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John Palarski
Tarleton State University

Shelby Simons
University of Georgia

Bradley W. Kubečka
University of Georgia

Theron M. Terhune II
Tall Timbers Research Station and Land Conservancy

Greg Hagan
Florida Fish and Wildlife Coservation Commission

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HIGHLY VARIABLE AUTUMN CALLING RATES OF NORTHERN BOBWHITE FOLLOWING TRANSLOCATION

John Palarski[1,2]
Department of Wildlife and Natural Resources, Tarleton State University, Stephenville, TX 76402, USA

Shelby Simons
Warnell School of Forestry and Natural Resources, University of Georgia, 180 East Green Street, Athens, GA 30602, USA

Bradley W. Kubečka[2]
Warnell School of Forestry and Natural Resources, University of Georgia, 180 East Green Street, Athens, GA 30602, USA

Theron M. Terhune II[3]
Tall Timbers Research Station and Land Conservancy, 13093 Henry Beadel Drive, Tallahassee, FL 32312, USA

Greg Hagan
Florida Fish and Wildlife Conservation Commission, 13093 Henry Beadel Drive, Tallahassee, FL 32312, USA

ABSTRACT

Fall covey counts are a popular index for monitoring population trends of northern bobwhite (*Colinus virginianus*; hereafter, bobwhite), but their utility is tenuous under different scenarios. Detecting an individual covey is the product of the probability that the covey's activity center is located within the sampling frame, the probability the covey is located within the sampling frame during the sampling periods, the probability of the covey vocalizing, and the probability an observer will detect a calling covey. Researchers attempt to maximize detection or account for these potential sources of error using standardized protocol of limiting counts to certain weather conditions, replication, and distance sampling. Variation in calling rates across a range of bobwhite densities could lead to tenuous inference of population abundance from fall covey counts, particularly at low densities. Our objectives were to assess fall calling rates at 2 sites with low bobwhite density during population restoration. Our study sites were located in Erath County, Texas, USA and Leon County, Florida, USA and received translocated bobwhite during 2019 and 2020. We hypothesized calling rates would be influenced by the number of adjacent coveys that called, and thus, would be low for our sites. Although we did not estimate bobwhite density on our study sites, we surmised that their respective populations were <1 bird/3 ha. Calling rate at the Erath County site was 0 in 2019 ($n = 10$ counts) and increased to 0.79 (standard error [SE] = 0.07, $n = 34$ counts) in 2020. Calling rate was assessed only in 2020 at the Leon County site and averaged 0.13 (SE = 0.07, $n = 23$ counts). Detection rate at count stations was 0 in 2019 and 0.78 (SE = 0.08, $n = 27$ calling coveys) in 2020 at the Erath County site. In 2020, detection rate at count stations was 0 ($n = 3$ calling coveys) at the Leon County site. We documented high annual variation in calling rates among low-abundance sites, suggesting researchers should seek to empirically estimate this parameter rather than applying arbitrary correction factors based on previous literature. Low and variable calling rates limit detection and can bias inference.

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Key words: calling rates, *Colinus virginianus*, detection, northern bobwhite, point counts, translocation

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[1] *E-mail: jpalarski@talltimbers.org*

[2] *Present address: Tall Timbers Research Station and Land Conservancy, 13093 Henry Beadel Drive, Tallahassee, FL 32312, USA*

[3] *Present address: Orton Plantation, 9149 Orton Road SE, Winnabow, NC 28479, USA*

Fall covey counts are a popular index for monitoring population trends of northern bobwhite (*Colinus virginianus;* hereafter, bobwhite), but their utility is tenuous under different scenarios (DeMaso et al. 1992, Wellendorf et al. 2004, Wellendorf and Palmer 2005, Rusk et al. 2007). Despite concerns of accuracy, wildlife managers and researchers often use covey counts to index bobwhite populations (Kubečka et al. 2019). Covey counts are advantageous because they can cover large areas and provide data on post-recruitment population abundance (DeMaso et al. 1992). However, one critical assumption of covey counts is that calling rate is constant over time and space. Constant calling rates lead to more consistent detection probability when detectability is not empirically estimated. It is imperative that detection probability is consistent to reliably estimate population trends. Researchers maintain consistency in survey methodology to standardize effects that may lead to differential calling rates and detection. Researchers conduct surveys in the fall approximately 45 minutes before sunrise until sunrise because calling rates are highest during this period (Guthery 1986, DeMaso 1992). Additionally, observers ensure consistency in detection probability by using 1) standardized protocol that limits surveys to optimal weather conditions (e.g., low wind, no precipitation) and 2) replication. Nevertheless, bobwhite exhibit antiphonal calling, that is, density-dependent calling activity (Stokes and Williams 1968), which may violate the assumption of constant detection probability and lead to erroneous abundance estimates.

Researchers have also used covey counts to assess bobwhite population responses to various treatments, such as translocation (Scott et al. 2013, Downey et al. 2017, Palarski 2021). Translocation of wild bobwhite has gained popularity as a conservation tool to combat population decline over the last 2 decades. Some of these efforts seek to evaluate specific research questions like effects of source population (Palarski 2021) or landscape connectivity (Coppola et al. 2021) on key demographic rates, such as survival, reproduction, and dispersal. However, many studies attempt to evaluate translocation success or efficacy using call counts in order to assess abundance in addition to demographics (Sisson et al. 2012, Downey et al. 2017, Sisson et al. 2017, Palarski 2021). Although call counts are often used, inference may be tenuous because they are often poor predictors of density at smaller scales (Kubečka et al. 2019).

Bobwhite translocations typically occur in areas with low abundance and densities (<1 bird/3 ha; Terhune et al. 2010, Downey et al. 2017, Palarski 2021), or in areas where bobwhite have been extirpated (Scott et al. 2013). As a result, calling rates may vary due to low populations before and during translocation. These low populations may negatively influence calling rates, and thus render covey call counts poor predictors of actual abundance. As a result, researchers may draw inaccurate conclusions on short-term success. Our objectives were to assess fall covey calling rates at sites with low bobwhite density (<1 bird/3 ha) during translocation. Specifically, we used our data to 1) quantify calling rates for known coveys and 2) calculate detection rate at predetermined call count stations.

STUDY AREA

We conducted this study in 2 locations: Erath County in Texas, USA, and Leon County in Florida, USA. Both study sites were actively managed for bobwhite and were undergoing translocation during the study period. We estimated that fall bobwhite density was <1 bird/3 ha on both study sites based on anecdotal observations, number of birds translocated to each site, and demographic rates from radio-marked bobwhite. Following a second year of translocation in 2020, fall populations likely increased from 2019 but remained low for both sites (<1 bird/3 ha).

Erath County

The first study area was a 1,011-ha private property located in western Erath County near De Leon, Texas (Figure 1). The area was in the Cross Timbers ecoregion, which was defined by forest (primarily *Quercus* spp.) intermixed with patches of grassland prairies (DeMaso and Dillard 2007). Herbaceous vegetation was dominated by little bluestem (*Schizachyrium scoparium*), while woody vegetation consisted of elbowbush (*Forestiera pubescens*), sandplum (*Prunus angustifolia*), and oak (*Quercus* spp.) mottes. Long-term (30-year) average annual precipitation for the area was 86.2 cm; maximum monthly precipitation occurred bimodally, peaking in May and September (PRISM Climate Group 2020). Average monthly temperatures ranged from 7–28° C (PRISM Climate Group 2020). We translocated 167 and 236 bobwhite to this study site in 2019 and 2020, respectively. A subset of these individuals (n = 111 and n = 110 in 2019 and 2020, respectively) were radio-marked with very high frequency (VHF) transmitters (American Wildlife Enterprises, Monticello, FL, USA). Bobwhite abundance in both study years was low (< 1 bird/3 ha) during covey counts.

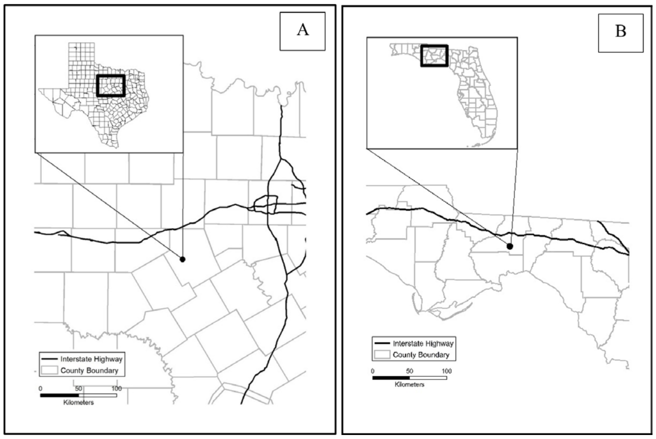

Fig. 1. Location of northern bobwhite (*Colinus virginianus*) translocation sites in A) Erath County, Texas, USA and B) Leon County, Florida, USA. The black dot represents the location of the release sites within each county.

Leon County

The second study area was a 1,538-ha unit of the Apalachicola National Forest in southern Leon County near Tallahassee, Florida. The area was located within the Munson Sandhills region distinguished by predominantly upland longleaf pine ecosystem and dry, well-drained sandy soils. Long-term (30-year) average annual precipitation for the area was 151.3 cm, peaking between June and August (PRISM Climate Group 2020). Average monthly temperatures ranged from 10–27° C (PRISM Climate Group 2020). Dominant woody cover consisted of bluejack oak (*Quercus incana*), sand post oak (*Quercus margarettae*), longleaf pine (*Pinus palustris*), dwarf huckleberry (*Gaylussacia dumosa*), and darrow's blueberry (*Vaccinium darrowii*). Herbaceous vegetation primarily consisted of wiregrass (*Aristida stricta*), pineywoods dropseed (*Sporobolus junceus*), bluestem (*Andropogon* spp.), witchgrass (*Dichanthelium* spp.), pineland pinweed (*Lechea sessiliflora*), silkgrass (*Pityopsis* spp.), gopher apple (*Geobalanus oblongifolius*), and saw greenbrier (*Smilax bona-nox*). This site was also included in an active translocation program during 2019 and 2020. We translocated 80 and 81 individuals to this study site in 2019 and 2020, respectively. We trapped 11 and 28 resident bobwhite on the study site during February 2019 and February 2020, respectively. We radio-marked all translocated and resident individuals with VHF transmitters.

METHODS

Field Methods

We conducted covey counts from 27 September–24 November in 2019 and 2020. The night before each formal call count, observers located the radio-marked covey's roost. Roost locations were determined approximately 1 hour after official sunset the night prior to counts to minimize disturbance near the roost site during the morning of counts. Observers located radio-marked coveys via VHF radio-telemetry by homing to approximately 30 m (White and Garrot 1980). At the Erath County site, we conducted covey counts using 2 observers. One observer was stationed at predefined call count stations used for long-term data collection at varying distances from the marked covey. This observer was used to estimate detection probabilities. The second observer was positioned approximately 125 m from the marked covey (Wellendorf et al. 2004). We chose this distance because we believed that likelihood of detection of calls at this distance was approximately 1 and minimized the effects that observers had on calling rate. Thus, the second observer served to estimate calling rate.

At the Leon County site, we obtained roost locations the night preceding call counts by homing to approximately 30 m. To estimate calling rates, we placed a Song Meter SM3 acoustic recording device (Wildlife Acoustics Inc., Maynard, MA, USA) on a nearby tree approximately 1.5 m above ground level during the roost visit. We assumed likelihood of detection by the device was 1 at a distance of 30 m from the covey (Wilhite et al. 2020). Similar to the Erath County site, the following morning, observers were positioned at predefined listening stations within the radius of audibility of the marked coveys; we assumed that observers could detect coveys up to 600 m (Reyna et al. 2012).

Observers arrived at listening stations at least 45 minutes before official sunrise and recorded whether the radio-marked covey called and, if so, the time it called. The survey stopped at sunrise if no calls were heard, or 20 minutes after the first call was heard (DeMaso et al. 1992). Observers replicated covey counts ≥3 times for each radio-marked covey. All observers were trained prior to conducting call counts. Training trials occurred beforehand until trainees achieved similar estimates for the number of coveys heard (Kubečka et al. 2019). Call counts were not conducted when wind speeds exceeded 16 km/hr or if it was raining.

Acoustic recordings from the Leon County site were manually reviewed by 1 observer. At both study sites, calling rate was calculated by dividing the number of radio-marked coveys that called by the number of radio-marked coveys monitored at each study site. Detection rate was calculated by dividing the number of radio-marked coveys heard at the established call count station by the number of radio-marked coveys that called.

RESULTS

We monitored 2 coveys in 2019 and 8 coveys in 2020 at our Erath County site. Calling rate at the Erath County site was 0 in 2019 (n = 10 counts) and increased to 0.79 (standard error [SE] = 0.07, n = 34 counts) in 2020. Detection rate, conditional on calling, was 0 in 2019 and 0.78 (SE = 0.08, n = 27 calling coveys) at the Erath County site. We monitored 8 coveys at the Leon County site in 2020. Calling rate at the Leon County site averaged 0.13 (SE = 0.07, n = 23 counts), but detection rate was 0 (n = 3 calling coveys). At the Erath County site, the mean distance from the covey to observer when coveys called but were not detected was 446 m (range = 409–515, n = 6 counts). At the Leon County site, the mean distance from the covey to observer when coveys called but were not detected was 362 m (range = 143–612, n = 3 counts). At the Leon County site, average calling time for radio-marked coveys was 4 seconds (range = 1–7, n = 3 calling coveys). Average number of calling events was 3 (range = 2–7, n = 12 events). Calling time and number of events were not assessed at the Erath County site.

DISCUSSION

Calling rate estimates for our Erath County site were highly variable between years. This variability can limit inference from fall covey counts and thus bias estimates. We caution researchers using covey call counts to assess population response from translocation.

Although we did not empirically estimate density, we surmised that bobwhite populations were low (<1 bird/3 ha) on both study sites. Since we did not compare calling rates across bobwhite density values, we acknowledge that attributing calling rate variability to low density is tenuous. We believe that low bobwhite density on our study sites resulted in highly variable calling rates between years (Stokes and Williams 1968, Lituma et al. 2017) though that relationship is speculative. Yeiser et al. (2021) sought to evaluate precision and bias of bobwhite density estimation via covey call counts under various scenarios. They suggested that a large number of call count stations ($n = 35$) over multiple years ($n = 5$) can produce unbiased estimates of bobwhite density. However, these recommendations are often untenable for both land managers and researchers. To survey 35 call count stations ≥3 times/year would require 105 total surveys. This sampling regime would also require a minimum area of approximately 4,000 ha assuming a 600-m radius of audibility for each call count station. The need for high intensity sampling coupled with large area size would preclude many areas from having unbiased estimates as proposed by Yeiser et al. (2021). Furthermore, simulations conducted by Yeiser et al. (2021) assumed bobwhite densities greater than estimates for our study sites (≥0.62 bird/ha). As a result, surveys would likely need to be repeated more than 3 times/season to reduce bias and increase precision on smaller areas. To mitigate logistical constraints surrounding human observers, acoustic recording units (ARUs) could be used to meet high demand from surveys (Wilhite et al. 2020). Although further development is needed, ARUs may provide a mechanism to achieve high intensity surveying.

Documenting a population response from translocation, and thus defining short-term success, is a primary objective of many translocation efforts. Prior translocations in Texas have been designated as failures because of the inability to document substantial increases in call counts on the release site (Scott et al. 2013, Downey et al. 2017). Notably, Downey et al. (2017) reported demographic rates of translocated bobwhite in the Rolling Plains ecoregion of Texas comparable to stable populations but failed to document a population response on the release site compared to a control site after 2 years of translocation. The population response was partially assessed by fall covey counts. It is possible that variability in calling rates, lack of precision in indices, and variation in detection could have affected abundance comparisons.

Rusk et al. (2007) documented that covey call counts consistently underestimated bobwhite density and did not reflect changes in population abundance. With a calling rate of 0.70, similar to the rate we reported from 2020 in Erath County, bobwhite density estimates were still biased low compared to distance-based aerial (helicopter) surveys (Rusk et al. 2007). Results from Rusk et al. (2007) and our data suggest that using covey call counts to designate translocation success in the short term may be unreliable unless paired with estimates of detection and calling rate.

Mean distances from radio-marked coveys that called but were not detected at a call count station were within the 600 m radius of audibility at both study sites. We assumed a 600-m radius of audibility under ideal conditions, but topography, vegetation, and observer acuity may limit distances where calls can be heard. These factors can produce inconsistent and reduced detection probabilities. Our data may also be partially explained by results from Seiler et al. (2005), who estimated a mean measurement error of 75 m between known calling covey locations in rolling terrain. Additionally, we documented short calling durations and few calling events at our Leon County site, which may further limit detection at long distances (>400 m) from the observer.

The effects of conspecifics on calling behavior are well documented in the literature such that birds are known to increase calling activity in response to the presence of conspecifics (Penteriani et al. 2002, Sexton et al. 2007). It is plausible that use of playback calls may increase calling rates; however, use of this technique has yielded mixed results among songbirds and bobwhite. Lituma et al. (2017) found that the number of bobwhite conspecific calls and individual calling rate of conspecifics increased the likelihood of detection and an individual's detection availability during the breeding season. Other studies have shown that the use of playbacks to stimulate calling activity using the assembly call increased detection during the breeding season (Bailey 1978, Coody 1991) and non-breeding season (Wellendorf et al. 2001) under varying conditions. At low-density sites, the availability of a covey to be detected is low because of the ostensible lack of conspecifics present or high vulnerability to predation risk (or both) (Lima 1993, Bleicher 2017, Gaynor et al. 2019). Wellendorf et al. (2001) documented no difference between natural calling rates and stimulated calling rates during good weather conditions (<50% cloud cover and <16 km/hr wind speeds) but did detect an increase in stimulated calling rates during poor weather conditions (>50% cloud cover and >16 km/hr wind speeds); however, their study was conducted on moderate-density sites. Additionally, playbacks may not provide the necessary call frequency or magnitude needed to simulate a wild covey and elicit a response by unobservable coveys (DeMaso 1991, DeMaso et al. 1992, Rusk et al. 2009). Although there was an increase in calling rates using the playback device during poor weather conditions, we standardized our protocol to not conduct counts during these conditions. Regardless, when using call counts with or without playbacks, collecting data to decouple detection components by using time-of-detection and dependent double-observer methods is important to provide reasonable estimates of availability and detection given availability (Riddle et al. 2008, 2010). However, few studies have been conducted on low density (<1 bird/3 ha) sites for bobwhite using playbacks. More research is warranted to understand how playbacks at low densities influence calling rate and availability of detection.

Similarly, more research is needed to understand variability in peak covey calling spatially and temporally as well as alternatives to obtaining population estimates for assessing population growth, particularly germane to translocation success. We used a standardized protocol that provides guidance on when to conduct counts; it incorporates weather conditions and time of year to capture peak calling activity. However, peak calling could also be assessed temporally and spatially by monitoring number of calling coveys heard and determining when calling rates peaked post hoc. For example, calling rates in Erath County during the first week (1 Oct–8 Oct) was 0.13, but increased to 1 for all subsequent weeks of the survey. Additionally, automated recording devices could be used to ascertain peaks in calling activity and to increase sampling area and frequency (Wilhite et al. 2020). Call count data could then be used during this peak to further reduce variation in calling rates. Last, our study focused on design-based methods to minimize variability in detection probability. Abundance estimates can also be improved by using statistical models that may further reduce bias and increase the likelihood of detecting population trends (Yeiser 2021). Modeling detection by incorporating distance-to-observer, time-of-removal information, or repeat visits or observers can be an effective method to estimate abundance (Thompson 2002).

MANAGEMENT IMPLICATIONS

In light of the unreliability of covey call counts at low population densities, we suggest utilizing alternative approaches to determine short-term success of translocation. We suggest integrating appropriate detection estimation procedures such as the dependent double-observer and time-of-detection method. When using covey call counts as a means to document population response, we recommend that researchers empirically estimate calling rate rather than applying arbitrary correction factors based on previous literature. Further refinement of acoustic recording units could provide a possible remedy for determining calling peaks, obtaining sufficient sample sizes, and reducing observer bias.

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