Observer Group Accuracy in Plotting Locations of Northern Bobwhites when using Fall Covey Calls

Ted Seiler,[1] *Department of Fisheries and Wildlife Sciences, The School of Natural Resources, 302 Anheuser-Busch Natural Resources Building, University of Missouri, Columbia, MO 65211*

Ronald D. Drobney, *U.S. Geological Survey, Biological Resources Division, Missouri Cooperative Fish and Wildlife Research Unit, 302 Anheuser-Busch Natural Resources Building, University of Missouri, Columbia, MO 65211*

Thomas V. Dailey, *Missouri Department of Conservation, 1110 S. College Ave., Columbia, MO 65211*

Abstract: Morning covey call counts are popular for estimating fall abundance of northern bobwhite (*Colinus virginianus*). However, veracity of the technique's abundance estimates are questionable with numerous assumptions inherent to the technique. Therefore, we used captive bobwhites to test ability of three groups of observers to plot calling bobwhite locations on an aerial photo. We found no difference ($P < 0.05$) between observer groups when plotting calling bobwhites from within a grid cell. Accuracy was generally poor ($\bar{x}$ = 75.0 m, SE = 10.9) regardless of where in the grid cell the calling bird was located. We also compared accuracy in plotting captive birds and recorded calls and found that recorded calls can be used as a substitute for captive bobwhites when testing observer groups. However, there are potential sources of error including time of day and possibility of observer group accuracy changing as number of attempts to plot coveys increases during the day. We advise caution in using the covey call technique and recommend further research.

Key words: Colinus virginianus, covey calls, density, *Missouri*, northern bobwhite, observer, population estimation, recorded calls

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 59:57–65

Estimation of animal density is important for evaluation of habitat management, behavior, and density-dependent population phenomena. For northern bobwhite (*Colinus virginianus*, hereafter referred to as bobwhite), various methods have been evaluated including drive counts (Dimmick et al. 1982, Janvrin et al. 1991, Stauffer 1993), morning covey calls (Guthery 1986, DeMaso et. al. 1992, Seiler et al. 2001, Wellendorf et al. 2004), distance sampling (Guthery 1988, Kuvlesky et al. 1989), covey mapping, and mark-recapture techniques (Dimmick et al. 1982, Lancia et al. 1994). Potential problems include violation of assumptions, observer errors,

1. Present address: 2108 US Hwy 63, Suite B, Macon, MO 63552.

cost, and logistics. In the context of management, cost and lack of time limit usefulness of labor-intensive methods. The fall covey call technique is appealing to managers because only 1–2 hours of daily data collection during October are needed.

Bobwhites form coveys in fall with intense vocalization at dawn. Previous studies of wild bobwhite indicate that calling begins about 25 minutes before sunrise, calling duration by a covey is generally <2 minutes, and most calling by bobwhites in a local geographic area lasts <15 minutes (Wellendorf et. al. 2004). Observers commonly detect calling bobwhites at a distance of 500 m with weather, vegetation, and observer's hearing ability causing variation (Seiler et al. 2001, W.E. Palmer, Tall Timbers Research Station, personal communication). Researchers are uncertain about calling behavior of individuals within a covey, with >1 bird sometimes calling (Wellendorf 2000).

When morning covey call counts (hereafter referred to as call counts) are used to determine population density, estimation is based on 25 ha (500 x 500 m) grid cells (Wellendorf 2000). In this method, observers ($N = 4$) are positioned at the midpoint of each side of the cell, listening for calling bobwhites and recording an azimuth to the calls, time calls occurred, and an estimate of distance to the calling covey. Sampling is conducted from 45 minutes before sunrise until sunrise during September–November. At sunrise, the observers convene to classify calling coveys as being inside or outside the grid cell boundaries marked on an aerial photo. For coveys heard by >1 observer, calling event times, intersecting azimuths, and distance to coveys are used to plot estimated covey locations on an aerial photo. For coveys heard by only one observer, there is more uncertainty in determining locations because distance can only be estimated by perception of loudness of calling. Immediately after plotting coveys, observers search areas where coveys were plotted in an attempt to flush coveys and count individuals.

We conducted a pilot study of wild bobwhites in 1999 which raised questions about ability of observer groups to detect, count, and accurately plot calling bobwhite locations on an aerial photo. Thus, our objective was to test observer group accuracy using known locations of captive bobwhites. Because bobwhites call only briefly each morning, amount of data collected when testing observer groups is limited. Data are further reduced by inclement weather or when captive birds do not call. The problem of a small data set could be overcome if recorded calls could be used as a substitute for captive bobwhites. Therefore, we also tested observer group accuracy using a recorded calling device.

Study Area

To examine covey plotting accuracy, we used a single 500 x 500 m cell on the Prairie Fork Conservation Area in Callaway County, Missouri, during 15 September–10 November 2000. The cell contained open fields dominated by herbaceous vegetation (mostly Indiangrass *Sorghastrum nutans*, big bluestem *Andropogon gerardii*, and goldenrod *Solidago* spp.) 1–2 m tall with a small, wooded draw running through the northwest quadrant. The cell was located on a rolling hill with the center of the cell being near the highest point. We chose this area because wild bobwhites were scarce and thus would not add calling during tests, but land cover was suitable for bobwhites.

Methods

Because weather may affect calling behavior and observer accuracy, we recorded wind speed (km/h), temperature (C), and barometric pressure (mb Hg) daily at the hour closest to sunrise at the Prairie Fork Conservation Area weather station. We visually estimated percent cloud cover at sunrise and calculated a mean value across the four observers. We did not sample if it was raining or if wind speed exceeded 8 km/h.

Because there was no previous research evaluating observer group accuracy for call counts, we tested the simplest scenario of one calling captive bobwhite in the cell. This was done to determine how an observer group's ability to detect and plot a single "covey" varies with calling location relative to locations of observers. We were concerned about calling location with respect to its distance from the 4 observers, not absolute location in the grid cell. Therefore, we considered a point 50 m directly in front of one observer equal to a point 50 m directly in front of another observer.

To optimally space calling points for testing observer groups, we divided the grid cell into four equal quadrants by drawing a line from the midpoint of the north boundary to the midpoint of the south boundary, and likewise on the east/west boundaries. We bisected each of these quadrants by drawing a diagonal line from corner to corner across the grid cell, making eight equal half-quadrants. Each of these half-quadrants was equal to all other half-quadrants with respect to distance from observers. We distributed nine potential calling points approximately evenly through one of the half-quadrants. This arrangement positioned a calling point in the approximate area of all potential covey locations in the grid cell with respect to distance from the observers. For each calling point, a half-quadrant was randomly assigned. We used this semi-random placement rather than random placement to gain the most information possible from a small sample.

For each calling point, UTM coordinates were determined. One hour before sunrise, one captive bobwhite was placed at the GPS-determined location. Observers were unaware of the location or number of calling birds. Captive birds were used instead of recorded calls because they, like wild birds, can vary their calling intensity, direction, and duration. We placed a tape recorder beside the captive bird to record calling. If the bird did not call, the observation was discarded.

Three groups of observers were tested in this study. Each group was tested twice per week, and only one group was tested each day. Each observer was a member of only one group, and therefore each observer group consisted of the same four observers each time the group was tested. Each observer stood at the same listening post (e.g., north side of the cell) each time their group was tested. Observers were in position 45 minutes before sunrise. Upon hearing a calling bobwhite, observers recorded the time, azimuth, and estimated distance to the calling bird. At sunrise observers convened away from the grid cell and, as a group, plotted calling bobwhites on an aerial photo.

We collected 2 observations using taped calls for every observation using captive bobwhites. While the observer group was plotting the morning's captive bobwhite, the bobwhite was removed and a Johnny Stewart game caller (manufactured by Hunter's Specialties in Cedar Rapids, Iowa) with recorded covey calls was placed at a point equivalent to the previous location of the captive bird, but in a different half-quadrant (test series referred to as Tape 1). We did not use captive bird location because observers might be predisposed to orient their listening toward that location. Observers returned to their listening posts for 30 minutes and we played the recorded call at about the same volume as a captive bobwhite. We directed the speaker toward each observer for 1 or 2 series of calls (about 10 seconds each direction). Observers then followed the protocol used for tests of captive bobwhites.

We were concerned that topography or vegetation may cause a difference between observer group error when plotting the captive bird and Tape 1, so we tested recorded calls from the exact locations of the captive birds, but on different dates (test series referred to as Tape 2). While observer groups were plotting Tape 1 calls, the game caller was moved to a location that was one of the exact points where a captive bird had been, or would be placed for observers on a future date. Again, observers returned to their listening posts and we played the tape with the speaker facing each observer. Observer groups plotted the location of the calling activity on an aerial photo. We did not inform observers of the location of the recording, or that locations were correlated with captive bird locations. The same recorded call was used for all testing.

We digitized plotted locations for captive birds and recorded calls on a digital ortho-quarter quad (DOQQ) map in ArcView 3.2 (ESRI 1996) using observer groups' marks on the aerial photo. On occasions when observer groups plotted >1 covey, the point closest to the actual call location was used. We measured plotting errors by observer groups using the ruler in ArcView 3.2 (ESRI 1996). We assume that any errors due to digitizing were consistent among all treatments. We attempted to test each observer group one time for each of the 9 covey locations for a total of 27 observations using captive birds.

We hypothesized no difference in observer group plotting accuracy among calling bobwhite locations. We analyzed data using a single factor analysis of variance (ANOVA) (Snedecor and Cochran 1989) with 9 treatments (bird locations) and 3 replicates (observer groups) per treatment. The response variable was observer group error in plotting the captive bird. We tested the null hypothesis that observer group error was equal when plotting captive bobwhites and recorded calls using a randomized complete block design. An ANOVA (SAS 1989) was used to test for main effects of the type of call (captive bird, Tape 1 or Tape 2) and calling bobwhite location differences. The response variable was observer group plotting error. Mean differences in effects of type of call were determined using Fisher's Least-Squares Means.

We also wanted to determine what factors influenced ability of observer groups to detect and accurately plot calling bobwhites to help managers set up a protocol for accurate data collection. We were not interested in developing models to predict observer group accuracy, but rather factors affecting observer group accuracy. Therefore, we used AIC (Akaike information criteria) for small samples, calculated from residual sum of squares for each model. Then, ΔAIC values were calculated for each model (Burnham and Anderson 1998), and model weights were calculated to determine probability of each model being the best given the candidate model set (Burnham and Anderson 1998).

We used Spearman correlation analyses to compare each independent variable against observer error (distance between observer group plotted location and actual location). We considered all variables with >0.20 correlation coefficient as potential variables in linear regressions. Variables used in regression models included attempt (number of times an observer group had been tested), mean distance to 2 closest observers (average distance to 2 closest observers was used instead of average to all 4 observers because normally only 2 observers are needed to plot approximate location of a covey), temperature, and wind speed. All 4 variables were used to form a global model. We hypothesized that location of the bird within the grid cell, quantified as mean distance to 2 closest observers, would have most influence on ability of observer groups to detect and accurately plot calling bobwhites. We formed models using covey location, wind, temperature, and attempt to determine which factors were most influential in determining location of the calling bobwhite. We analyzed all data (SAS 1989) with significance levels set at $\alpha = 0.05$.

Results

Due to inclement weather, not all groups were tested with all 9 points. Additionally, on 2 occasions, the observer group did not detect a calling bobwhite and those observations were discarded. Each of the 9 points was tested with captive birds using ≥2 observer groups. We had 21 useable observations using captive bobwhites. Mean observer group error was 75.0 m (SE = 10.9m) and ranged from 27.5 to 85.7 m. There were 23 observations using Tape 1 and 21 observations using Tape 2. Mean observer group error was 70.2 m (SE = 8.20) for Tape 1 and ranged from 13.5 to 93.5 m. Mean observer group error was 38.1 m (SE = 3.17) for Tape 2 and ranged from 17.0 to 50.5 m. We found no difference in plotting accuracy between bobwhite locations within the grid cell ($F_{8,34} = 0.94$, $P = 0.49$).

AICc scores for the seven test models ranged from 76.00 for the location only model to 80.40 for the global model (Table 1). AIC scores went up as more variables were added to the model, and none of the models had an AICc score lower than that of the intercept only model (74.88), indicating that all models perform poorly. Observer group error differed in plotting real birds to Tape 1 and Tape 2 ($F_{2,34} = 4.02$, $P = 0.02$). Observer group plotting error for captive birds was similar to Tape 1 ($T_{34} = -0.24$, $P = 0.81$), despite the tape being played from a different half-quadrant. However, plotting error for captive birds differed from Tape 2 ($T_{34} = 2.55$, $P = 0.02$) even though the tape was played from the exact point at which the captive bird had called, only on a different day. Tape 1 also differed from Tape 2 ($T_{34} = 2.42$,

Table 1. Linear regression models and their AICc, ΔAIC, and model weights for predicting ability of observer groups to detect and plot a calling bobwhite on Prairie Fork Conservation Area in Callaway County, Missouri, during fall 2000.

Model	AICc	ΔAIC	Weight
Intercept only model	74.88	0	0.345
–69.542 + 0.716Ave[a]	76.00	1.22	0.197
92.702 – 4.814Attempt	76.39	1.51	0.162
24.134 – 7.269Wind + 1.263Temp	77.48	2.60	0.094
–43.024 + 0.613Ave – 4.605Wind	77.71	2.83	0.084
–100.977 + 0.624Ave – 5.514Wind + 1.281Temp	78.75	3.87	0.050
–100.445 + 0.717Ave – 3.307Attempt + 1.037Temp	78.95	4.07	0.045
–67.522 + 0.582Ave – 3.756Attempt – 5.972Wind + 1.122Temp (global)	80.40	5.52	0.022

a. Ave = mean distance to the nearest 2 observers; Attempt = the number of attempts by the observer group; Wind = wind speed in kmph; Temp = temperature in °C.

Table 2. Observer group error in plotting captive bobwhites and recorded calls at 9 different points in a 500 × 500 m grid cell on Prairie Fork Conservation Area in Callaway County, Missouri, during fall 2000. Tape 1 was played from a point equal to the captive bird location in its distance from the 4 observers. Tape 2 was played from the exact point that a captive bird had been or would be placed in the future. The error is the 3-group mean distance (m) between the observer group plotted location and the actual location of the captive birds, or speaker in the case of recorded calls. The value is the mean error from 1–3 observer groups, with number of observer groups denoted by *N*.

	Captive bobwhite		Tape 1		Tape 2	
Point	$\bar{x}$	*N*	$\bar{x}$	*N*	$\bar{x}$	*N*
1	89.7	3	86.0	2	42.5	2
2	27.5	2	13.5	2	40.5	2
3	73.3	3	83.7	3	44.0	2
4	76.0	3	83.0	3	31.5	2
5	80.5	2	93.5	2	50.5	2
6	76.0	2	56.0	2	34.5	2
7	34.0	2	64.3	3	42.0	2
8	57.3	3	89.0	3	39.7	3
9	150.0	1	66.3	3	17.0	2

$P = 0.02$). Observer group error was consistently lower for Tape 2 than for the captive bird or Tape 1 (Table 2).

Discussion

We tested observer groups using a single bird to simulate a wild bobwhite covey. We assume that a single bird has similar detection probability and plotting accuracy to that of a wild covey. When listening for wild bobwhites, more than one bird per covey may call, possibly leading to different results than we found. Our study was also conducted entirely on one study site and results may not be consistent throughout the bobwhite's range.

In the event that the observer group did not detect the calling bobwhite ($N = 2$), the observation was discarded because we chose not to assign an arbitrary value for observer group error. These 2 observations are important but we could not use them in our analysis; our error computations would be greater if these "missing" values had been used. Moreover, it is clear that 100% calling bobwhite detection can not be assumed when using a 25-ha grid cell.

Our results suggest that observer group accuracy in plotting calling bobwhites was poor regardless of the bird's location within the grid cell. Further, observer group accuracy in plotting calling bobwhites did not vary with the bird's location within the grid cell as hypothesized. Rather, error associated with plotting calling bobwhites seemed to be highly variable regardless of the location of the calling bird within the grid cell.

One problem arising from observer group error when plotting coveys is that if observer groups are only accurate within 75 m of the true location (mean observer group error during this study), any calling bobwhite ≥75 m of the edge of the grid cell could be recorded as being located outside the grid cell or vice versa. Error of this magnitude demonstrates considerable uncertainty in ability of groups to discriminate between bobwhites calling from inside or outside the grid cell. This uncertainty could have a profound effect on accuracy of estimates of number of bobwhites in a grid cell.

Despite our efforts to select a site that was devoid of wild bobwhites, some did occur on the area. The senior author stood in the center of the grid cell during the pen-raised bobwhite test each morning and detected wild bobwhites on 11 of 21 occasions. Our data were collected using a single captive bird in the grid cell, and on 17 of 21 occasions the observer groups plotted multiple calling bobwhites. On eight occasions, observer groups plotted ≥3 calling bobwhites. Although some additional calling bobwhites counted were undoubtedly wild birds, we believe that in many instances when multiple "coveys" were recorded, the observer groups were overestimating number of bobwhites actually calling. This counting inaccuracy, along with less than 100% detection observed during our study, raises doubt about observer groups correctly counting number of calling bobwhites in a grid cell. If number of calling bobwhites is counted correctly, call counts could be effective in spite of large observer group plotting errors if observers could subsequently locate and flush bobwhites that had called. However, because of plotting errors, flushing bobwhites would be more difficult and an alternative method for determining covey size might be needed for this technique to be effective.

Our regression models to determine what factors influence observer group accuracy become less likely to be the best model as variables were added. The intercept-only model (with no predictive variables) was the most likely to be the best model, indicating that none of the test models was a good predictor of observer group plotting accuracy. Therefore, all variables tested appear to be unimportant influences on observer group accuracy.

Our analyses suggested that recorded calls can be used as a substitute for captive birds when testing observer group ability to detect and plot coveys. Ability to use recorded calls as a substitute for captive birds will allow future researchers to obtain large data sets of observer accuracy with less effort. We recommend testing observer groups in a variety of habitats and topographies, with multiple callers, to determine whether observer group error can be considered constant across the range of landscapes within the bobwhite's range, and if observer groups accurately count calling quail.

There are some potential error sources that researchers must understand when using recorded calls to test observer groups. During our study, observer group accuracy in plotting location of recorded calls immediately following the captive bird calls (Tape 1) did not differ from the captive bird, but Tape 2 differed from both Tape 1 and the captive bird. Tape 2 was consistently plotted with greater accuracy than the captive bird or Tape 1. The difference may be a result of observers already having attempted to plot 2 other sets of calls that morning. The difference could also be due to different time of day the calls were given. Captive birds called <45 minutes prior to sunrise. Tape 1 was played about 30 minutes after sunrise, and Tape 2 was played about 1 hour after sunrise. Differing environmental conditions may occur during these time periods, possibly leading to greater accuracy later in the morning.

Although our study did not conclusively validate or invalidate call counts, our results do raise questions regarding utility of the current protocol. The next step should be to further evaluate whether observer groups can accurately count calling coveys within a grid cell. If calling coveys can be accurately counted, call counts could be useful in spite of high observer group error when plotting calling coveys. With the ability to count calling coveys and an estimation of the proportion of coveys that call (Seiler et al. 2001), number of coveys on an area can be estimated. If calling coveys are not counted correctly, it may be necessary to reduce size of grid cells. One negative consequence of reducing grid size, however, is that more sampling days would be required to sample an area.

Call counts should be thoroughly validated before using population density estimates for anything more than an index of bobwhite populations.

Acknowledgments

We thank our many dedicated technicians and volunteers who made this project possible. We also thank Mark Ellersieck for statistical assistance. This research was supported by Quail Unlimited, The Prairie Fork Conservation Area Charitable Endowment, and the Missouri Department of Conservation. This paper is a contribution from the Missouri Cooperative Fish and Wildlife Research Unit, Biological Resources Division of the U.S. Geological Survey, Missouri Department of Conservation, and the University of Missouri. Animal Care Use Protocol No. 3115. Shane Wellendorf and Mike Wallendorf provided initial reviews of the manuscript.

Literature Cited

Burnham, K. P. and D. R. Anderson. 1998. Model selection and inference: a practical information-theoretic approach. Springer Verlag, Inc., New York, New York.

DeMaso, S. J., F. S. Guthrey, G. S. Spears, and S. M. Rice. 1992. Morning covey calls as an index of northern bobwhite density. Wildlife Society Bulletin 20:94–101.

Dimmick, R. W., F. E. Kellog, and G. L. Doster. 1982. Estimating bobwhite population size by direct counts and the Lincoln index. Proceedings of the National Quail Symposium 2:13–18.

ESRI. 1996. Using ArcView GIS. Environmental Systems Research Institute (ESRI) Inc. Redlands, California.

Guthrey, F. S. 1986. Beef, brush, and bobwhites-quail management in cattle country. Ceasar Kleberg Wildlife Research Institute Press, Texas A&I University, Kingsville.

______. 1988. Line transect sampling of bobwhite density on rangeland: evaluation and recommendations. Wildife Society Bulletin 16:193–203.

Janvrin, J. A., E. P. Wiggers, and T. V. Dailey 1991. Evaluation of drive counts for estimating northern bobwhite densities. Wildlife Society Bulletin. 19:475–481.

Kuvlesky, W. P. Jr., B. H. Koerth, and N. J. Silvy. 1989. Problems of estimating northern bobwhite populations at low density. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 43:260–267.

Lancia, R. A., J. D. Nichols, and K. H. Pollock. 1994. Estimating the number of animals in wildlife populations. Research and Management Techniques for Wildlife and Habitats 5:215–253

SAS 1989. SAS users manual/statistics, Version 6. SAS Institute, Inc. Cary, North Carolina.

Seiler, T. P., R. D. Drobney, and T. V. Dailey. 2001. Use of weather variables for predicting fall covey calling rates of northern bobwhites. Proceedings of the National Quail Symposium 5:91–98.

Snedecor, G. W. and W. G. Cochran. 1989. Statistical Methods. Iowa State University Press, Ames.

Stauffer, D. F. 1993. Quail methodology: where are we and where do we want to be? Proceedings of the National Quail Symposium 3:21–33.

Wellendorf, S. D., W. E. Palmer, and P. T. Bromeley. 2004. Estimating call rates of northern bobwhite coveys and censusing populations. Journal of Wildlife Management. 68:672–682.

Wellendorf, S. D. 2000. Factors influencing early morning covey calling in northern bobwhites. M.S. Thesis. North Carolina State University, Raleigh.