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From the Field

Factors Affecting Trapping Success of Northern Bobwhites in the Rolling Plains of Texas

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ABSTRACT Trapping of northern bobwhites (*Colinus virginianus*) is commonly conducted for research purposes. We investigated the influence of weather, lunar phase, time of day, and season on bobwhite trapping success in the Rolling Plains ecoregion of Texas, USA, from 2009 to 2011. We trapped bobwhites in autumn (Oct–Nov) and spring (Feb–Mar) using walk-in funnel traps baited with sorghum. We used a negative binomial regression to examine effects of temperature, humidity, wind speed, lunar phase, time of day, season, the number of traps set, and year on the number of bobwhites captured per trapping session. More bobwhites were trapped during the spring, in the evenings, and when temperatures were cooler. There was also some evidence for an influence of lunar phase on the number of bobwhites captured with greater counts during the new moon and third quarter. These variables may be important to consider for maximizing catch-per-unit-effort, when using trapping data to estimate relative abundance, or when conducting mark–recapture studies.

KEY WORDS *Colinus virginianus*, lunar phase, negative binomial, northern bobwhite, temperature, Texas, trapping, weather.

Northern bobwhite (*Colinus virginianus*; hereafter, bobwhites) is one of the most intensively researched and managed wildlife species in North America (Hernández and Peterson 2007). Studies often require that bobwhites be captured alive to be fitted with radiotelemetry collars and leg bands for the purpose of monitoring various demographic parameters (Rollins et al. 2005). Capture–recapture studies require bobwhites to be caught over multiple intervals throughout time that may, especially in open populations, encompass diverse sampling conditions (O'Brien et al. 1985). When conducting such studies, bobwhites are most commonly captured using a walk-in funnel trap described by Stoddard (1931). Despite the fact that trapping success of bobwhites in this manner can be highly variable, there is a lack of information about what factors influence trapping success and why success varies from day to day and across seasons.

In many other species—primarily rodents, meso-carnivores, and reptiles—trapping success has been used as an index of relative abundance (Hein and Andelt 1995, Cross et al. 1998, Ruette et al. 2003, Whisson et al. 2005, Spence-Bailey et al. 2010). Traditionally, trapping success as an index of relative abundance has been used only sparingly for comparing bobwhite populations. Webb and Guthery (1982) used trapping to obtain what they termed minimum known population sizes for comparison among habitat treatments. Investigating the factors that affect bobwhite trapping success may allow trap catch (i.e., catch-per-unit-effort) to be used more commonly as a complement to other indices used in quail management (e.g., spring cock-call counts; Rollins et al. 2005). Previous research has identified factors that affect trapping success in a variety of other species (Van Hensbergen and Martin 1993, Read and Moseby 2001, Prugh and Brashares 2010, Spence-Bailey et al. 2010). These factors included temperature, humidity, rainfall, wind speed, seasonality, lunar phase, and trapping effort.

There has been some anecdotal, albeit conflicting, evidence that weather (i.e., daily temp, humidity, wind speed, and precipitation) affects trapping success of bobwhites. Inman and Eitel (1949) reported that bobwhites were captured more often on cold, wet mornings. Reeves (1952) stated that bobwhites in Indiana, USA, were captured at a greater rate during warm, clear weather. Other studies have presented findings on the effects of weather on other aspects of bobwhite behavior and activity levels such as covey movements (Klimstra and Ziccardi 1963) and calling frequency (Hansen and Guthery 2001, Wellendorf et al. 2004), but we

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are not aware of any empirical studies that have investigated the effects of weather or other factors on trapping success of bobwhites.

Our objective was to determine whether weather, lunar phase, time of day, or season influenced bobwhite trapping success in the Rolling Plains ecoregion of Texas, USA. Specifically, we asked the questions: 1) does the number of quail caught during a particular trapping session vary as a function of wind speed, temperature, humidity, or moon phase on the day of trapping? and 2) is there a difference in the number of quail caught in the morning compared with the evening or in autumn versus spring? Our goal was to identify variables that influence bobwhite trapping success to aid bobwhite research on 2 fronts by determining 1) the timing of trapping that will maximize catch-per-unit-effort, and 2) what covariates should be controlled or accounted for in mark–recapture studies or when using catch-per-unit-effort as an index of relative abundance.

STUDY AREA

We conducted our study on the Rolling Plains Quail Research Ranch (RPQRR) near Rotan, Fisher County, Texas. The RPQRR was a 1,900-ha nonprofit ranch dedicated to research and extension on quail management and ecology in the Rolling Plains ecoregion. This ecoregion was characterized by gently undulating terrain interspersed with cropland and mesquite (*Prosopis glandulosa*)-dominated grasslands (Rollins 2007). The vegetation and topography of RPQRR was typical of the Rolling Plains Ecoregion within a clay–loam soil type. The RPQRR soils consisted of Paducah loam, Miles sandy loam, Latom–Vernon complex, Woodward clay–loam, and Wichita clay loam types (Natural Resource Conservation Service 2015). Plains were broken up by several rocky ridges that bisected RPQRR. Elevation ranged from 500 m to 900 m above sea level.

The RPQRR has been managed for quail since it was purchased in 2007, with little to no cattle grazing pressure in that time. Prior to 2007, the property was managed for cattle production. The RPQRR was divided into 12 different pastures ranging in size from 79 ha to 298 ha. Previous brush management (i.e., thinning) was done on a pasture level. Brush density was variable by pasture and ranged from <1% in areas formerly enrolled in the Conservation Reserve Program to >80% cover of mesquite in a pasture that had not been thinned in >30 years. However, brush density in a majority of the pastures fell within the generally accepted 5–25% threshold for bobwhites (Hernández and Guthery 2012).

There was a large diversity of grasses, forbs, and shrubs on RPQRR. Dominant grass species were silver bluestem (*Bothriochloa saccharoides*), sideoats grama (*Bouteloua curtipendula*), purple threeawn (*Aristida purpurea*), and Texas wintergrass (*Nassella leucotricha*). Common forb species were western ragweed (*Ambrosia psilostachya*), annual sunflower (*Helianthus annuus*), croton (*Croton* spp.), Illinois bundleflower (*Desmanthus illinoensis*), American basketflower (*Plectocephalus americanus)*, and filaree (*Erodium* spp.). Shrub species included mesquite, lotebush (*Ziziphus obtusifolia*), algerita (*Berberis trifoliolata*), catclaw acacia (*Senegalia greggii*), catclaw mimosa (*Mimosa pigra*), elbow-bush (*Forestiera pubescens*), littleleaf sumac (*Rhus microphylla*), skunkbush sumac (*R. aromatica*), live oak (*Quercus virginiana*), netleaf hackberry (*Celtis laevigata* var. *reticulata*), and wolfberry (*Lycium barbarum*).

Average annual rainfall in Fisher County was 56 cm. Both 2009 and 2010 study years were above average, with 57 cm and 64 cm of rainfall, respectively; however, 2011 was characterized by exceptional drought, with only 21 cm of precipitation. Snow events were uncommon; Fisher County averaged 5 cm of snowfall annually.

Bobwhites have suffered a decline across their range, including the Rolling Plains ecoregion (Rollins 2007). Texas Parks and Wildlife Department's (TPWD 2012) annual roadside counts during this study were well below the long-term mean of 20.5 bobwhites/32-km route for the Rolling Plains. Declines in relative abundance at RPQRR were also observed based upon various ongoing indices (e.g., helicopter surveys; Schnupp et al. 2013). Helicopter surveys were conducted annually during the first week of November. The number of coveys counted on RPQRR declined from 54 in 2008 to 11 in 2011 (D. Rollins, unpublished data). Quail hunting pressure was light and restricted to 2 hunts in 2009, 1 in 2010, and none in 2011.

METHODS

Field Methods

We trapped bobwhites on the RPQRR for 3 years (2009–2011) using walk-in funnel traps set alongside dirt ranch roads and baited with sorghum. We trapped each pasture twice per year in the autumn and late winter. The exact start and end dates for trapping varied between years because of weather or other circumstances (i.e., technician availability), but autumn trapping was always conducted 1 October–30 November and late-winter trapping was 1 February–31 March. By trapping some pastures concurrently, on average we were able to trap the entire RPQRR by trapping 5 days/week for 5 weeks. We checked traps twice daily—3 hr after sunrise and at dusk. Each trap check constituted one session; the average number of traps set per session was 42 (SD = 19). The number of traps set per session was dependent on the number of people available to check traps. We never set out more traps than could be checked in a 2-hr period. This was done to minimize trap mortalities due to predators locating captured bobwhites. Although the number of traps per day varied among sessions, all pastures were ultimately trapped at a similar trapping intensity of 1 trap/6 ha for 5 days over a period of no >2 weeks/pasture. We recorded the number of traps set to use as a covariate in our analysis. We prebaited trapping locations with sorghum for >2 weeks prior to the beginning of trapping in that pasture. We collected bobwhites from traps and placed them in zippered cotton pillowcases to affix leg bands and determine sex, age, and mass. We marked each pillowcase with the trap location so that all bobwhites could be released where they were captured to minimize stress. We

Table 1. Mean number of northern bobwhites captured and traps set per trapping session during biannual trapping efforts on the Rolling Plains Quail Research Ranch, Fisher County, Texas, USA, 2009–2011.

Year	Season	Time of day	*N*	Mean count	SE	Mean traps	SE
2009	Spring	AM	26	6.5	1.6	29.7	2.2
		PM	27	12.6	2.8	31.6	1.9
	Autumn	AM	31	11.0	2.0	68.7	5.2
		PM	39	20.2	3.0	67.0	3.8
2010	Spring	AM	21	5.8	1.4	21.6	1.6
		PM	26	7.0	1.1	27.3	2.3
	Autumn	AM	21	4.0	0.9	42.9	3.4
		PM	25	7.1	1.9	45.4	2.8
2011	Spring	AM	18	6.2	1.8	37.6	3.0
		PM	20	11.2	2.1	41.4	1.6
	Autumn	AM	28	5.7	1.2	40.9	2.8
		PM	32	8.4	1.1	43.8	2.2
Total			314	9.4	0.6	43.4	1.2

held and handled all bobwhites in accordance with the protocol approved by Texas A&M University Institutional Animal Care and Use Committee (AUP no. 2009-57).

We downloaded weather data from a Vantage Pro 2 weather station (Davis Instruments, Hayward, CA, USA) located on RPQRR. The weather station recorded temperature (°C), relative humidity, and wind speed (km/hr) every 15 min throughout the entire study period. We averaged these values over the 3 hr preceding the checking of traps for each session. We used the 3-hr window before each trap check because bobwhites are most likely to be foraging during that time and, therefore, weather would have the greatest impact on their behavior. We divided lunar phase into 4 categories: new moon, first quarter, full moon, and third quarter.

Statistical Analysis

The response variable—count or total number of quail captured including recaptures during a trapping session—was not normally distributed; counts were skewed toward zero. We attempted to transform the data using a Box-Cox transformation (PROC TRANSREG, SAS 9.2; SAS Institute, Cary, NC, USA) to achieve a normal distribution, but the data remained skewed. Therefore, to determine a more appropriate distribution for analysis, we used the FITDISTPLUS package and function GOFSTAT in Program R (R Core Team 2011). We found that the negative binomial distribution was adequate to describe the data ($P > 0.05$ for 5 models). Using PROC GLIMMIX in SAS 9.2 (SAS Institute), we regressed the following variables on count in a negative binomial model: temperature, humidity, wind speed, lunar phase, season, time of day (AMPM), year, pasture, and number of traps set (TRAPS). We accounted for lunar phase as a categorical variable with 3 parameters; we arbitrarily assigned third quarter to be the reference level. We also included an autocorrelation term to account for similarity between observations due to the short amount of time between sampling sessions (i.e., trapping on successive days). We tested a null model and 80 other models, determined *a priori*, with different combinations of the variables contained in the global model. All models contained the variable describing the number of traps set during each session.

Several of the variables in our analysis had the potential to be confounded with each other (e.g., season, AMPM, temperature, and humidity). We used variance inflation factor (VIF) to test for multicollinearity among our weather and temporal predictors and found a low incidence of multicollinearity with all VIFs <2.3. Multicollinearity is considered high when VIF values are >10 (Zar 1984); therefore, we concluded that multicollinearity was not a concern in our analysis.

Table 2. Model selection criteria for the top negative binomial models in which the number of northern bobwhites captured per trapping session (C) was estimated as a function of year, season, time of day (AMPM), number of traps set (TRAPS), temperature (TEMP), humidity(HUMID), wind speed (WS), and moon phase (LUNAR). Bobwhites were trapped during autumn and spring trapping sessions on the Rolling Plains Quail Research Ranch, Fisher County, Texas, USA, 2009–2011.

Competitive models	K[a]	Log likelihood	AIC_c[b]	ΔAIC_c	Likelihood	w_i[c]
C(TRAPS + YEAR + SEASON + AMPM + PASTURE + TEMP + HUMID)	19	−1,624.21	3,297.41	0.00	1.00	0.41
C(TRAPS + YEAR + SEASON + AMPM + PASTURE + TEMP + HUMID + LUNAR)	22	−1,621.84	3,289.00	1.59	0.45	0.19
C(TRAPS + YEAR + SEASON + AMPM + PASTURE + LUNAR + TEMP + HUMID + WS)	20	−1,624.19	3,289.47	2.06	0.36	0.15
C(TRAPS + YEAR + SEASON + AMPM + PASTURE + HUMID)	18	−1,626.92	3,290.73	3.32	0.19	0.08
C(TRAPS + YEAR + SEASON + AMPM + PASTURE + TEMP + HUMID + WS + LUNAR)	23	−1,621.83	3,291.11	3.70	0.15	0.07
C(GLOBAL)	2	−1,621.79	3,293.00	5.75	0.06	0.02
C(.)	2	−1,691.79	3,387.59	100.18	0.00	0.00

[a] No. of parameters.
[b] Akaike's Information Criterion corrected for small sample size.
[c] Akaike's wt.

We compared the strength of evidence for each model using Akaike's Information Criterion with a correction for small sample size (AIC_c). We ranked models based on differences in AIC_c values (ΔAIC_c) and assessed the weight of evidence for a particular model using Akaike weights (w_i; Burnham and Anderson 2010). We considered models within 2 ΔAIC_cs of the highest ranked model to be competitive and used parameter estimates and standard errors from those models to evaluate the explanatory value of each variable. We used the function $\exp(\beta_0 + \beta_1 x_1)$ to estimate count for each of our predictor variables and the function $[-100(1 - \exp\beta_1)]$ to interpret slopes and calculate percent change in count as a function of the predictor variables.

RESULTS

We trapped on 314 sessions and captured 2,966 bobwhites from 2009 to 2011 at RPQRR. Trapping success varied from 0 to 84 quail caught in one session. The average number of quail caught per session was 9.4 (SE = 0.6; Table 1); however, 0 quail were caught in 18% of the trapping sessions and <5 quail were caught in 40% of the sessions.

The 2 competitive models in our analysis were as follows: count = year + season + AMPM + TRAPS + pasture + temperature + humidity; and count = year + season + AMPM + TRAPS + pasture + temperature + humidity + lunar (Table 2). Only 2 terms from the global model did not appear in the top models—temporal autocorrelation and wind speed.

Although lunar phase appeared in the second-ranked model, it was uninformative in describing count. Confidence intervals surrounding the percent change in count for all 3 levels (i.e., new moon, first quarter, full moon) overlapped zero ($\beta_{NEW\ MOON} = -0.08$, $SE_{NEW\ MOON} = 0.13$; $\beta_{FIRST\ QUARTER} = -0.01$, $SE_{FIRST\ QUARTER} = 0.05$; $\beta_{FULL\ MOON} = 0.02$, $SE_{FULL\ MOON} = 0.06$), indicating that counts during these lunar intervals were not different from the reference level (i.e., third quarter). As a result of this ambiguity, we chose to ignore lunar phase as an uninformative parameter and interpret the most parsimonious competitive model (Arnold 2010).

An estimated 41% ($\beta_{SEASON} = -0.52$, $SE_{SEASON} = 0.17$) fewer quail were trapped in the autumn when compared with spring and an estimated 61% ($\beta_{AMPM} = -0.94$, $SE_{AMPM} = 0.15$) fewer quail were caught during morning trapping sessions when compared with evening. The number of quail caught was 61% lower in 2010 and 44% lower in 2011 compared with 2009 ($\beta_{2009} = 0.38$, $SE_{2009} = 0.13$; $\beta_{2010} = -0.17$, $SE_{2010} = 0.14$); however, 95% confidence intervals surrounding all year terms were large and the β_{2010} confidence interval included zero indicating no difference between 2010 and 2011. There was an estimated 2% ($\beta_{TEMP} = -0.02$, $SE_{TEMP} = 0.009$) decrease in count for every 1°C increase in temperature and an estimated 1% ($\beta_{HUMID} = 0.01$, $SE_{HUMID} = 0.003$) increase in count for every 1% increase in humidity (Fig. 1). For each additional trap set, the estimated increase in the number of quail caught was 6% ($\beta_{TRAPS} = 0.06$, $SE_{TRAPS} = 0.008$).

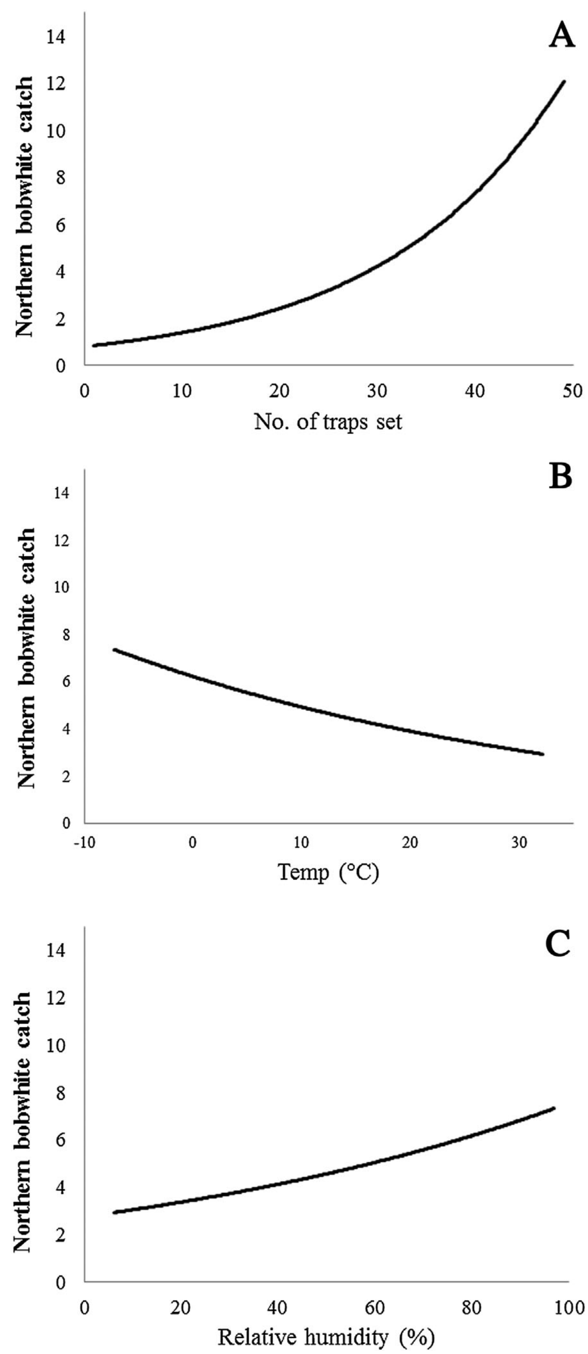

Figure 1. Relationship between number of bobwhites caught in an individual trapping session and (A) number of traps set, (B) temperature, (C) relative humidity. Temperature and relative humidity were averaged over the 3 hr prior to checking traps on the Rolling Plains Quail Research Ranch in Fisher County, Texas, USA, during the spring and autumn trapping in 2009, 2010, and 2011. The predicted values were calculated from a negative binomial regression in which the number of bobwhites trapped was regressed on year, season, time of day (e.g., AM or PM), temperature, pasture, and number of traps set.

DISCUSSION

We found that on average more bobwhites were trapped at RPQRR during spring, in evenings, when temperatures were cooler, and when humidity was higher. There was little evidence for an effect of lunar phase, wind speed, or temporal autocorrelation.

It seems logical that more bobwhites would be trapped in the autumn given that populations should be greatest at that time of the year (Lehmann 1984). But the fact that more bobwhites were caught in the spring may suggest that trapping numbers are less dependent on the population size and more dependent on the behavior of the birds themselves. In autumn, bobwhites were trapped after the year's recruitment and before the population had been subjected to winter mortality. Spring trapping sessions were conducted after approximately 60 days of winter mortality and before reproduction; therefore, we were inherently trapping a smaller population in the spring than was present during the previous autumn. However, catch was greater in spring compared with autumn. It could be that the bait offered in the trap was more attractive to the bobwhites than the food sources found in their environment. Throughout autumn and winter, seeds typically comprise >70% of the bobwhite diet (Rollins 1981, Larson et al. 2010). However, during late winter and early spring, seeds are often in short supply; and although greens are an important part of a bobwhite's diet in the spring (Larson et al. 2010), seeds have greater metabolizable energy (Guthery 2006).

The number of bobwhites caught decreased as temperatures increased. A similar inverse relationship exists between temperature and caloric demands of bobwhites, possibly making the sorghum bait more appealing during cooler periods. A bobwhite requires approximately 50 Kcal/day at 0° C; whereas, at 30° C their requirement is approximately 20 Kcal/day (Guthery 2006). Such reductions in energy requirements could account for the decrease in trap catch, but warmer temperatures may also be correlated to other affecting factors. Warmer temperatures facilitate earlier covey breakup (Hernández and Peterson 2007) and may also be correlated with a greater availability of insects, resulting in reduced bobwhite interest in the sorghum bait.

Webb and Guthery (1982) used relative abundance determined by trapping to compare bobwhite response to habitat treatments. Season, time of day, humidity, and temperature were accounted for by blocking temporally across control and treatment sites (i.e., trapping bobwhites on both sites at the same time). Temperature and humidity were also effectively accounted for by establishing treatment and control plots in close proximity (i.e., <1 km). Based on our results, we would recommend other studies conducting trapping for comparisons of relative abundance should follow this example. In addition, mark–recapture studies may obtain better estimates of recapture rate if they are allowed to vary by season, time of day, humidity, and temperature.

Our models did not account for all the variation in trapping success; however, the objective of our analysis was to identify factors that have an influence on trapping success of bobwhites. We did not intend to create a predictive model to estimate the number of bobwhites one would expect to catch under a specific set of circumstances. Not only would the inference of such a model be restricted solely to the location where the study was conducted, but it would also likely need to contain far more variables than we measured and would likely never be able to account for the stochastic nature of bobwhite behavior.

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LITERATURE CITED

Arnold, T. W. 2010. Uninformative parameters and model selection using Akaike's Information Criterion. Journal of Wildlife Management 74:1175–1178.

Burnham, K. P., and D. R. Anderson. 2010. Model selection and multimodel inference: a practical information-theoretic approach. Second edition. Springer-Verlag, New York, New York, USA.

Cross, M., A. Smale, S. Bettany, M. Numata, D. Nelson, R. Keedwell, and J. Ragg. 1998. Trap catch as a relative index of ferret (*Mustela furo*) abundance in a New Zealand pastoral habitat. New Zealand Journal of Zoology 25:65–71.

Guthery, F. S. 2006. On bobwhites. Second edition. Texas A&M University Press, College Station, USA.

Hansen, H. M., and F. S. Guthery. 2001. Calling behavior of bobwhite males and the call-count index. Wildlife Society Bulletin 29:145–152.

Hein, E. W., and W. F. Andelt. 1995. Evaluation of indices of abundance for an unexploited badger population. Southwestern Naturalist 40: 288–292.

Hernández, F., and F. S. Guthery. 2012. Beef, brush, and bobwhites: quail management in cattle country. Texas A&M University Press, College Station, USA.

Hernández, F., and M. J. Peterson. 2007. Northern bobwhite ecology and life history. Pages 40–64 *in* L. A. Brennan, editor. Texas quails: their ecology and management. Texas A&M University Press, College Station, USA.

Inman, E. B., and W. Eitel. 1949. A preliminary report on trapping and marking bobwhite quail. Proceedings of the Oklahoma Academy of Science 30:215–216.

Klimstra, W. D., and V. C. Ziccardi. 1963. Night roosting habitat of bobwhites. Journal of Wildlife Management 27:202–214.

Larson, J. A., T. E. Fulbright, L. A. Brennan, F. Hernández, and F. C. Bryant. 2010. Texas bobwhites: a guide to their foods and habitat management. University of Texas Press, Austin, USA.

Lehmann, V. W. 1984. Bobwhites in the Rio Grande Plain of Texas. Texas A&M University Press, College Station, USA.

Natural Resource Conservation Service [NRCS]. 2015. Web Soil Survey. Accessed 1 Oct 2015. http://websoilsurvey.nrcs.usda.gov/app/websoilsurvey.aspx

O'Brien, T. G., K. H. Pollock, W. R. Davidson, and F. E. Kellogg. 1985. A comparison of capture-recapture with capture removal for quail populations. Journal of Wildlife Management 49:1062–1066.

Prugh, L., and J. Brashares. 2010. Basking in the moonlight? Effect of illumination on capture success of the endangered giant kangaroo rat. Journal of Mammalogy 91:1205–1212.

R Core Team. 2011. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Read, J. L., and K. E. Moseby. 2001. Factors affecting pitfall capture rates of small ground vertebrates in arid South Australia: the influence of weather and moon phase on capture rates of reptiles. Wildlife Research 26:53–60.

Reeves, M. C. 1952. Mechanical aids useful in studying bobwhite quail. Journal of Wildlife Management 16:316–319.

Rollins, D. 1981. Diets of sympatric bobwhite and scaled quail in southwestern Oklahoma. Proceedings of Southeastern Association of Fish and Wildlife Agencies 35:239–249.
Rollins, D. 2007. Quails on the Rolling Plains. Pages 117–141 *in* L. A. Brennan, editor. Texas quails: their ecology and management. Texas A&M University Press, College Station, USA.
Rollins, D., J. L. Brooks, R. N. Wilkins, and R. D. Ransom Jr. 2005. Counting quail. Texas Agrilife Extension Service, Bulletin B-1673, College Station, USA.
Ruette, S., P. Stahl, and M. Albaret. 2003. Factors affecting trapping success of red fox *Vulpes vulpes,* stone marten *Martes foina*, and pine marten *M. martes* in France. Wildlife Biology 9:11−19.
Schnupp, M. J., F. Hernández, E. J. Redeker, F. C. Bryant, J. P. Rusk, S. J. Demaso, J. P. Sands, T. W. Teinert, L. A. Brennan, D. Rollins and R. M. Perez. 2013. An electronic system to collect distance-sampling data during helicopter surveys of northern bobwhite. Wildlife Society Bulletin 37:236–245.
Spence-Bailey, L. M., D. G. Nimmo, L. T. Kelly, A. F. Bennett, and M. F. Clarke. 2010. Maximising trapping efficiency in reptile surveys: the role of seasonality, weather conditions, and moon phase on capture success. Wildlife Research 37:104−115.
Stoddard, H. L. 1931. The bobwhite quail: its habits, preservation, and increase. Charles Scribner's Sons, New York, New York, USA.
Texas Parks and Wildlife Department [TPWD]. 2012. Quail forecast. http://www.tpwd.state.tx.us/huntwild/hunt/planning/quail_forecast/forecast/rolling_plains. Accessed 5 Mar 2013.
Van Hensbergen, H. J., and S. C. Martin. 1993. Climatic factors affecting trapping success of some South African small mammals. South African Journal of Wildlife Research 23:87−94.
Webb, W. M., and F. S. Guthery. 1982. Response of bobwhite to habitat management in northwest Texas. Wildlife Society Bulletin 10:142–146.
Wellendorf, S. D., W. E. Palmer, and P. T. Bromley. 2004. Estimating calling rates of northern bobwhite coveys and measuring abundance. Journal of Wildlife Management 68:672−682.
Whisson, D. A., R. M. Engeman, and K. Collins. 2005. Developing relative abundance techniques (RATs) for monitoring rodent populations. Wildlife Research 32:239−244.
Zar, J. H. 1984. Biostatistical analysis. Second edition. Prentice-Hall, Englewood Cliffs, New Jersey, USA.

Associate Editor: Guttery.