Food Habits of Hunter Collected Northern Bobwhite Quail in South Texas

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Abstract: We investigated the feeding habits of wild northern bobwhites (*Colinus virginianus*) harvested from the Chaparral Wildlife Management Area in south Texas in October 2004 and January 2005. The contents of 200 crops were dried, sorted, and weighed to the nearest 0.0001 g. Percent dry weight was used to assess differences among season harvested, sex, and age. About 76% of the fall diet consisted of seeds, with 64 plant species represented. Croton (*Croton* spp.), woolly croton (*Croton capitatus*), and bristlegrass (*Setaria* sp.) composed greater than 50% by weight of seeds found in the fall diet. Fruit, almost entirely spiny hackberry (*Celtis ehrenbergiana*), comprised 17% of the fall diet. Invertebrates made up about 5% and green vegetative matter contributed 0.1% to the fall diet. No differences in feeding habits between sexes or age class were detected for fall. The winter diet consisted of 63% green vegetative matter, 28% seeds, 5% invertebrates, and 0.40% fruit. Common yellow oxalis (*Oxalis stricta*) and a species of pellitory (*Parietaria* sp.) made up over 50% of the green vegetative matter. Percent green vegetation consumed by females (78%) exceeded ($P = 0.007$) that of males (53%) in winter. Additionally, in winter green vegetation consumed by adults (70%) exceeded ($P = 0.016$) that of juveniles (59%). Differences by sex in the winter diet might be due to differences in nutritional requirements in the pre-breeding period.

Keywords: Colinus virginianus, food habits, northern bobwhite, south Texas

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Annual variations in northern bobwhite (*Colinus virginianus*) populations are hypothesized to be associated with fluctuations in the amounts and patterns of rainfall (Lehmann 1953, Kiel 1976), and the resulting alterations in food supply (Wood et al. 1986, Guthery 2000, Perez et al. 2002). In south Texas, numerous northern bobwhite food habit studies have been performed to gather information about seasonal fluctuations in productivity and to supply critical information needed for land managers to create optimal habitat (Lehmann and Ward 1941, Campbell-Kissock et al. 1985, Wood et al. 1986, Harveson et al. 2004). Most studies concentrated on seasonal variations in overall diet over numerous sites. Several studies have been conducted on northern bobwhites at the Chaparral Wildlife Management Area (CWMA; Guthery et al. 2002, Perez et al. 2002, Harveson et al. 2004); however, none of these were comprehensive studies focused on dietary differences due to sex and age during two seasons. Dietary research separating factors such as sex and age can reveal relationships that are not apparent with combined data. The management staff of CWMA needed detailed dietary information on northern bobwhites to assess impacts of habitat modifications and management practices which were a part of the area's management plans.

The objective of this study was to report food habits of northern bobwhites harvested on CWMA in south Texas during the 2004–05 hunting season and to assess dietary differences by season, sex, and age.

Study Area

The study area was the CWMA, near Artesia Wells, Texas, located within the Rio Grande Plains Ecological Region. The CWMA, owned and operated by Texas Parks and Wildlife Department, encompasses 6,151 ha on the county line between La Salle and Dimmit counties (9925W, 2820N). The CWMA employed a variety of management practices (e.g., prescribed burning, brush removal, modified grazing practices) aimed at game and non-game species such as northern bobwhite, wild turkey (*Meleagris gallopavo*), white-tailed deer (*Odocoileus virginianus*), and Texas tortoise (*Gopherus berlandieri*). The soils were predominantly Duval fine sandy loam and Dilley very fine sandy loam (Perez et al. 2002). The plant community was a mesquite (*Prosopis glandulosa*)-spiny hackberry (*Celtis ehrenbergiana*) association. Other woody species found on the site included acacia (*Acacia* spp.), brasil (*Condalia hookeri*), and prickly pear (*Opuntia* spp.) scattered throughout a grassland. Herbaceous species included Lehmann lovegrass (*Eragrostis lehmanniana*), fringed signalgrass (*Urochloa ciliatissima*), hairy grama (*Bouteloua hirsuta*), croton (*Croton* spp.), coreopsis (*Coreopsis nuecensoides*), lazydaisy (*Aphanostephus* spp.), and partridge pea (*Chamaecrista fasciculata;* Ruthven and Synatszke 2002).

The Rio Grande Plains Ecological Region was characterized by long hot summers and short mild winters with a mean winter temperature of 12.7C, and a mean summer temperature of 29.4C. The mean annual precipitation was 55.4 cm per year (Perez et al. 2002). During the growing season (2004) affecting our study, precipitation was above average (109 cm; National Climatic Data Center 2008). Peak rainfall occurred during the late spring (May-June) and early fall (September-October). Times of low rainfall could be severe, often resulting in drought conditions. The plant community at the CWMA was well adapted to an arid, desert environment (Ruthven 2001).

Methods

Over 1000 northern bobwhite crops were collected from hunters in October 2004 (fall) and January 2005 (winter). We selected crops in a stratified random manner to produce equal numbers of males, females, juveniles, and adults up to 100 crops per season for identification and analysis. A cumulative species curve was constructed which indicated 100 crops accounted for approximately 80% of the species eaten. In winter, collected crops were limited to 39 adults, with only 13 adult females, but were otherwise selected to keep categories balanced. We used crops from 25 adult males, 25 adult females, 25 juvenile males, and 25 juvenile females for analysis of the fall diet and 26 adult males, 13 adult females, 30 juvenile females, and 31 juvenile males for analysis of the winter diet.

We numbered each crop and recorded the date, time of day, age (adult or juvenile), and sex of the bird. Crops were placed on ice in the field and transferred to a freezer within 12 h. The contents of individual crops were washed through four sieves (screen sizes = 0.035, 0.025, 0.010, and 0.002 mm) to rinse and separate items into size classes. Animal matter was separated from vegetative matter and stored in vials of 70% ethanol. Plant material was further separated into green vegetative matter (primarily foliage), seeds, corn, and fruit, then dried for 1–2 h in a dryer and placed in paper coin envelopes. Food items were assigned to the following categories: invertebrates, green vegetation, seeds, fruit, and other. For the purposes of this study, fruits containing seeds were considered one unit and placed in the fruit category because there was no way to discern if those items were eaten for the seed or fruit component. Evidence suggests that seeds such as hackberry (*Celtis* sp.) do not add nutritionally to the diet and are passed through birds undigested (Sternberg and Wilson 2004). Materials such as unidentifiable seed coats, down feathers, and dirt were labeled as debris. Small rocks presumably used as an aid for grinding food in the gizzard were labeled as grit. Because corn was found in only three crops during one season, it was combined with debris and grit and categorized as other. After all food items were dried 1–2 h in a dryer, we sorted them by species and used a non-histological method for the identification of undigested food items (Korschgen 1962). We identified seeds and fruits to species using a reference collection at Texas A&M-Kingsville, plant guides (Jackson 1969, Landers and Johnson 1976, Rosene and Freeman 1988), U.S. Department of Agriculture, Natural Resources Conservation Service (2008), and reference specimens collected from CWMA. Green vegetation was identified from reference specimens collected at CWMA, U.S.Department of Agriculture, Natural Resources Conservation Service (2008), and consultation with D. Lemke, Texas State University-San Marcos. Current taxonomic classification of all plants followed the U.S. Department of Agriculture, Germplasm Resources Information Network (2008). Insects and other invertebrates were identified by National Audubon Society (1995), J. Abbot (University of Texas-Austin, personal communication), and A. Blair (Texas State University-San Marcos, personal communication). Unidentified specimens were labeled as unknown. We weighed the contents of each crop by species or category to 0.0001 gram on an electronic analytical scale (Model AG204, Mettler-Toledo, Inc., Columbus, Ohio). Items weighing less than 0.0001 grams were recorded as trace. The name, total dry weight (g), percent dry weight, and frequency of occurrence of each food item in each crop were recorded for fall and winter. Percent dry weight of food categories were calculated by season, sex, and age. The weights of unknown food items were included in their respective food category for analysis.

We used a three-way Analysis of Variance (ANOVA; R Development Core Team 2005) accounting for unbalanced sample size to test for differences among food item categories by season, sex, and age. We analyzed only the most abundant food items (seeds and green vegetation) which accounted for ≥75% of the overall diet. The response variables were tested for normality with a Kolmogorov-Smirnov test and homoscedasticity with an *F*-test. In the event assumptions were violated, we used a $\log_e$ transformation of the data. Tukey's *post hoc* tests were performed on the ANOVA results to examine possible interactions and isolate significant differences within season, sex, and age. Tests were considered significant at $\alpha = 0.05$.

We chose not to perform a Multivariate Analysis of Variance (MANOVA) because ambiguity was often present regarding which independent variable affected any particular dependent variable. Additionally, because dependent variables were expressed as percentages, we suspected high correlation between variables would confound results. Consequently, we concluded little advantage would be gained by including more than one dependent variable, particularly given the resultant loss in degrees of freedom (Tabachnick and Fidell 1996).

Results

We found seeds from 64 species of plants, fruits from three species of plants, 40 invertebrate families, and green foliage from approximately 20 species of plants in the 200 crops. Seeds of croton, bristlegrass (*Setaria* sp.), and woolly croton (*Croton capitatus*) comprised over 50% of the fall diet, while 16% consisted of spiny hackberry fruit. The young leaves and shoots of pellitory (*Parietaria* sp.),

Table 1. Percent dry weight (g) and percent frequency of occurrence (frequency) of primary foods in hunter harvested northern bobwhite quail crops from the Chaparral Wildlife Management Area, Artesia Wells, Texas, October 2004 (fall) and January 2005 (winter). Weight is a pooled value.

Food species	Fall (*n* = 100) Weight (%)	Fall (*n* = 100) Frequency (%)	Winter (*n* = 100) Weight (%)	Winter (*n* = 100) Frequency (%)
Seeds of forbs and woody plants				
Croton (*Croton* spp.)	27.13	90.00	4.18	27.00
Woolly croton (*Croton capitatus*)	10.49	33.00	0	0
Convolvulaceae	5.19	79.00	18.15	50.00
Annual ragweed (*Ambrosia artemisiifolia*)	2.37	6.00	0	0
Partridge pea (*Chamaecrista fasciculata*)	1.16	23.00	0.92	10.00
Camphorweed (*Heterotheca subaxillaris*)	1.14	5.00	0.06	3.00
Other[a]	3.37	—	3.46	—
Seeds of grasses				
Bristlegrass (*Setaria* sp.)	14.29	77.00	0.45	14.00
Plains bristlegrass (*Setaria leucopila*)	3.78	42.00	0.11	6.00
Slender panicgrass (*Panicum capillarioides*)	2.32	37.00	0.04	6.00
Fringed signalgrass (*Urochloa ciliatissima*)	2.21	48.00	0.97	27.00
Panicgrass (*Panicum* sp.)	1.10	23.00	0.03	1.00
Other	0.64	—	0.04	—
Fruits				
Spiny hackberry (*Celtis ehrenbergiana*)	16.55	63.00	40.00	6.00
Other	0.04	—	6.00	—
Invertebrates				
Grasshopper (Acrididae)	2.83	36.00	0.12	2.00
Other	0.04	—	16.38	—
Green vegetation				
Pellitory (*Parietaria* sp.)	0	0	19.98	86.00
Common yellow Oxalis (*Oxalis stricta*)	0.10	9.00	14.70	95.00
Meadow garlic (*Allium canadense*)	0.04	15.00	8.43	86.00
Vetch (*Vicia* sp.)	0	0	2.27	14.00
Wild carrot (*Daucus* sp.)	0	0	1.13	42.00
Other[a]	0.04	—	16.38	—

a. Includes items with less than 1.0% dry weight for both seasons

common yellow oxalis (*Oxalis stricta*), and meadow garlic (*Allium canadense*) comprised 43% of total crop contents for winter. Convolvulaceae seeds constituted an additional 18% of the winter diet. Small seeds, such as fringed signalgrass, often composed a small percentage by dry weight yet were present in a large number of crops. However, species which made up the greatest percent of the dry weight, such as croton and bristlegrass, were generally found in the largest number of crops (Table 1). Forty invertebrate families contributed 5.33% to the overall diet. Grasshoppers (Family Acrididae) were the largest group, accounting for 2.83% of the fall diet and 0.12% in the winter diet. Leafhoppers (Cicadellidae; 0.76%), ironclad beetles (Zopheridae; 0.56%), and owlet moths (Noctuidae; 0.46%) were the greatest contributors to the winter diet. Amount consumed from other invertebrate families was negligible in fall and winter.

Results from the Kolmogorov-Smirnov test indicated that the data was not normally distributed ($D = 0.280$, $P = <0.001$). Additionally, heteroscadasticity was present in our data ($F_{199} = 1.273$, $P = 0.05$). Because assumptions of normality and equal variances were violated, the data were transformed using $\log_e$ prior to performing the ANOVAs.

We detected differences in seed consumption between northern bobwhites harvested in fall versus winter ($F_{1,192} = 277.439$, $P < 0.001$). Additionally, we found differences between seasons for amount of green vegetation consumed ($F_{1,192} = 1109.606$, $P < 0.001$). The proportion of seeds represented in the fall diet was estimated to be 2.7 times greater by dry weight than in the winter diet, and green vegetation in the winter diet was 628.8 times greater than in the fall diet (Table 2).

Table 2. Dry weight and percent dry weight of seeds, fruit, invertebrates, green vegetation, and other found in hunter harvested bobwhite quail crops (*n* = 100) by sex and age on the Chaparral Wildlife Management Area, Artesia Wells, Texas, October 2004 (fall) and January 2005 (winter).

	Food category									
	Seeds		Fruit		Invertebrates		Green Veg		Other[a]	
	Wt (g)	%	Wt (g)	%	Wt (g)	%	Wt (g)	%	Wt (g)	%
Fall										
Males (*n* = 50)	51.26	75.77%	10.87	16.07%	3.86	5.71%	0.08	0.11%	1.58	2.34%
Adult (*n* = 25)	30.18	79.87%	4.52	11.97%	1.88	4.98%	0.05	0.14%	1.15	3.04%
Juvenile (*n* = 25)	21.08	70.59%	6.35	21.25%	1.98	6.62%	0.03	0.08%	0.44	1.46%
Females (*n* = 50)	46.52	75.40%	10.59	17.16%	3.08	4.99%	0.05	0.07%	1.47	2.38%
Adult (*n* = 25)	25.31	81.55%	3.84	12.37%	1.12	3.61%	0.03	0.11%	0.74	2.37%
Juvenile (*n* = 25)	21.21	69.17%	6.75	22.00%	1.96	6.40%	0.01	0.05%	0.73	2.39%
Winter										
Males (*n* = 57)	7.80	39.84%	0.03	0.13%	1.05	5.36%	10.31	52.66%	0.39	2.01%
Adult (*n* = 26)	2.56	31.80%	0.00	0.00%	0.42	5.19%	4.96	61.47%	0.13	1.55%
Juvenile (*n* = 31)	5.24	45.48%	0.03	0.22%	0.63	5.47%	5.35	46.49%	0.27	2.33%
Females (*n* = 43)	1.58	11.76%	0.11	0.79%	0.67	4.97%	10.47	77.73%	0.64	4.75%
Adult (*n* = 13)	0.23	6.60%	0.06	1.72%	0.04	1.06%	3.10	88.55%	0.07	2.07%
Juvenile (*n* = 30)	1.35	13.58%	0.05	0.47%	0.63	6.34%	7.37	73.94%	0.57	5.68%

a. Includes items with less than 1.0% dry weight for both seasons.

We found no significant differences in seed consumption by season, sex, or age. Additionally, no significant differences were found in green vegetation consumption for either age or sex during fall. In winter, however, females had proportionally more green vegetation in their diet than males ($F_{1,192}$ = 4.881, P = 0.007), and adults utilized more green vegetation than juveniles ($F_{1,192}$ = 4.005, P = 0.016; Table 2).

Discussion

Our research concurs with previous studies (McRae et al. 1979, Peoples et al. 1994) showing that seeds are the major component of northern bobwhite diets in the fall. The amount of invertebrates found in fall and winter crops was similar to Campbell-Kissock et al. (1985) in South Texas. Lehmann (1984), however, found that invertebrate consumption was much higher in South Texas during the fall (17.9%) and winter (23.3%). Additionally, our research revealed no differences in diets by sex or age during the fall. However, northern bobwhites consumed considerably more green vegetation and fewer seeds and invertebrates during winter. Consumption of green vegetative matter increases during winter in warmer areas, or early spring in cooler climates (Baldwin and Handley 1946, Jackson 1969, Wiseman 1977, McRae et al. 1979, Lehmann 1984, Campbell-Kissock et al. 1985, Wood et al. 1986, Peoples et al. 1994). In south Texas, Campbell-Kissock et al. (1985) found that green vegetation was the major component of the diet during October through February.

Due to 80%–90% water content, green vegetation is low in caloric content compared to insects, fruit, and most forb seeds (Guthery 2000). Few publications have given much attention to the green vegetative component of northern bobwhite diets, calling it poor quality food eaten mainly because of a reduction in high caloric food availability during winter (Lehmann 1984, Campbell-Kissock et al. 1985, Leif and Smith 1993). In addition, no northern bobwhite food preference study has included a green vegetation component (Jensen and Korschgen 1947, Ellis 1961, Giuliano et al. 1996, Madison and Robel 2001). Green vegetation is high in calcium and protein and contains moderate levels of calories, minerals, and phosphorus (Wood et al. 1986, Leif and Smith 1993, Guthery 2000). By contrast, seeds contain less than half the calcium of green vegetation. Grass seeds in particular contain a fraction of the calcium, less phosphorus and approximately half the protein as green vegetative matter (Wood et al. 1986, Leif and Smith 1993).

We found a pre-breeding food bias by sex and age within a single population of northern bobwhites. We suggest that increased intake of green vegetative matter prior to egg production is more relevant than a mere mechanism to deal with starvation (Lehmann 1984, Campbell-Kissock et al. 1985, Leif and Smith 1993). Breeding northern bobwhite females require higher levels of protein, calcium, phosphorus, energy, and other nutrients than at other times of the year (National Research Council 1977). Insufficient levels of protein, energy, and possibly calcium/phosphorous associations in the diet may affect northern bobwhite egg production (Cain et al. 1982, Giuliano et al. 1996). Wood et al. (1986) demonstrated that during spring, females selected a diet that was 70% higher in calcium than males, while both sexes consume similar percentages during other times of the year. Energy for egg production is largely obtained during fall and stored as fat, because the winter diet, high in green vegetation, is low in caloric value (Guthery et al. 1988, Guthery 2000). Guthery (1999) and Koerth and Guthery (1990) found water intake by egg producing females must increase by 40%–60% in contrast to non-laying birds, and that most of this is obtained through eating insects, greens, and fruit.

Other than energy and protein, no significant association has been established between levels of dietary components and production success. Our results suggest that green vegetation may be consumed by adult females prior to egg production to supply prebreeding nutritional requirements such as water, calcium, phosphorus, protein, or other vitamins and minerals.

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Literature Cited

Baldwin, W. P. and C. O. Handley. 1946. Winter food of bobwhite quail in Virginia. Journal of Wildlife Management 10:142–149.

Cain, J. R., S. L. Beasom, L. O. Rowland, and L. D. Rowe. 1982. The effects of varying dietary phosphorus on breeding bobwhites. Journal of Wildlife Management 46:1061–1065.

Cambell-Kissock, L., L. H. Blankenship, and J. W. Stewart. 1985. Plant and animal foods of bobwhite and scaled quail in southwest Texas. Southwestern Naturalist 30:543–553.

Ellis, J. A. 1961. Consumption of some food items by pen-reared bobwhites. Journal of Wildlife Management 25:258–264.

Giuliano, W. M., R. S. Lutz, and R. Patino. 1996. Reproductive responses of adult female northern bobwhite and scaled quail to nutritional stress. Journal of Wildlife Management 60:302–309.

Guthery, F. S. 1999. The role of free water in bobwhite management. Wildlife Society Bulletin 27:538–542.

———. 2000. On Bobwhites. First edition. Texas A&M University Press, College Station, Texas.

———, N. E. Koerth, and D. S. Smith. 1988. Reproduction of northern bobwhites in semiarid environments. Journal of Wildlife Management 52:144–149.

———, J. J. Lusk, D. R. Synatzske, J. Gallagher, S. J. DeMaso, R. R. George, and M. J. Peterson. 2002. Weather and age ratios of northern bobwhites in south Texas. Pages 99 –105 *in* S. J. DeMaso, W. P. Kuvlesky, Jr., F. Hernandez, and M. E. Berger, editors. Quail V: Proceedings of the Fifth National Quail Symposium. Texas Parks and Wildlife Department, Austin, Texas.

Harveson, L. A., F. S. Guthery, and E. C. Hellgren. 2004. Invertebrate consumption by breeding northern bobwhites and its relation to production. Southwestern Naturalist 49:472–477.

Jackson, A. S. 1969. Handbook for bobwhite quail management in the west Texas rolling plains. Bulletin 48. Texas Parks and Wildlife Department, Austin.

Jensen, G. H. and L. J. Korschgen. 1947. Contents of crops, gizzards, and droppings of bobwhite quail force-fed known kinds and quantities of seeds. Journal of Wildlife Management 11: 37–43.

Kiel, W. H. 1976. Bobwhite quail population characteristics and management implications in south Texas. Transcontinental North American Wildlife and Natural Resources Conference 41:407–420.

Koerth, N. E. and F. S. Guthery. 1990. Water requirements of captive northern bobwhites under subtropical seasons. Journal of Wildlife Management 54:667–672.

Korschgen, L. J. 1962. Food habits of greater prairie chickens in Missouri. American Midland Naturalist 68:307–318.

Landers, J. L. and A. S. Johnson. 1976. Bobwhite quail food habits in the southeastern United States with a seed key to important foods. Miscellaneous Publication 4. Tall Timbers Research Station, Tallahassee, Florida.

Lehmann, V. W. 1953. Bobwhite population fluctuations and vitamin A. Transcontinental North American Wildlife Conference 18:199–246.

———. 1984. Bobwhites in the Rio Grande plains of Texas. First edition. Texas A&M University Press, College Station, Texas.

——— and H. Ward. 1941. Some plants valuable to quail in southwestern Texas. Journal of Wildlife Management 5:131–135.

Leif, A. P. and L. M. Smith. 1993. Winter diet quality, gut morphology and condition of northern bobwhite and scaled quail in west Texas. Journal of Field Ornithology 64:527–538.

Madison, L. A. and R. J. Robel. 2001. Energy characteristics and consumption of several seeds recommended for northern bobwhite food plantings. Wildlife Society Bulletin 29:1219–1227.

McRae, W. A., J. L. Landers, J. L. Buckner, and R. C. Simpson. 1979. Importance of habitat diversity in bobwhite management. Proceedings from the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 33:127–135.

National Audubon Society. 1995. Field guide to North American insects and spiders. Fourteenth edition. Chanticleer Press, Inc., New York, New York.

National Climatic Data Center. 2008. NOAA Satellite and Information Service. NCDC. www.ncdc.noaa.gov/oa/ncdc.html.

National Research Council. 1977. Nutrient requirements of poultry. Seventh edition. National Academy of Science, Washington, D.C.

Peoples, A. D., R. L. Lochmiller, J. C. Boren, D. M. Leslie, Jr., and D. M. Engle. 1994. Limitations of amino acids in diets of northern bobwhites (*Colinus virginianus*). American Midland Naturalist 132:104–116.

Perez, R. M., J. F. Gallagher, and M. C. Frisbie. 2002. Fine scale influence of weather on northern bobwhite abundance, breeding success, and harvest in south Texas. Pages 106–110 *in* S. J. DeMaso, W. P. Kuvleksy, Jr., F. Hernandez, and M. E. Berger, editors. Quail V: proceedings of the fifth national quail symposium. Texas Parks and Wildlife Department, Austin, Texas.

R Development Core Team. 2005. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. www.R-project.org.

Rosene, W. and J. D. Freeman. 1988. A guide to and culture of flowering plants and their seed important to bobwhite quail. Morris Communications Corporation, Augusta, Georgia.

Ruthven, D. C. 2001. Herbaceous vegetation diversity and abundance beneath honey mesquite (*Prosopis glandulosa*) in the south Texas plains. Texas Journal of Science 53:171–186.

——— and D. R. Synatzske. 2002. Response of herbaceous vegetation to summer fire in the western south Texas plains. Texas Journal of Science 54:195–210.

Sternberg, G. and J. W. Wilson. 2004. Native trees for North American landscapes: from the Atlantic to the Rockies. Portland: Timber Press.

Tabachnick, B. G. and L. S. Fidell. 1996. Using Mutivariate Statistics. Harper Collins College Publishers, New York, New York.

U.S. Department of Agriculture (USDA), Germplasm Resources Information Network. 2008. GRIN Taxonomy for Plants. USDA. www.ars-grin.gov/npgs/searchgrin.html.

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service. 2008. Plants Database. USDA. www.plants.usda.gov.

Wiseman, D. S. 1977. Food habits and weights of bobwhite from northeastern Oklahoma tall grass prairie. Proceedings from the Oklahoma Academy of Science 57:110–115.

Wood, K. N., F. S. Guthery, and N. E. Koerth. 1986. Spring-summer nutrition and condition of northern bobwhites in south Texas. Journal of Wildlife Management 50:84–88.