Early Summer Diet of Male Northern Bobwhite in the North Carolina Sandhills

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Abstract: Crops from adult male northern bobwhite (*Colinus virginianus*) were collected May–July 1985 ($N = 43$) and April–June 1986 ($N = 45$). Woody plant, legume, and grass seeds accounted for >90% of the total crop volume in both years, but the relative proportions of seed types varied significantly ($X^2 = 66.38$, $P < 0.005$) between years. This was partly due to differences in plant fruiting chronology and seed availability during sample periods, as rye (*Secale cereale*) was unavailable to most quail collected in 1986. Rye, red bay (*Persea borbonia*), acorns (*Quercus* spp.), shrub lespedeza (*Lespedeza bicolor*), and red maple (*Acer rubrum*) seeds were important summer food items. Animal matter contributed 7%–8% to the crop volume each year and was comprised of a variety of beetles, true bugs, ants, and grasshoppers. Management practices should be implemented to increase the variety of native seed- and fruit-producing plants in order to develop a dependable food base between seasons and years. Rye and shrub lespedeza plantings may enhance the quality of the summer range, and are utilized by bobwhites when native foods are apparently in short supply.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildlife Agencies 44:250–259

Few data are available that describe the early summer diet of adult northern bobwhite quail. Although thousands of fall and winter crops have been examined from locations throughout the bobwhite's range, records of only 475 summer crops were found in the literature. Stoddard (1931) listed the principal foods from 154 crops and gizzards of adult bobwhites collected from 1 May to 1 November. Grasshoppers, fruits, and grasses were the dominant food items. Allen and Pearson (1945) examined 38 crops collected from June–August in northern Alabama, and found Johnson grass (*Sorghum halepense*) to be the most important component of

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the diet. Harshbarger and Buckner (1971) described the contents of 55 spring and summer (April–September) crops from the Georgia flatwoods. Bobwhites relied heavily on the seeds of several native grasses and herbs, but used cultivated grains when available. Although Reid and Goodrum (1979) examined 7,147 winter crops during 11 years (1941–56), only 92 samples were obtained from spring through fall. They noted that quantities and frequencies of major food categories changed with the seasons. Robinson and Barkalow (1979) described the contents of 36 quail crops taken during April from North Carolina pocosin habitats converted to loblolly pine (*Pinus taeda*). Red maple samaras were the most important food. McRae et al. (1979) documented the major plant foods of 95 bobwhite crops collected in north Florida during March–September 1968. Grass seeds were important in late spring, and panic grass (*Panicum* spp.) was the dominant food in May.

Bobwhite quail tend to forage opportunistically depending upon the availability of various food items (Stoddard 1931, Nestler et al. 1945, Michael and Beckwith 1955, Laessle and Frye 1956, Bookhout 1958). A large variety of seeds and fruits may be consumed depending upon geographic location, vegetation types, farming activities, land use, and cultural practices (Stoddard 1931, Errington 1939, Davison 1942, Wilson and Vaughn, 1944, Baldwin and Handley 1946, Korschgen 1948, Barbour 1951, Baumgartner et al. 1952, Lehmann 1953, Robinson 1957, Larimer 1960).

The highest densities of northern bobwhite quail are found in the longleaf-slash pine (*P. palustris-P. elliottii*) forest type along the Atlantic and Gulf Coastal Plains (Reid and Goodrum 1979). Quail hunting in these open, park-like, woodlands is very popular, and fire can be used as a tool to increase habitat quality and the abundance of native food plants (Stoddard 1931, 1957; Wahlenberg 1946; Rosene 1969). Winter bobwhite food habits have been intensively studied, primarily from crop samples obtained during hunting season (Baldwin and Handley 1946, Barbour 1951, Dickson 1972, Brunswig and Johnson 1973, Reid and Goodrum 1979). Weber (1976) examined 4,157 crops obtained from hunter-harvested quail during 1961–67 in the North Carolina Sandhills. Longleaf pine mast, red bay (*Persea borbonia*), shrub lespedeza, rye, and beggarweed (*Desmodium* spp.) were the most important foods consumed. Red bay was used extensively in late winter and during years with scarce pine mast.

The objective of our research was to describe the early summer diet of adult male northern bobwhites collected in the North Carolina Sandhills. This paper identifies important food items from Sandhills plant communities and information for enhancing the quality of early summer range.

Funding was provided by the Department of Defense-Fort Bragg, the National Rifle Association, the International Quail Foundation, and the North Carolina Wildlife Resources Commission. C. F. Robinette, R. M. Oates, T. L. Myers, C. A. Schock, M. S. McKellar, D. H. Cockman, E. L. Hoffman, C. E. Sorensen, D. L. Landis, T. K. Hughes, L. Buchannan, and T. Odenbaugh cooperated in data collection. C. E. Sorensen assisted with invertebrate identification.

Methods

Study Area

Two Sandhills sites on public lands were selected for summer quail collections. Fort Bragg Military Reservation (FB) in Cumberland and Hoke counties, North Carolina, is comprised of 55,000 ha of which about 40,000 ha are woodland. The 23,000-ha Sandhills Game Lands (SGL) is located in Scotland, Moore, and Richmond counties. A longleaf pine-turkey oak-wiregrass (*P. palustris-Quercus laevis-Aristida stricta*) community (Wells and Shunk 1931) occurs on upland sites in both areas. Drainages intersect the broad ridges with intermittent and perennial streams, resulting in a gently rolling topography. Wetland areas contain a dense evergreen shrub community including red bay, pond pine (*P. serotina*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), red maple, and bitter gallberry (*Ilex glabra*). Coarse, sandy soils are found on the ridgetops, and clays are exposed on the lower slopes and along stream channels.

Crop Collection

Male bobwhites were lured to a tape-recorded assembly call and shot. Adult or subadult male bobwhites were sampled to reduce the impact on nesting success and productivity. Most quail were collected 2–3 hours prior to sunset so that their crops were likely to contain food.

Crop contents were removed 1–2 hours after collection and air-dried. Contents were then sorted into individual taxa and measured in graduated cylinders to determine dry volume. The amount of grit was usually small and was not included in volume determinations. The aggregate volume method (Korschgen 1971) was used to express food amounts in all crops during each year. Frequencies of occurrence also were calculated for food items and expressed as percentages. One or more particles or fragments of a food item in a crop was counted as an occurrence. Plant seeds were identified from a reference collection and according to Landers and Johnson (1976). Invertebrates were identified according to Swain (1957).

Results

During 1985, 25 bobwhites (58%) were collected at FB between 2 May–17 July and 18 (42%) were collected from SGL between 24 June–12 July. In 1986, 21 bobwhites (47%) were collected at FB from 14 April–29 May and 24 (53%) were collected at SGL from 11 April–25 June.

Seeds and fruits accounted for >90% of the summer diet during 1985–86, and the proportion of woody plant, legume, and grass seeds varied significantly ($X^2 = 66.38$, $P < 0.005$) between years (Fig. 1). Rye and red bay totaled 68% of the food volume in 1985, but acorns, shrub lespedeza, red maple, and corn accounted for about 70% of the diet in 1986 (Table 1). In total, huckleberries, blueberries, and blackberries accounted for <3% of the food volume during both years.

Animal matter made up only 7%–8% of the summer foods of adult and subadult

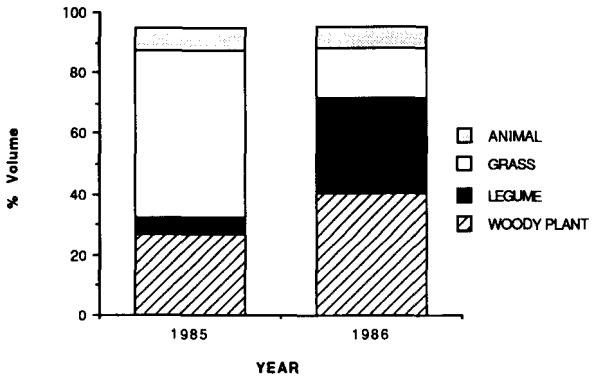

Figure 1. Percentage volume of major food types from 88 northern bobwhite quail crops collected in the North Carolina Sandhills during May–July 1985 and April–June 1986.

male quail collected in the North Carolina Sandhills (Fig. 1). Several types of beetles and true bugs made up most of the animal volume in the 1985 diet, and grasshoppers accounted for <1% of the total volume (Table 2). During 1986, grasshoppers, stink bugs, and leaf beetles each contributed 1%–2% to the total crop volume. Ants were found in 50%–60% of the crops each summer, but always in a relatively low volume. Ground and leaf beetles were found in 20%–30% of the crops we examined during 1985 and 1986.

Discussion

Bobwhites from the North Carolina Sandhills utilized summer food items in different proportions and frequencies than those reported in other Piedmont and Coastal Plain investigations. Land managers responsible for longleaf woodlands should implement agricultural and forestry practices which increase the variety of native seed- and fruit-producing plants to develop a dependable food base (Reid and Goodrum 1979). Prescribed burning, field harrowing, mowing, and fertilization can be used to increase the variety of native grasses, herbaceous plants, and insects (Landers and Mueller 1986) to complement mast from mid- and overstory trees. McRae et al. (1979) noted that the importance of maintaining bobwhite habitat diversity has not been adequately stressed.

About 30% of the spring and 20% of the summer food volume of quail from Louisiana consisted of seeds from woody plants (Reid and Goodrum 1979); blackberries, blueberries, huckleberries, and maple seeds were used extensively. In the Georgia flatwoods, seeds made up nearly 50% of the summer diet, and blueberry and huckleberry fruits accounted for 15% of the summer foods (Harshbarger and Buckner 1971). McRae et al. (1979) noted that blackberries accounted for 75% of the June diet and black cherry (*Prunus serotina*) was the most important food in July for bobwhites in north Florida. In contrast, seeds and fruits accounted for more than 90% of the summer diet of adult male bobwhites in our study (Fig. 1). Huckleberries, blueberries, and blackberries accounted for <3% of the diet of

Table 1. Percentage volumes and frequencies of occurrence of plant foods found in crops from 88 northern bobwhite quail collected in the North Carolina Sandhills during May–July 1985 and April–June 1986.

Food item[a]	1985 (N = 43)		1986 (N = 45)	
	% Vol.[b]	% Occ.[c]	% Vol.	% Occ.
Rye (*Secale ceraeale*)	49.1	48.8	2.1	4.4
Red bay (*Persea borbonia*)	18.9	34.9	0.4	4.4
Acorns (*Quercus* spp.)	6.1	18.6	30.1	42.2
Wheat (*Triticum aestivum*)	5.8	2.3		
Unidentified seeds	3.7	20.9	0.4	24.4
VA-70 lespedeza (*L. bicolor*)	3.2	2.3		
Red maple (*Acer rubrum*)	1.7	18.6	7.7	28.9
Green vegetation	0.4	9.3	1.7	35.6
Shrub lespedeza (*L. bicolor*)	tr[d]	2.3	24.8	20.0
Corn (*Zea mays*)			6.1	6.7
Soybean (*Glycine max*)			4.9	2.2
Panic grass (*Panicum* spp.)	tr	2.3	4.3	28.9
Sorghum (*Sorghum vulgare*)			4.1	6.7
Blueberry (*Vaccinium* spp.)			1.7	4.4
Beggarweed (*Desmodium* spp.)	tr	2.3	1.4	13.3
Total plant volume (%)[e]	91.8		92.3	

[a]Food items that totaled <1% volume during both years are not shown in the table.
[b]% Vol. = % aggregate volume (Korschgen 1971).
[c]% Occ. = frequency of occurrence.
[d]tr = <0.1% volume.
[e]Total volume was 154.03 ml in 1985 and 133.69 ml in 1986.

Table 2. Percentage volumes and frequencies of occurrence of animal food items found in crops from 88 northern bobwhite quail collected in the North Carolina Sandhills during May–July 1985 and April–June 1986.

Food item[a]	1985 (N = 43)		1986 (N = 45)	
	% Vol.[b] (Tot. vol. = 154.03 ml)	% Occ.[c]	% Vol. (Tot. vol. = 133.69 ml)	% Occ.
Darkling beetles (Tenebrionidae)	1.4	4.7	tr[d]	2.2
Broad-headed bug (Alydidae)	1.0	9.3	tr	4.4
Scarab beetles (Scarabaeidae)	0.8	16.3	0.2	8.9
Grasshoppers (Acrididae)	0.7	14.0	1.8	11.1
Ants (Formicidae)	0.7	51.2	0.8	60.0
Snout beetles (Curculionidae)	0.7	9.3	tr	8.9
Ground beetles (Carabidae)	0.6	30.2	0.7	20.0
Stink bugs (Pentatomidae)	0.4	14.0	1.3	15.6
Leaf beetles (Chrysomelidae)	0.3	27.9	1.4	31.1
Total animal volume (%)[e]	7.8		6.9	

[a]Food items that totaled <0.5% volume during both years are not shown in the table.
[b]% Vol. = % aggregate volume (Korschgen 1971).
[c]% Occ. = frequency of occurrence.
[d]tr = <0.1% volume.
[e]Total volume was 154.03 ml in 1985 and 133.69 ml in 1986.

Sandhills quail during both years. Huckleberries were just beginning to ripen during our collection periods, and unpublished data from SGL (T. Sharpe) indicated heavy use of this soft mast from late July to early September.

Bobwhite quail frequently utilized mast from mid- and overstory trees in Sandhills habitats when it became available. Weber (1976) emphasized that variable mast crops in longleaf forests had a strong influence on quail diet, and red bay was an important food during late winter. In our study, red bay and rye made up 68% of the early summer food volume during 1985, but these items were infrequently consumed the following summer (Table 1). During 1986, acorns and shrub lespedeza accounted for 55% of the food volume. In contrast, Weber (1976) found acorns in only trace amounts during his 7-year study.

Reid and Goodrum (1979) emphasized that it takes several years to obtain a good picture of quail diets in a forest environment. They also observed that bobwhites have an ability to adapt to a varying food supply and that a variety of seed- and fruit-producing plants are necessary for a stable quail food base in longleaf habitats. Forest and range management practices that work toward less complex plant communities or single species units, will eliminate important quail food sources (Reid and Goodrum 1979).

Shrub lespedeza and rye were planted to improve habitat quality at FB and SGL. Rye was planted on fire lanes and fields during fall to stabilize soil and provide winter forage for white-tailed deer (*Odocoileus virginianus*). Plants that survived deer grazing produced seed during June and July, and rye fields were used extensively by bobwhites during mid-summer. All but 5 crops were collected prior to June during 1986, and rye was unavailable to most quail sampled due to plant fruiting chronology. This disparity in rye availability contributed to the significant difference in seed types observed in bobwhite crops during 1985 and 1986 (Fig. 1). Weber (1976) noted that shrub lespedeza and red bay were consumed more regularly during fall and winter following a pine mast failure. Therefore, in years with good longleaf or acorn crops, red bay and lespedeza may have greater availability during the following spring and summer.

We also observed that bobwhites consumed acorn fragments throughout the year following a good mast crop from oaks. Coveys were frequently flushed from turkey oak, scrub post oak (*Quercus margaretta*), and blackjack oak (*Q. marilandica*) thickets, and apparently fed on acorn fragments dropped by white-tailed deer. The extended availability of acorns was due to the dry, sandy soils which reduce the acorn spoilage rate, and the fact that many turkey and blackjack oak acorns remain attached to the tree until spring. The extensive use of mast persisting from the previous fall acorn crop by Sandhills quail was in contrast with the more typical pattern of utilizing ripening seeds and fruits as they become available.

Landers and Johnson (1976) noted that acorns were in the first or second highest significance class by volume in 67% of the published bobwhite food habits studies from the southeastern Coastal Plain and Piedmont. McRae et al. (1979) emphasized the importance of maintaining a mast-producing hardwood component in regularly-burned pine woodlands to increase habitat diversity. In the North Carolina Sandhills,

we have the opposite problem. Longleaf pine forests are often choked by scrub oak thickets, and it is difficult to maintain herbaceous layer diversity in pine savannas due to poor fire management practices. Usually there is no shortage of oak mast, and we recommend the use of fire to control hardwood encroachment and enhance the production of native legume seed in the herbaceous layer.

Reid and Goodrum (1979) reported that animal matter accounted for 14.2% and 41.2% of spring and summer bobwhite food volumes respectively, and grasshoppers were frequently taken. Allen and Pearson (1945) found that grasshoppers were consumed in greatest quantity during summer in northern Alabama. Insects made up 30% of the total summer food volume in the Georgia flatwoods (Harshbarger and Buckner 1971), and grasshoppers and crickets made up 50% of the animal matter consumed on an annual basis. In contrast, animal matter made up only 7%–8% of the early summer diet of adult male bobwhites collected in this study (Fig. 1). Insects were an important component of quail chick diets (Hurst 1972), and bobwhites with broods may consume a greater proportion of animal matter than we observed, or forage in different habitat types (Landers and Mueller 1986:13). Also, insect densities may be lower for coarse-grained, Sandhills soils due to their poor water-holding capacity.

We observed ants in 50%–60% of the bobwhite crops examined each summer. Ehrlich and Roughgarden (1987) noted that the nesting and brood rearing behavior of ants exposes them to pathogenic fungi, and in response, ants secrete antibiotics. Potts (1986) also found that 68% of all the insects eaten by 21 grey partridge (*Perdix perdix*) chicks aged 2–6 weeks were ant pupae. Insect proteins were extremely important for partridge chick growth and feather development. Research is needed to determine if ants have an antibiotic function in northern bobwhites, or if ants provide essential nutrients.

Ground and leaf beetles were found in 20%–30% of the crop during 1985 and 1986 (Table 2). Hurst (1972) ranked beetles, true bugs, leafhoppers, spiders, ants, grasshoppers and flies, in order from most to least important for quail chicks in Mississippi. Crop and gizzard contents from 126 juvenile quail indicated that 83% consumed beetles and 74% foraged on ants. Beetles were also an important early summer food for adult Sandhills bobwhites. It is not known if female quail or male bobwhites with broods have a diet similar to the birds we collected. Additional collections are necessary to determine the food selection of adult northern bobwhite quail with chicks.

Management Implications

Fire has long been recognized as an important bobwhite management tool in southern forests (Stoddard 1931, 1939; Rosene 1969). Frequent burning can increase the production of native legumes used by quail (Cushwa et al. 1969, Lewis and Harshbarger 1986). Platt et al. (1989) emphasized that the season of burning was a critical factor for maintaining habitat diversity in Sandhills vegetation types, and spring fires produced significantly greater mortality of oaks than burns in any other

season. Timing and intensity of growing season fires also affected the flowering and fruiting of herbaceous ground cover species. Growing season fires will improve Sandhills habitat quality for bobwhites by increasing the diversity, abundance, and fruiting of native plants, and controlling hardwood encroachment in pine stands.

Hurst (1972) recognized the importance of insects in the summer diet of young quail. In old-field habitats, fire increased insect abundance and removed accumulated litter making travel easier for chicks. Growing season fires in pine woodlands also can provide bugging sites for quail broods (Landers and Mueller 1986:30), and adults with chicks are often attracted to areas burned during summer. Animal matter may provide a larger component of adult male quail diets in Sandhills habitats after implementation of a growing season burning program.

Disking can increase plant species diversity and total seed production of native herbs in southeastern pine woodlands (Buckner and Landers 1979, Landers and Mueller 1986). We advise against disking large areas of Sandhills habitat because of the destruction of wiregrass clumps, which bobwhites use for nesting cover (Curtis and Doerr 1990). Our observations indicate that native vegetation on coarse, infertile, sandy soils responds poorly to disking. The most fertile sites are usually found in midslope areas within 50 m of a stream or drainage. Occasional strip-disking, burning, or mowing should be used to maintain openings and increase habitat diversity.

Prescribed burning will continue to be the primary tool for forest wildlife management in Sandhills habitats. With judicious use of growing season fires, plant and animal diversity can be improved in pine woodlands (McRae et al. 1979, Platt et al. 1989). Northern bobwhite habitat management can be compatible with management practices for a variety of other game, nongame, and plant species.

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