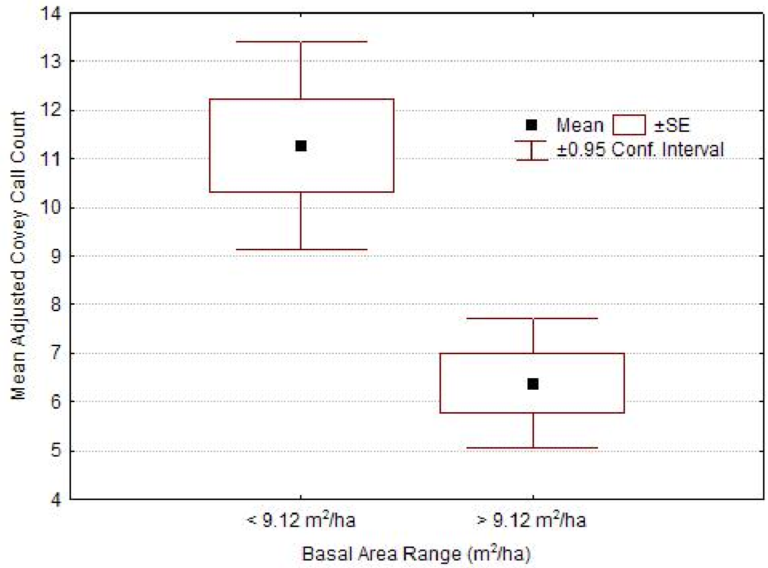

Figure 2: Mean adjusted covey call counts and associated 95% CI of northern bobwhite (*Colinus virginianus*) coveys at 11 sites with <9.18 m^2/ha (40 ft^2/ac) of timber basal area, and 12 sites >9.18 m^2/ha, Thomas and Grady counties, Georgia and Leon County, Florida, 2002 - 2004.

above, 40 ft^2/ac of basal area (Figure 2).

Discussion

Prior to this study, it had been hypothesized that bobwhite populations begin to decline at timber densities greater than 13.8 m^2/ha (Rosene 1969). Our data suggests that, where bobwhite populations are the primary objective of land management, mature pine stands should be maintained at approximately 10 m^2/ha or less.

While bobwhite abundance was greatest in timber stands below 10 m^2/ha, their abundance was still considered very good at higher timber volumes. Based on comparisons of bobwhite densities to point counts (Wellendorf and Palmer 2005), our data suggest that bobwhites can be maintained with sound management at approximately 2.5 bobwhites per ha when timber basal areas range from 10 - 14 m^2/ha (about 40 to 60 ft^2/ac). This range of timber density is also suitable for other pine forested obligate species including red-cockaded woodpeckers (*Picoides borealis*) (Engstrom and Palmer 2003). Above 14 m/ha, we expect that bobwhite populations would decline due to declining suitability of ground cover composition and structure. However, given that the areas we measured are all managed for bobwhites, few of the stands we measured were above 15 m^2/ha. Additional research needs to be conducted on stands in the 16 to 20 m^2/ha range. The greatest basal area we measured was 19.6 m^2/ha and the adjusted covey count was the lowest we measured at 3.2, which is approximately 1 bobwhite/1.6 ha. It is likely that a combination of factors influence bobwhite abundance as timber density increases, principally the suitability of the groundstory composition and structure, which likely affects predation rates, foods and foraging efficiency, and microclimate.

The replacement of frequently burned, open pine woodlands, with modern agriculture and closed pine plantations has been a primary cause for the decrease in bobwhite abundance throughout much of its distribution (Brennan 1991, Brennan et al. 1998, Palmer et al. 2004). Bobwhite managers working with upland pine forests should recognize that even with biennial prescribed fire, appropriate scale of management (10-50 ha burn units), and other management practices such as supplemental feeding and predation management, density of timber on a site has a relatively large effect on bobwhite abundance. Therefore, when planning restoration of bobwhites on a site, both reducing canopy coverage of timber and frequent prescribed fire are needed to sustain bobwhite populations.

Management Implications

We recommend on southeastern hunting plantations where maximum bobwhite populations are desired for hunting that managers maintain timber density less than 9.18 m^2/ha (40 ft^2/ac). However, this low level of timber density may not be suitable for some plantation owners due to the loss of revenue from timber sales. Within the groundstory management parameters of our study areas, huntable populations of bobwhites can still be achieved with timber densities ranging from 10 to 15 m^2/ha. While we did not measure timber density greater than 19.8 m^2/ha we would expect that bobwhite population sustainability would be greatly impacted by timber density greater than this.

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