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USE OF SPRING WHISTLE COUNTS TO PREDICT NORTHERN BOBWHITE RELATIVE ABUNDANCE

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ABSTRACT

Spring whistle counts are commonly used to index northern bobwhite (*Colinus virginianus*) breeding populations and make inference about relative autumn abundance. They are relatively cheap and easy to implement and provide the advantage of surveying bobwhite populations from multiple points daily and early in the year. This could prove useful on properties available for potential lease, purchase, or as translocation sites; as well as to monitor population trends. Our objective was to determine whether spring whistle counts reliably forecast autumn covey numbers on a wide range of sites, years, and densities on 6 properties in southwestern Georgia from 2006 to 2015. We conducted spring whistle counts weekly during peak calling activity (late May–early Jun, for 4–6 consecutive years) on an average of 7 points/property (range = 5–9). We conducted autumn covey counts using these same sampling points as an index of relative abundance. Peak number of males heard in spring and number of coveys heard in autumn was strongly correlated ($R^2 = 0.791$, $n = 198$) for all points combined, indicating that spring whistle counts are a reliable tool for assessing bobwhite relative abundance on sites where autumn covey counts are precluded or the information is needed prior to autumn.

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Key words: Colinus virginianus, covey counts, Georgia, northern bobwhite, translocation, whistle counts

Spring whistle counts have been used by researchers and managers for decades as an index to spring breeding-population levels of northern bobwhites (*Colinus virginianus*) and have been evaluated extensively as a way to predict autumn population densities with varying results (Speake and Haugen 1960, Norton et al. 1961, Robel 1969, Rosene 1969, Wells and Sexon 1982, Curtis et al. 1989, Hansen and Guthery 2001, Terhune et al. 2009, Parent et al. 2012, Reyna et al. 2012). More recent work demonstrated a strong relationship ($R^2 = 0.975$) between spring whistle counts and autumn density, derived from covey call counts, when the peak of spring whistling activity is used (Terhune et al. 2009). Peak male whistling activity occurs more than once during the nesting season, coincides closely with peak nesting activity by hens, and varies by year and site (Hansen and Guthery 2001, Terhune 2002, Terhune et al. 2009). The most consistent and intense peak was during week 7–9 of the nesting season in South Georgia (late May–early Jun; Terhune 2002). Additional studies have shown that calling activity during this time period is more consistent than either before or after (Wellendorf and Palmer 2012). Terhune et al. (2009) underscored the need to test the validity of their findings on more sites and with a wider range of densities to better inform management and a broader use of the technique.

The value of predicting autumn population levels of bobwhites prior to (≥6 months) hunting season has several advantages such as to afford managers a practical and reliable method to forecast quail numbers to set lease hunting prices (Reyna et al. 2012) or establish conservative bag limits or quota permits. In the southeastern United States, we have often been asked to evaluate properties for potential lease, purchase, or as a suitable translocation site in advance of the season appropriate for accurate covey census. Given the great deal of time and effort going into a translocation project, knowing in advance whether a property meets the minimum population requirements for permitting is very valuable (Terhune et al. 2009). Part of the translocation permitting process required by the Georgia Department of Natural Resources, Wildlife Resources Division (GA DNR WRD), and several other states, was to conduct both spring whistle counts and autumn covey counts on translocation recipient sites. This provided us with the opportunity to compare these counts on multiple sites, over multiple years, and over a wide range of densities to evaluate the utility of spring whistle counts as a valid metric for assessing relative autumn abundance.

STUDY AREA

We conducted both spring whistle counts and autumn covey counts on 6 study sites in 6 different counties in

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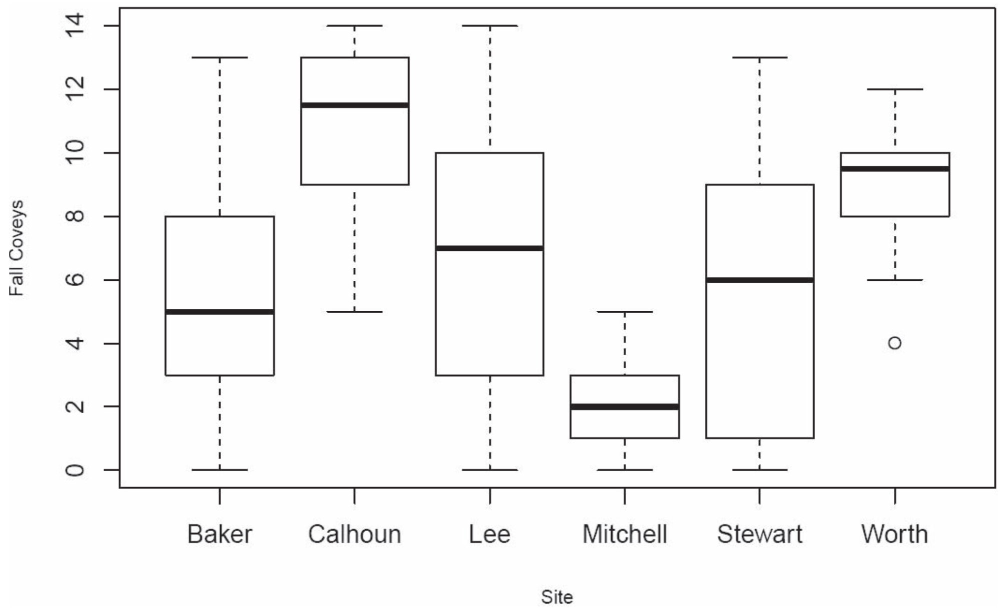

Fig. 1. Average number of northern bobwhite coveys heard delineated by site during October–November on 6 sites in southwestern Georgia, USA, 2006–2015.

southwestern Georgia (Fig. 1). Two sites located in Calhoun and Worth counties had a long history of intensive quail management and relatively high densities of bobwhites whereas the other 4 sites located in Stewart, Baker, Mitchell, and Lee counties were either newly established or renovated wild quail hunting properties with a more recent history of wild quail management and a low initial quail density. All 6 sites were managed intensively for wild quail throughout the study as described by Stribling and Sisson (2006), including maintaining open canopy pine (*Pinus* spp.) forests with frequent prescribed fire, mowing and roller chopping, herbicides, and disking of fallow openings, along with predator management and supplemental feeding of quail. Spring whistle and autumn covey counts were initiated on each site because of new owners and their desire to measure the bird numbers prior to purchase, in response to newly implemented management regimes, or as translocation monitoring as required by GA DNR WRD.

METHODS

Spring Whistle Counts

We followed the protocol of Terhune et al. (2009), which was based on previous research on male calling behavior (Ellis et al. 1969, Rosene 1969, Wells and Sexon 1982, Curtis et al. 1989, Hansen and Guthery 2001) to ensure accurate counts and to mitigate the influence of weather (i.e., wind, fog, rain, and cloud cover) on whistling males. We conducted numerical counts of whistling males along standardized call count routes each week at 5–9-day intervals (mid-May–mid June) during 2006–2015. We counted the number of individual males heard whistling during the first 2 hours after sunrise, the "calling optimum" (Rosene 1969, Hansen and Guthery 2001), on days when the wind velocity was $\leq$16 km/hour and cloud cover was $\leq$75%. Spring whistle count routes comprised an average of 7 listening points (range = 5–9), 0.81 km apart, evenly distributed throughout the study area. The observer stopped and listened for 5 minutes at each point and recorded the start time; number of whistling males; and climate conditions such as wind speed and direction, cloud cover, or fog. We ran the spring whistle-count route backward on alternating weeks to decrease bias of optimal calling time and listening point locale. We used the peak number of males heard whistling at each point in the analysis.

Autumn Covey Counts

We used autumn covey counts (DeMaso et al. 1992, Seiler et al. 2002, Wellendorf et al. 2004) to evaluate autumn covey numbers during 2006–2015. We conducted autumn covey counts from mid-October to late-November. We used point count techniques to estimate bobwhite covey numbers where a single observer listened for the "koi-lee" covey calls (Stoddard 1931) given by bobwhites before sunrise and recorded the unique number of calling coveys. We conducted autumn covey counts using the same points as those used for the spring whistle counts, repeated each 2–3 times, and used the high count from each point for analysis (Wellendorf et al. 2004).

Statistical Approach

We used generalized linear models (R Core Team 2015) to estimate effects of peak spring whistle counts during the breeding season, site, and year on the peak numbers of calling coveys in the autumn. For our analysis, we were most interested in determining whether the number of whistling males during the peak of spring calling was correlated with the number of distinct calling coveys in the

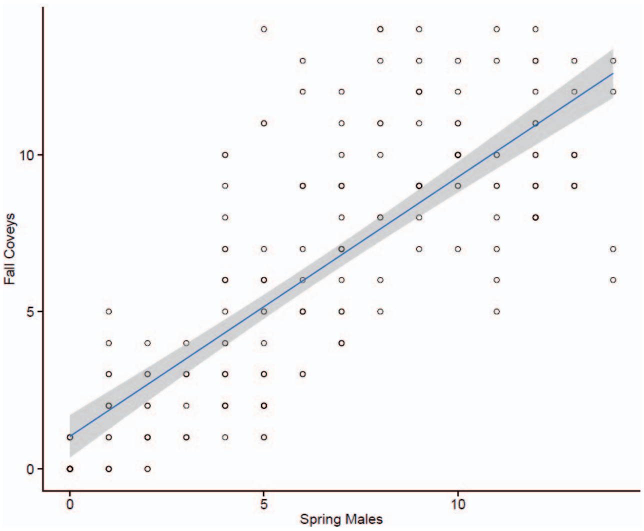

Fig. 2. Generalized linear regression model using the peak of northern bobwhite calling activity plotted with prediction limits for 6 study sites in southwestern Georgia, USA, 2006–2015. Regression equation and coefficients: y = 1.03289 + 0.82589 × (Spring Northern Bobwhite Count); $R^2 = 0.791$.

autumn. As such, we controlled for variation in year and site by including these terms in our models. To facilitate interpretation of regression coefficients, we standardized the continuous predictors and the response variable by unit normal scaling (Montgomery and Peck 1992).

We used an information-theoretic approach (Anderson et al. 2000, Burnham and Anderson 2002) to evaluate a set of 7 candidate models describing breeding season calling of bobwhite males compared with autumn covey counts. We determined the best approximating model in the set of candidate models by Akaike's Information Criteria (AIC; Burnham and Anderson 2002). We used model likelihoods computed from Program R (https://www.r-project.org/; R Core Team 2015) to compute AIC and compare each candidate model. We considered the model with the lowest AIC value to be the best approximating model given the data. We assessed model fit by model coefficient of multiple determination (R^2) and mean squared error. We also evaluated model fit using residual analysis where sample size was adequate. During initial model fitting, no intercept models of bobwhite abundance predicted from counts of breeding calling males were found to best fit the data.

RESULTS

The examination of residual plots suggested the fit for the most highly parameterized models evaluating the effects of male calling activity, year, and site on autumn coveys heard was acceptable. Visual observation of normal probability plots revealed some slight departure from normality for all of the models, but this departure was not severe (Hosmer and Lemeshow 2004). Based on these model residuals plotted against residual values, we assumed that the fit of the most highly parameterized models and the fit of subsequent candidate models also was adequate.

Table 1. Model selection results for examination of factors (year, site, and males calling in the spring) affecting northern bobwhite covey calls heard during the subsequent autumn on 6 sites in southwestern Georgia, USA, 2006–2015.

Model	K	Dev	AIC	ΔAIC
MH[a] + MH × site[b]	12	892.7354	908.74	0.00
MH + site	8	879.2602	911.26	2.53
MH + site + year[c]	16	858.7636	918.77	10.03
MH + site + year + site × year	30	899.1107	921.11	12.38
MH + year	11	896.0564	936.06	27.32
MH + MH × year	20	932.256	936.26	27.52
MH	2	939.3894	939.39	30.65

[a] No. males heard.
[b] Site indicates all 6 sites.
[c] Year indicates all 10 yr of the study.

The average number of coveys heard in the autumn across all sites and years combined was 6.268 (SE = 0.042) and ranged from 0 to 14, representing a wide range of bobwhite densities (Fig. 1). The most supported model among those evaluated included males and site, suggesting that variation in the number of coveys heard in the autumn was largely associated with the number of whistling males in the spring and varied by site (Table 1; y = 1.03289 + 0.82589 × (Spring Northern Bobwhite Count). There was virtually no support for any of the remaining candidate models or year based on model weights and AIC (Table 1). The number of bobwhite coveys heard in the autumn was highly correlated ($R^2 = 0.791$; Fig. 2) with the peak number of males whistling in the spring. The magnitude of the slope or strength in this relationship, however, varied by site (Fig. 3).

DISCUSSION

Our results indicate that spring whistle counts are a reliable predictor of autumn covey numbers in our area when counts are conducted properly. Repeating spring whistle counts and ascertaining the peak number of whistling males during each year likely increases the utility of spring counts (Terhune et al. 2009). This is an important point because calling activity varies by year, within a season, and across sites (Hansen and Guthery 2001, Terhune 2002, Terhune et al. 2009). To accurately depict spring breeding numbers point counts must coincide with peak female nest incubation, which is an important variable driving the variability of fluctuating whistling activity (Terhune 2002, Terhune et al. 2009).

The utility of spring whistle counts have been criticized in the past largely because they do not directly incorporate information on reproductive success and seasonal survival (Norton et al. 1961). Our results indicate a consistent relationship between spring whistle counts and autumn covey counts where reproductive effort is generally consistent from year to year. However, in more arid and weather-driven portions of the bobwhite range, this relationship may be less reliable (Reyna et al. 2012). For example, Parent et al. (2012) found a fairly significant

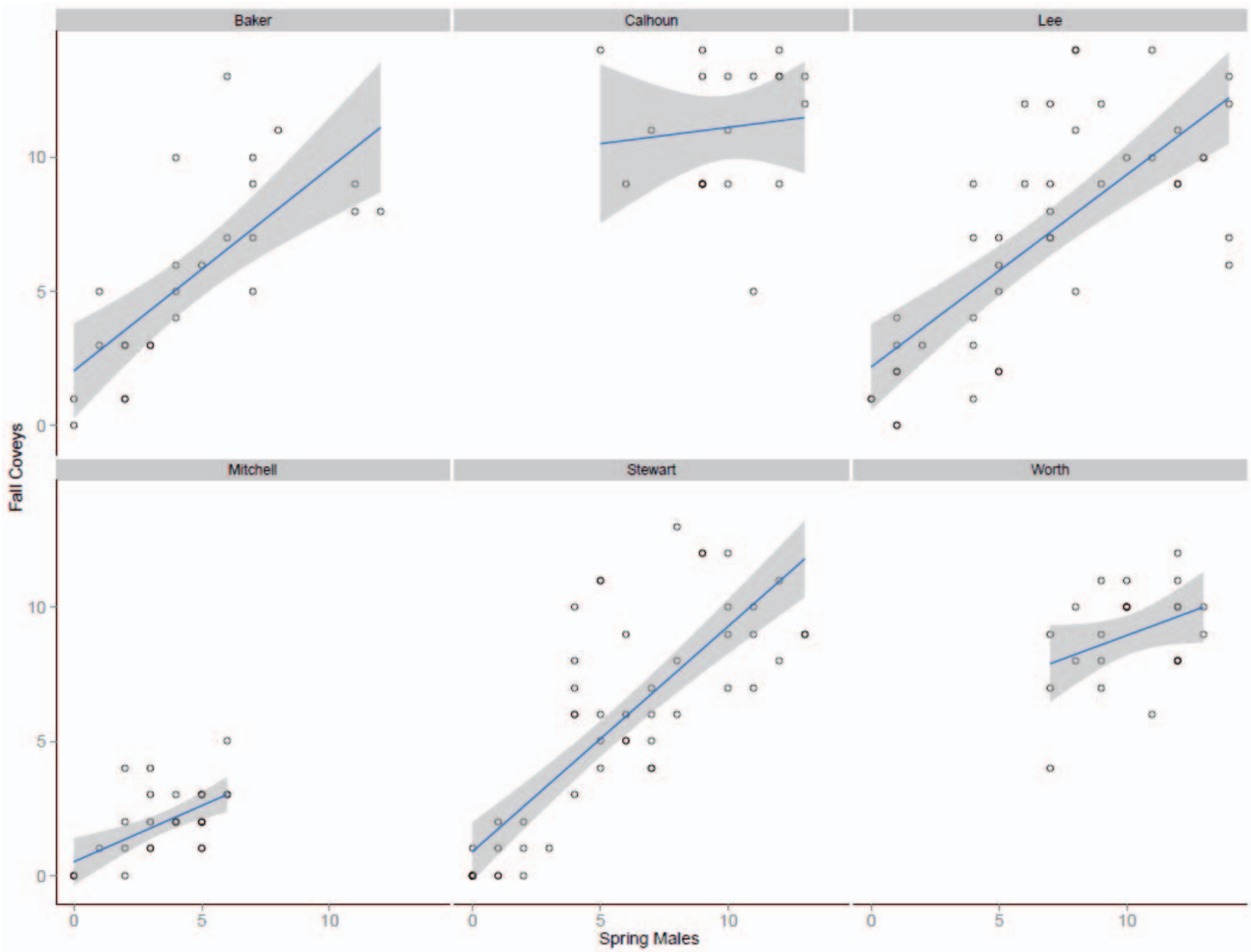

Fig. 3. Generalized linear regression model using the peak of northern bobwhite calling activity delineated by site and plotted with prediction limits for 6 study sites in southwestern Georgia, USA, 2006–2015.

relationship ($R^2 = 0.68$) in Texas between spring whistle counts and autumn helicopter surveys, whereas Reyna et al. (2012) did not ($R^2 = 0.41$). In relatively stable weather environments, such as our studies in the Deep South, it makes sense that spring whistle counts ostensibly have more predictive power ($R^2 = 0.791$).

Overwinter survival and available breeding birds have long been considered important to subsequent autumn populations (Stoddard 1931). More recent analysis of the sensitivity of populations to demographic parameters has reinforced this notion (Sandercock et al. 2008). It is logical then that having an accurate measure of spring breeding numbers would have some bearing on the subsequent autumn population. By doing repeated counts with experienced observers we were able to get accurate counts of peak calling numbers each year during the most consistent time of calling activity in both spring and autumn. These results seem to verify Rosene's findings from decades ago that each whistling male heard in the spring would represent a covey in the autumn (Rosene 1969), although his point counts were conducted haphazardly as convenient sampling during spring and summer.

The variation explained by site in our results is not unexpected because there was a wide range of initial densities on our study sites (Fig. 1). Although some sites started with virtually zero birds, others had 8–10 males whistling on some points. Higher density sites experienced more subtle increases in population growth while other sites observed dramatic increases during the course of the study. The relationship of spring whistle counts to autumn covey counts on high-density sites may not be as reliable compared with lower density sites. The presence of conspecifics calling elicits more calling activity whereby higher densities of whistling males results in higher calling rates (Wellendorf and Palmer 2012). On some of our study sites male whistling density was high (>10 birds calling/point), rendering it difficult to discern individual whistling males. This might reduce one's ability to report accurate numbers, supporting previous findings by Ellis et al. (1972). Although our sample size was lower, we observed higher variation in point-count estimates at higher densities, suggesting that the technique may be more appropriate and more meaningful when measuring lower densities (<1 bird/acre) or tracking population increases to get to high density. At higher densities the quadrat method of covey census is more dependable (Wellendorf et al. 2004); however, the need to switch to this method because of density is already indicative of some level of success. These findings are important and novel because previous studies did not incorporate such a wide range of sites with varying population density and, thus, were unable to address the performance of using spring whistle counts in varying bird densities. More research is needed to better understand if this relationship holds up at higher densities.

The lack of support for annual variation as a predictor in our study may be attributed to the lack of dramatic population growth observed temporally in the southeastern United States compared with other boom-and-bust type populations. We do not typically observe the dramatic annual swings in populations such as occur in more weather-driven populations in the bobwhite range to the west or north. As such, spring whistle counts in these environments have not been shown to be as reliable of a predictor of autumn populations or breeding activity (Bridges et al. 2001, Reyna et al. 2012).

MANAGEMENT IMPLICATIONS

Our results indicate spring whistle counts are a reliable tool in the Deep South of the United States for predicting autumn covey numbers for purpose of lease, purchase, or translocation eligibility as long as the counts are done correctly (i.e., at peak of calling activity). We recommend that counts should be conducted by experienced observers and repeated weekly to ascertain the peak number of calling males from each point for comparison from year to year and across sites. The timing of spring whistle counts provides an advantage over autumn covey counts to forecast baseline autumn population abundance to meet permit requirements for translocation (such as that stipulated in the GA DNR WRD permitting requirements). However, given that peak spring whistle counts are a predictor and not an actual estimate of autumn abundance, we do not recommend establishing bag limits from this method but rather using other methods to estimate autumn abundance for these purposes.

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