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Christopher M. Lituma
University of Tennessee

David A. Buehler
University of Tennessee

Evan P. Tanner
University of Tennessee

Ashley M. Unger
University of Tennessee

John J. Morgan
Kentucky Department of Fish and Wildlife Resources

See next page for additional authors

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MONITORING NORTHERN BOBWHITE BREEDING POPULATIONS IN THE CENTRAL HARDWOODS BIRD CONSERVATION REGION

Christopher M. Lituma
Department of Forestry, Wildlife and Fisheries, 274 Ellington Plant Sciences, University of Tennessee, Knoxville, TN 37996, USA

David A. Buehler[1]
Department of Forestry, Wildlife and Fisheries, 274 Ellington Plant Sciences, University of Tennessee, Knoxville, TN 37996, USA

Evan P. Tanner
Department of Forestry, Wildlife and Fisheries, 274 Ellington Plant Sciences, University of Tennessee, Knoxville, TN 37996, USA

Ashley M. Unger
Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, TN 37996, USA

John J. Morgan
Kentucky Department of Fish and Wildlife Resources, Frankfort, KY 40601, USA

Patrick D. Keyser
Department of Forestry, Wildlife and Fisheries, 274 Ellington Plant Sciences, University of Tennessee, Knoxville, TN 37996, USA

Craig A. Harper
Department of Forestry, Wildlife and Fisheries, 274 Ellington Plant Sciences, University of Tennessee, Knoxville, TN 37996, USA

ABSTRACT

Monitoring northern bobwhite (*Colinus virginianus*) breeding populations is an important component of the National Bobwhite Conservation Initiative as a means of evaluating success of achieving population goals. Northern bobwhite populations declined by 3.8% from 1980 to 2006 in the Central Hardwoods Bird Conservation Region (CHBCR). Northern bobwhite research in the CHBCR is limited and population trend estimates are based on North American Breeding Bird Survey (BBS) data. Monitoring northern bobwhite populations and developing accurate population estimates by incorporating detection functions and occupancy estimates are important components of the conservation initiative in this region. We documented northern bobwhite abundance throughout the CHBCR via a roadside-based removal and distance sampling survey method, and assessed differences in detection with respect to observer, northern bobwhite relative abundance, and land cover. We also addressed the potential for a roadside survey bias to ascertain if there was a seasonal, or site effect on northern bobwhite detection and occupancy through repeated surveys. Finally, we measured northern bobwhite calling rates by time of day and day of the breeding season to assess bobwhite availability for detection with radiotelemetry data. The spatially-balanced, roadside, monitoring strategy used counties as basic sampling units within bobwhite focal areas in the CHBCR ($n = 37$ counties). We randomly located 5, 15-km monitoring routes in each focal county along secondary roads. We conducted 5-min unlimited distance point counts along each route (30 counts/route) from May through July, 2008–2011. We conducted off-road and radiotelemetry surveys on Peabody Wildlife Management Area (PWMA), and additional off-road surveys on Fort Campbell Military Base, Tennessee-Kentucky and on private lands in Livingston County, Kentucky from May through July, 2010–2011.We detected 6,440 individual northern bobwhite on roadside survey routes; >95% of the survey routes had at least 1 northern bobwhite detection. We developed a suite of 17 *a priori* removal models in Program MARK to estimate roadside survey detection probabilities. The best model included differences in time interval detection, observer, and 3 covariates: distance from the observer, number of individuals aurally detected, and percent forested habitat within a 100-m radius of the point count. Detection probabilities were greatest during the first minute of detection, and then decreased. Detection probabilities ($\pm$ SD) decreased as distance from the observer ($\beta = -0.0020 \pm 0.0005$, $n = 6{,}440$) increased, but increased as the number of individuals detected at a point ($\beta = 0.15 \pm 0.04$, $n = 6{,}440$) increased. We used the most parsimonious model and mean covariate values to generate overall parameter estimates, which differed

[1]*E-mail: clituma@utk.edu*

between observers and time intervals. We detected 637 individual northern bobwhite on 90 off-road transects across 4 sites from 2010 to 2011. We developed a suite of 10 *a priori* occupancy models in Program MARK to estimate off-road survey detection probabilities and site occupancy. Detection probabilities were greater (>26%) during the second point count visit ($\rho = 0.69 \pm 0.03$) versus first ($\rho = 0.51 \pm 0.04$) and third ($\rho = 0.47 \pm 0.04$) visits ($n = 270$). Detection probability increased as relative abundance increased ($\beta = 2.90 \pm 0.22$, $n = 270$). Occupancy was held constant and was not affected by any covariates evaluated. Peak northern bobwhite detection probabilities occurred from 1 to 25 June, an important consideration for population models that use breeding season survey data. Distance from road was not a significant grouping variable in any of the models, suggesting that roadside bias may not be an important consideration in designing bobwhite monitoring strategies. We located 295 radio-marked male bobwhites from 2010 to 2011. Marked males called on 115 of 295 points (39.0%). The furthest distance a radio-marked male moved during the survey period was 60 m, and movement distances were generally small ($\bar{x} = 4.2 \pm 10.3$ m, $n = 295$). We compared 8 *a priori* time-of-detection models in Program MARK to estimate radiotelemetry survey detection probabilities. We grouped surveys based on year and included time-of-day, and day-of-year as additional temporal covariates. Detection probability was inversely related to time of day ($\beta = -0.04 \pm 0.10$, $n = 105$), but positively related to day of year ($\beta = 0.010 \pm 0.008$, $n = 105$); β estimates overlapped 0 suggested weak relationships. Our results documented the first attempt to explicitly model differences in northern bobwhite detection related to spatial (potential roadside biases, habitat parameters, northern bobwhite distances), temporal (seasonality, annual fluctuations), and behavioral (observer, northern bobwhite relative abundance) variables. We used a combination of 3 methodologies to estimate detection parameters and will adjust indices of relative abundance and density estimates across a broad spatial extent. Our spatially-balanced roadside survey can be effectively used to monitor northern bobwhite populations across broad spatial extents and incorporates the components of detection to improve estimates of northern bobwhite relative abundance.

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