DIETS OF SYMPATRIC BOBWHITE AND SCALED QUAIL IN OKLAHOMA[1]

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Abstract: Fall-winter diets of sympatric bobwhite *(Colinus virginianus)* and scaled quail *(Callipepla squamata)* in southwestern Oklahoma were compared during 1978 - 80 using analysis of crop contents. High overlap was present between the 2 species for 1978 - 79 (Overlap coefficient $C = 0.65$) and 1979 - 80 ($C = 0.88$). Staple items included seeds of wheat, mesquite *(Prosopis glandulosa),* broomweed *(Xanthocephalum dracunculoides),* buffalobur *(Solanum rostratum),* and flax (*Linum* sp.). Frequency of occurrence of broomweed seeds increased as winter progressed in 1979 - 80, possibly because of low availability of more preferred foods. Interspecific competition for food resources may become important during late-winter months when seed supplies are decreased.

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Bobwhite and scaled quail are sympatric over a large part of Texas, and portions of Oklahoma, Colorado, and New Mexico. Both species are granivorous, shrub-grassland birds having similar diets but different habitat preferences (Schemnitz 1964). Bobwhites prefer a more "closed" habitat with substantial grass cover (Hamilton 1962, Schemnitz 1964), Brown 1978), while scaled quail prefer a more "open" habitat with less grass cover (Wallmo 1956, Schemnitz 1964, Goodwin and Hungerford 1977).

The sympatric occurrence of these 2 important game species provided an opportunity to evaluate the degree of overlap in their diets. Several food studies have been conducted for scaled quail, but only in areas where bobwhites were absent (Wallmo 1956, Barkley 1972, Campbell et al. 1973, Davis and Banks 1973, Davis et al. 1975) or present only in relatively low numbers (Schemnitz 1961). Jackson (1969) conducted food studies for bobwhites where densities of the 2 species were more comparable, but did not report scaled quail food habits.

Schemnitz (1964) compared the diets of sympatric bobwhite and scaled quail in the Oklahoma panhandle and found that foods comprising 95% by volume of bobwhite diets comprised 73% of scaled quail diets. This high similarity was present despite the distinct separation in preferred habitats of the 2 species. Bobwhites were found predominantly in bottomlands while scaled quail were found more often in uplands. In this study, I compared food habits in a more homogeneous habitat where habitat preferences were not as marked and home ranges more likely to overlap.

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METHODS

Most of the sympatric range was mesquite-grassland usually referred to as the Rolling Plains (Jackson 1969). The study area of approximately 80 km^2 was located in extreme southwestern Oklahoma in southern Harmon County. Primary land uses of the area were cattle grazing interspersed with dryland wheat and cotton farming. Most of the native pastures were infested to varying degrees with mesquite; lotebush *(Ziziphus obtusifolia)* and netleaf hackberry *(Celtis reticulata)* were less common. Overgrazing was widespread, as indicated by the abundance of mesquite, broomweed and prickly pear (*Opuntia* sp.). Dominant grasses included blue grama *(Bouteloua gracilis),* side-oats grama *(B. courtipendula),* dropseed (*Sporobolus* spp.), buffalograss *(Buchloe dactyloides)* and threeawns (*Aristida* spp.). Gypsum outcrops and narrow, untillable ravines were common throughout the area. Topography, climate, and soils for this area were described by Barber (1979) and Morrison and Lewis (1976).

Quail were collected by shooting during the 1978 - 79 and 1979 - 80 (20 Nov - 1 Feb) hunting seasons; hunter donations were used whenever available. Additional birds were collected in February and October, 1979. Bobwhite and scaled quail were collected within 1 km of one another in an attempt to insure overlapping feeding areas. Seven quail (4 bobwhites, 3 scaled quail) were collected from mixed coveys.

Birds were frozen, transported to the laboratory, and crops removed. Crop contents were oven dried, segregated to species, and measured volumetrically using water displacement to the nearest 0.1 cc. Foods present in less than 0.1 cc were recorded as trace items. Seed identification was facilitated by the seed collection of the Oklahoma Cooperative Wildlife Research Unit and by Martin and Barkley (1961). Frequency of occurrence and percentage total volume (Martin et al. 1946) were recorded for each food item. Plant names follow Waterfall (1972).

The degree of overlap in diet (C_o) was computed using a modified version of the formula reported by Horn (1966). The formula is:

$$C_o = \frac{2 \sum_{i=1}^{t} Bi\ Si}{\Sigma Bi^2 + \Sigma Si^2}$$

where t is the total number of food species and B_i and S_i are the proportions of the total diet of bobwhite (B) and scaled (S) quail taken from food species i. A coefficient of 0.0 indicates no overlap while a value of 1.0 indicates complete overlap.

RESULTS AND DISCUSSION

Diets of sympatric bobwhite and scaled quail exhibited a high degree of overlap in both 1978 - 79 ($C_0 = 0.65$) and 1979 - 80 ($C_0 = 0.88$). The major foods of both species were primarily agricultural grains and seeds of forbs, with insects and green vegetation consumed in lesser amounts (Table 1). Foods that comprised 94.2% of the scaled quail's diet constituted 96.1% of the bobwhite's diet. Schemnitz (1961, 1964) found that 95.2% of the bobwhite's diet constituted 73.5% of the scaled quail's diet ($C_0 = 0.87$) despite marked habitat preferences of the 2 species in the Oklahoma panhandle.

Both bobwhite and scaled quail actively select preferred food items (Davis et al. 1975) therefore a plant may be heavily used and yet be uncommon. Plant and seed availability data were not collected to determine if foods selected were eaten because of preference, availability, or both. Differences in diet and food preferences may be detected, however, because items available to bobwhites appeared to be equally available to scaled quail.

The main dissimilarity in diets found in this study was the number of different food species per crop. Scaled quail had a mean of 6.1 food species per crop, significantly ($P < 0.05$) higher than the average of 4.9 items per crop for bobwhites. Schemnitz (1961, 1964) also found that scaled quail consumed a greater variety of foods ($\bar{X} = 8.1$) than did bobwhites ($\bar{X} = 6.3$).

Wheat was the most important food by volume for bobwhites in both years and for scaled quail in 1979 - 80. Wheat ranked second to green vegetation for scaled quail in 1978 - 79. These findings contrast with Schemnitz's (1961, 1964), who found wheat to be of minor importance in fall-winter diets of bobwhite and scaled quail despite its widespread availability. Wheatfields often interface with native mesquite pastures in Harmon County, allowing quail to feed in open fields near escape cover. In all instances ($N = 8$, 2 bobwhite, 6 scaled quail) that coveys were observed actively feeding in wheatfields, coveys were within 15 m of available escape cover.

Most of the wheat available appeared to be waste from the previous year's harvest and "volunteer" growth. However, at least some newly sown seeds were eaten as indicated by the presence of seeds covered with a pink, antifungal chemical, Ceresan (methylmercury 2, 3-dihydroxypropyl mercaptide and methylmercury acetate) which is placed on seeds prior to sowing. No records of treated seed ingestion were made for the 1978 - 79 field season, but in 1979 - 80, 3 of 48 (6.2%) bobwhite crops and 4 of 82 (4.9%) scaled quail crops examined contained at least 1 treated seed. One bobwhite and 1 scaled quail had each consumed 2 treated seeds. Tucker and Crabtree (1970) suggested that Ceresan may be lethal to bobwhites. The possible impact of this chemical should be evaluated to determine its effect on wild quail.

The increased use of wheat by bobwhite and scaled quail in 1979 - 80 may have been a result of its prolonged availability. Wheat normally sown in September germinates soon thereafter and presumably becomes unavailable for quail. Because of low soil moisture, most wheat planted in September and October 1979 did not germinate. Poor stands predominated throughout the 1979 field season. Reduced germination and hence greater availability would have allowed both species of quail to eat more wheat than during more "normal" years.

Table 1. Crop contents of sympatric bobwhite and scaled quail collected November 1978 - February 1979 and October 1979 - January 1980 from Harmon County, Oklahoma.

	Bobwhite				Scaled Quail			
	1978-79 (16)[a]		1979-80 (48)		1978-79 (49)		1979-80 (86)	
Foods	Freq.[b]	Vol.[c]	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.
Seeds								
Wheat	12	16.3	58	56.0	18	13.9	43	34.5
Broomweed *(Xanthocephalum dracunculoides)*	0	0.0	50	11.6	4	t[d]	65	14.3
Western ragweed *(Ambrosia psilostachya)*	12	7.4	40	3.9			28	7.4
Buffalobur *(Solanum rostratum)*	49	9.6	6	t	55	5.4	27	6.3
Flax (*Linum* sp.)	19	1.1	29	4.9	29	0.2	47	6.4
Mesquite *(Prosopis glandulosa)*	25	3.5	12	1.3	57	13.9	16	1.0
Spurge (*Euphorbia* spp.)	62	10.3	15	0.7	26	10.4	7	0.2
Sorghum (*Sorghum bicolor* and *S. bicolor* × *S. sudanense*	12	11.7	15	5.9			19	8.1
Johnsongrass *(S. halepense)*	19	1.4	27	6.5	2	0.1	9	0.4
Doveweed *(Croton texensis)*	25	5.3	8	0.4	20	1.5	7	0.1
Sunflower (*Helianthus* sp.)			8	0.8			9	0.7
Loco (*Astragalus* spp.)			2	0.4			29	3.9

Table 1. Continued.

Foods	Bobwhite				Scaled Quail			
	1978-79 (16)[a]		1979-80 (48)		1978-79 (49)		1979-80 (86)	
	Freq.[b]	Vol.[c]	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.
Russian thistle *(Salsola kali)*	25	3.2			31	5.8	14	1.8
Smartweed (*Polygonum* sp.)	6	1.8	4	0.8	6	t	15	1.2
Netleaf hackberry *(Celtis reticulatus)*	13	1.1			18	9.1	5	0.4
Thistle *(Cirsium texanum)*			23	1.1	10	0.1	19	0.9
Grama grasses (*Bouteloua* spp.)	19	0.7	21	1.5	10	0.5	20	0.8
Pigweed (*Amaranthus* spp.)	12	4.2	12	0.1	61	2.9	23	0.6
Foxtail (*Setaria* sp.)	36	2.1	4	t	26	3.9		
Erect dayflower *(Commelina crispa)*	12	8.5			2	t		
TOTAL SEEDS IN COMMON		90.7		95.9		70.1		89.6
Green vegetation	69	4.6	48	1.9	59	16.1	59	8.8
Insects	56	1.1	21	1.9	31	2.1	12	1.0
TOTAL FOODS IN COMMON		96.4		99.7		88.3		99.4
Miscellaneous foods		3.6		0.4		11.6		0.6
TOTAL FOODS		100.0		100.1		99.9		100.0

[a] Sample size.

[b] Frequency of occurrence expressed as percent of total crop.

[c] Percentage of total volume.

[d] Items present in less than 0.1% of the total volume.

There was considerable annual variation in the diets. Mesquite was a staple food item for both species in 1978 - 79, but comprised less than 2% of the diet of either species in 1979 - 80. This change may have been due, in part, to reduced seed availability. Several centimeters of rain fell on the study area during July 1979, approximately the same time mesquite was flowering. Rainfall knocking the flowers off the plants may have been responsible for the poor bean crop observed. Other studies (Jackson 1969, Campbell et al. 1973, Davis et al. 1975) indicated mesquite seeds were a major constituent and preferred item in the diets of bobwhite (Texas) and scaled quail (New Mexico).

The apparent decrease in availability of some of the more staple foods was reflected by the high occurrence of broomweed in diets during 1979 - 80. Broomweed was found only in trace amounts in scaled quail and was absent in bobwhites in 1978 - 79. However, broomweed seeds were found in over 50% of the crops examined and comprised at least 10% by volume of the diet of both species in 1979 - 80. Davis and Banks (1973) concluded that *Xanthocephalum* was a non-preferred item. Presumably, as larger and more preferred seeds became scarce, quail consumed more of the less preferred but highly plentiful broomweed seeds. Jackson (1969:48) stated that broomweed may have been largely responsible for quail survival during harsh winters in the Texas panhandle. In addition to being an important food source, broomweed is excellent screening cover (Jackson 1962) allowing quail to forage with more security.

Monthly analyses indicated that as the occurrence of wheat, western ragweed *(Ambrosia psilostachya)*, and insects declined, the use of broomweed, green vegetation, and Russian thistle *(Salsola kali)* increased (Table 2). Green vegetation (Baumgartner et al. 1952) and Russian thistle (Jackson 1969:48) tend to increase in occurrence when more preferred items are scarce. Occurrence of Russian thistle in scaled quail crops increased as the winter progressed, but was not found in bobwhites in 1979 - 80.

Green vegetation was a staple item for both species during both years of the study. Scaled quail consumed about 4 times more green vegetation by volume than bobwhites. Schemnitz (1961, 1964) also found that scaled quail consumed more green material than bobwhites (2.8% and 0.9%, respectively). Campbell et al. (1973) and Davis et al. (1975) found that green vegetation comprised 8 - 10% of the fall-winter diet of scaled quail in New Mexico.

Spikelets of grama grasses (*Bouteloua* spp.), despite their apparent availability, consistently amounted to less than 2% of the diet of either species. Low use of grama grasses has also been reported by Schemnitz (1961), Jackson (1969), Campbell et al. (1973), and Davis et al. (1975).

Insects (primarily Orthoptera and Coleoptera) were found in quail crops in amounts ranging from 1 - 2% each year. Previous studies in New Mexico (Campbell et al. 1973, Davis and Banks 1973, Davis et al. 1975) and the Oklahoma panhandle (Schemnitz 1961, 1964) reported that insects comprised 5 - 8% of fall-winter diets. Decreased use of insects in this study may be related to decreased abundance. The winters of 1977 - 78 and 1978 - 79 were more severe than normal (U.S. Department of Commerce 1978, 1979) and may have depressed insect populations.

Table 2. Monthly occurrence of selected foods found in sympatric bobwhite and scaled quail collected October 1979 - January 1980 from Harmon County, Oklahoma. Numbers represent frequency of occurrence in percent of total crops examined.

	October		November		December		January	
Common name	Bobwhite (6)[a]	Scaled (7)	Bobwhite (16)	Scaled (42)	Bobwhite (21)	Scaled (27)	Bobwhite (5)	Scaled (10)
Broomweed	0	0	56	64	71	81	0	70
Wheat	67	58	81	60	43	22	40	20
Ragweed	67	43	50	41	33	7	0	20
Green vegetation	50	20	44	52	52	70	40	80
Insects	67	14	25	17	9	7	0	0
Russian thistle	0	0	0	0	0	30	0	40

[a] Sample size

Potential of Interspecific Competition for Foods

Whenever 2 closely related species having similar niches occupy the same range, the potential for interspecific competition exists. The amount of resource competition should be proportional to the degree of overlap if the resource is scarce (Pianka 1975:193). My data indicated that, within the same habitat, bobwhite and scaled quail consumed essentially the same diets.

Before competition for a resource can occur, the resource must be in short supply (Cody 1974:203). Although wheat was heavily eaten by both species, it probably was sufficiently available to preclude competition, at least until weather conditions favored germination and the subsequent loss of available seeds. As winter progresses, availability of seeds decreases and the degree of food competition may increase.

Seed availability may be affected by other species, including rodents (Jackson 1962) and other granivorous birds (Parmalee 1953). Harmon County harbors numerous migrant mourning doves *(Zenaida macroura)* (Morrison and Lewis 1976). In a study located approximately 20 km southeast of the current study, Morrison and Lewis (1976) found that wheat, haygrazer, spurge (*Euphorbia* spp.), pigweed (*Amaranthus* spp.), and other species were important early winter dove foods. Most of the wintering doves arrived in November and remained until March, or throughout the period of low seed availability. Doves were not collected during this study, but the data of Morrison and Lewis (1976) suggest that food competition analyses between quail may be confounded by seed depletion as a result of wintering doves. Parmalee (1953) concluded that large flocks of migrant mourning doves could be serious competitors with bobwhites for seeds in north-central Texas. Conversely, Griffing and Davis (1976) concluded that there was little overlap between scaled quail and dove food habits in southeastern New Mexico. This apparent contrast between Parmalee's and Griffing and Davis's findings may be a result of habitat differences between their study sites, different densities of doves, or some other factors.

Competitive Exclusion Principle

Quail production and food availability in the Rolling Plains are largely determined by annual precipitation patterns, range depletion, and recurring droughts (Jackson 1962). In years of average rainfall, food supplies and cover are abundant and probably not limiting to quail. During drought years, food resources are limited and competition highest. A drought year, or a series of 2 or more such years, will transform the available habitat from adequate to a shortgrass mesquite-parkland (Jackson 1947). Scaled quail seem to prefer more open habitats and may be better adapted to exploit the habitats created during drought years. This ability, plus apparently differential effects on the 2 species as a result of predation (Jackson 1947), endoparasite loads (Rollins 1980), effects of drought on reproduction (Schemnitz 1964), and livestock overgrazing (Brown 1978) would seem to favor scaled quail in sympatric ranges.

Scaled quail increased their range dramatically in southwest Oklahoma during the early 1960's (Jacobs 1960) and have increased dramatically in Harmon County from Schemnitz's (1959) estimate of less than 100 birds. Data for bobwhite

numbers for this area are unavailable, but Brown (1978) reported bobwhite populations have declined throughout the southwestern United States. Detailed, long-term population data for both species in sympatric ranges are necessary before conclusions can be made regarding the significance of competition in the ecology of these 2 game species.

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