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Winter Feeding Habits of Quail in Longleaf-Slash Pine Habitat

by

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Abstract

Crops of bobwhite quail (*Colinus virginianus*) collected in 11 years (7,147 in winter and 92 in other seasons) in the longleaf-slash pine (*Pinus palustris-P. elliottii*) forest type were examined for food content. Seeds of woody plants made up 45% or more of the volume of food found in crops in 9 of the 11 winters. Seeds of pines (*Pinus* spp.), drupes of red bay (*Persea borbonia*), and acorns from various oaks (*Quercus* spp.) were large-volume food items in certain years. As a group, seeds produced by legumes were next largest in volume, varying from 2 to 48% in the 11 winters. Seeds of partridge peas (*Cassia* spp.), common lespedeza (*Lespedeza striata*), bush clovers (*Lespedeza* spp.), milkpeas (*Galactia* spp.), and tick-clovers (*Desmodium* spp.) were important species. Volumes of seeds of grass, spurge, and sedge families were usually less than 12% for each group, and volumes of green leaves and animal matter less than 5% each. Panic (*Panicum* spp.) and paspalums (*Paspalum* spp.) were principal grass species. Availability of seeds influenced consumption by forest-dwelling quail. In habitat management for quail, a variety of trees and shrubs should be maintained in the forest type to better insure a dependable food base, season to season and year to year. Similarly, desirable herbaceous food plants should be encouraged by fire and mechanical means.

The longleaf-slash pine (*Pinus palustris-P. elliottii*) forest type stretches along the Atlantic and Gulf Coastal Plains from North Carolina to east Texas (Fig. 1) and supports the largest concentrations of bobwhite quail known (Stoddard 1931, 1957; Halls and Stransky 1971). Quail hunting in the piney woods has long been, and still is, considered an excellent sport, and this open, park-like, fire subclimax is susceptible to management for quail as well as for forest and range products (Stoddard 1931; Wahlenberg 1946; Stoddard 1957; Rosene 1969). The present report contains (1) findings about long-term winter food of quail in longleaf-slash pine habitat based on examination of a large series of crops, (2) information about food habits in the warm seasons of the year, (3) notes on yearly and seasonal availability and nutritional quality of some seeds, and (4) suggestions for management of some food plants in forest habitat.

Methods

Crops were collected from quail in 11 winters (1941, 1945, and 1947-55). Months representing winter were November through February. With a Thanksgiving Day opening of the hunting season, most of the November crops were collected the last week of the month. Crops taken in warmer seasons were not all collected in a single year but were grouped by months to represent foods of spring (March, April, May), summer (June, July, August), and fall (September, October).

Contents of the crops were air dried. Foods in each crop were separated by species, genus, or other more broad category, and the material measured in graduated cylinders or graduated centrifuge tubes to determine dry volume. Amount of grit was usually small and was not included in volume determinations. The aggregate volume method (Martin et al. 1946; Korschgen 1971) was used to express amounts of foods in all crops for specific periods, such as (1) each winter, (2) each month (November through February) for winters 1953-54, 1954-55, and 1955-56, and (3) for the spring, summer, and fall seasons. Also, frequencies of occurrence were calculated for food items. One or more particles (or particle fragment) of a given food in a crop was counted as an occurrence. Occurrences for food were expressed as percentages.

For some of the principal food items, volume was compared with frequency of occurrence by regression analysis. These comparisons were made with only data for the 9 consecutive winters when more than 100 crops were collected and examined annually.

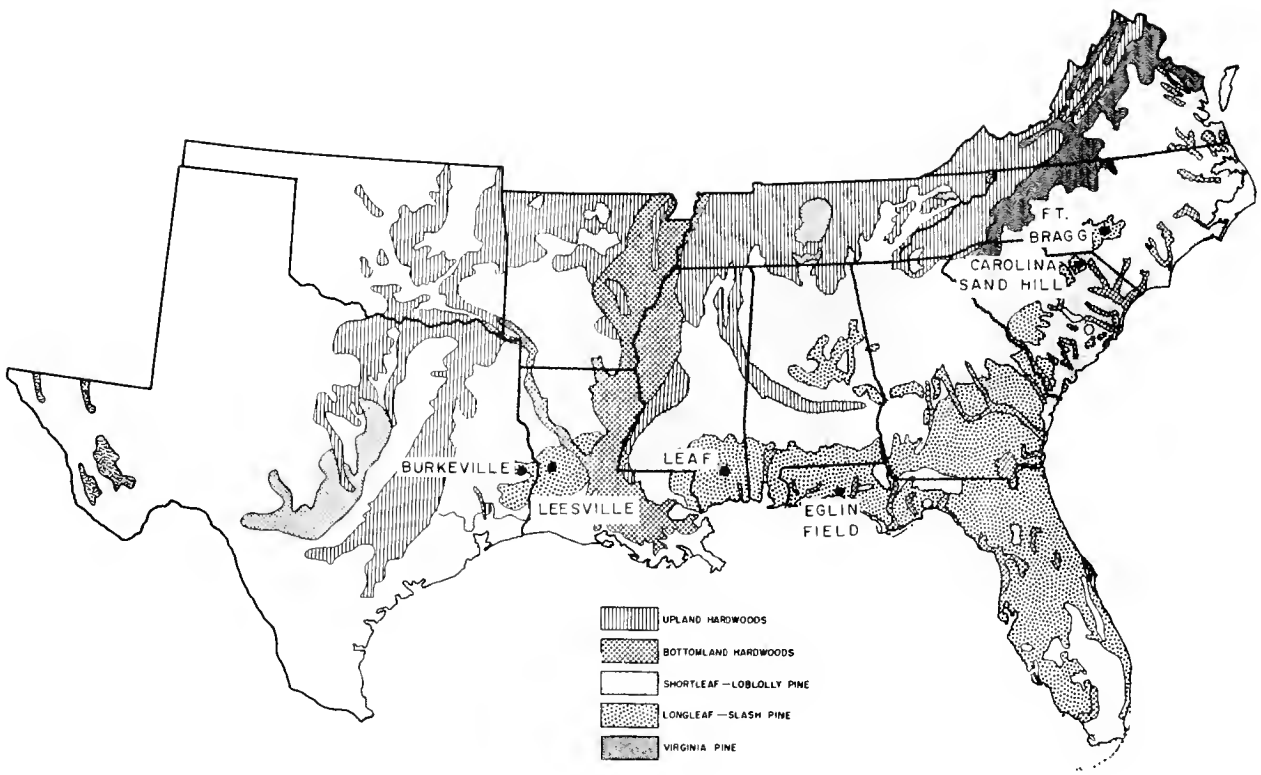

Fig. 1. Forest types of the Southeast and South and locations of areas where quail crops were collected. Most quail crops came from the southwestern extension of the longleaf-slash pine belt in the vicinity of Leesville, Louisiana, and Burkeville, Texas.

Information on plant phenology, including time of flowering, seeding, fruiting, and germinating was gleaned from several sources, principally Van Dersal (1938); U.S. Department of Agriculture [USDA] (1948, 1974); Vines (1960); Fowells (1965); Grelen and Duvall (1966); Correll and Johnston (1970); and Halls (1973).

Location and Description of Study Areas

Quail crops came from five localities (Fig. 1), but most were from national forest and commercial forest lands in the southwestern extension of the longleaf pine belt. Sources and numbers of winter crops were: (1) vicinity of Leesville, Louisiana, and Burkeville, Texas, 6,902; (2) Carolina Sandhills Wildlife Refuge, South Carolina, 46; (3) Leaf, Mississippi, 36; (4) Fort Bragg Military Reservation, North Carolina, 32; and (5) Eglin Air Force Base, Florida, 131. The 92 crops representing warm seasons of the year came from the Leesville area in southwestern Louisiana.

An assortment of tree and shrub species grow within the longleaf-slash pine belt and provide the forest type with species diversity (Wahlenberg 1946). Loblolly (*Pinus taeda*) and shortleaf (*Pinus echinata*) pines are coniferous associates, especially in the vicinity of mesic sites. Scattered stands of various scrub oaks (*Quercus* spp.) add multiformity to the type. Open seepy hillsides, baygalls, ravines, stream branches, and stream courses that finger through and drain the piney woods are heterogeneous entities within the broad type. Baygalls, boggy tracts usually overgrown with ink-berry (*Ilex glabra*), sweet bay (*Magnolia virginiana*), or red bay (*Persea borbonia*), may be near to or distant from main drainages. The drainage courses themselves range from thread-like ribbons to broad bottoms and contain such broad-leaved associates as large-growth form oaks (*Quercus* spp.), ash (*Fraxinus* spp.), black gum (*Nyssa sylvatica*), hickory (*Carya* spp.), and sweet gum (*Liquidambar styraciflua*).

Plant composition of ground mantle is about 80% grasses, 3% grasslike plants, 15% forbs, and 2% shrubs. Bluestem grasses (*Andropogon* spp.) are dominant in the western portion of the longleaf-slash pine belt (Langdon et al. 1952; Grelen and Duvall 1966; Sternitzke and Pearson 1974). East of the Apalachicola River, wiregrasses (*Aristida* spp.) replace bluestems as the dominant species (Duvall and Hilmon 1965). Air-dry herbage yields range from about 336 kg per hectare per year under fully stocked pulpwood

Fig. 2. Extensive clearcuts, scattered longleaf pine regeneration, few shrubs, and luxuriant herbaceous ground mantle characterized much of southwest Louisiana forest survey unit in 1955.

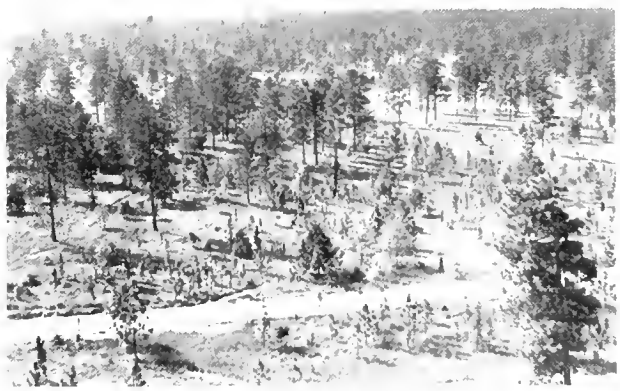

Fig. 3. Reproduction and second-growth, sub-sawlog-sized stands of longleaf pine in southwest Louisiana forest survey unit in 1955. The open park-like stands, natural occurring openings, and luxuriant herbaceous ground mantle make good basic quail habitat.

stands to over 3,360 kg per hectare on clear-cut areas (Duvall 1962; Duvall and Hilmon 1965; Duvall and Linnartz 1967; Wolters 1973).

The extreme southwestern extension of the longleaf pine belt is included in two U.S. Forest Service survey regions: southwest Louisiana and southeast Texas. Seventy-five percent or more of the area in 14 of the 29 parishes or counties in the two survey units is forested, and 10 parishes or counties range between 50 and 75% forested (USDA 1969).

Conditions in the two forest survey regions immediately before and at the time the quail crops were collected are described in Cruikshank (1939), Lay (1952), and USDA (1955, 1956). Briefly, the land supported a variety of forest stages: extensive clearcuts with dense stands of herbaceous ground cover and very few scattered trees and shrubs (Fig. 2); clearcuts with invading scrub-oak stands; natural and artificial pine regeneration; young and second-growth, sub-sawlog-sized stands (Fig. 3); merchantable second-growth; and a few remnant stands of old-growth trees (Fig. 4). Fire protection was improving during the period of study.

Fig. 4. A few remnant stands of old-growth longleaf pine were also present in the southwest forest survey region of Louisiana in 1955.

Fewer acres were being burned annually than in earlier years when forest and range fires were common in all seasons of the year. Resinous stumpwood left by earlier logging was being removed by dynamite and bulldozer for processing. Free-ranging cattle, horses, and hogs used the forest range yearlong.

Results

Winter Foods

Winter foods of quail were similar for all five areas, so data were combined to show feeding habits each winter by volume and frequency of occurrence (Table 1). Woody and herbaceous plant seeds or fruit made up 90 to 95% of the food volume; green, leafy material and animal matter made up the remainder (Fig. 5). Those known or unknown seeds or other foods making up less than 0.1% in volume most winters were not listed individually, but were grouped as "other" under appropriate headings (Table 1). It is doubtful that consistently small-volume, low-frequency foods are critically important to the nutritional quality of the diet or the physical welfare of quail (Davison 1958; Davison and Hamor 1960).

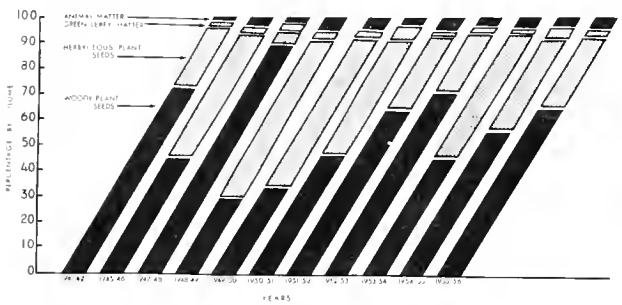

Fig. 5. Woody plant seeds and fruits made up 45% or more of the food volume found in crops in 9, and seeds of herbaceous plants 44% or more in 5, of 11 winters.

Woody Plant Seed

In 11 winters, seeds or fruits representing 43 woody plant genera were eaten. They were salient foods each winter and made up 45% or more of the food volume in 9 of 11 winters. Seeds of pine, red bay, and acorns from various species of oaks were especially important for these forest-dwelling quail. However, volumes and frequencies of these foods varied among years.

Pine seeds.—Some longleaf pine seed was eaten each winter and made up 22 to 46% of the food volume in good seed years, an event occurring three times (1947, 1951, 1955) in the 9-year period of consecutive sampling. Following the good seed crop in 1955, there was evidence that the next large longleaf seed crop occurred in 1958 (Boyer 1963). Thus, there may be 2 or 3 intervening years when availability of longleaf pine seed to quail is limited due to the small size of the seed crop.

In the good seed year, 1955, the trend in percentage volume and frequency of longleaf pine seed consumed by quail in the winter decreased from 72 and 85% in November to 2 and 9% in February (Table 2). In poorer seed years (1953 and 1954) the same decreasing trend in consumption of longleaf pine seed was apparent November through February, but use was not as pronounced in early fall (Tables 3 and 4).

Longleaf pine seedfall usually begins in October, peaks in November, and terminates abruptly in December. Seeds germinate in November and December. Dormancy in longleaf pine seed is rare; thus, its availability to quail diminishes sharply from fall to spring.

Although smaller in magnitude, volume and frequency percentages of loblolly pine seed in the crops tended to increase and decrease in the same years as did longleaf pine seed, with peaks every 4th year (Table 1). In the good seed year (1955), consumption of loblolly seed increased November to February, whereas that of longleaf pine seed was declining (Table 2). In poor seed years (1953 and 1954), this trend was not apparent, presumably because few loblolly seeds were available as a food source (Tables 3 and 4).

Loblolly pine seeds are shed in fall and winter as the cones gradually open. Dormancy in seeds is not unusual; germination occurs in spring. Loblolly seeds, therefore, are available to feeding quail for a longer time than are longleaf seeds.

Shortleaf pine seeds were small-volume, low-frequency food items (Table 1), primarily because of limited distribution and number of trees in localities where the birds were collected.

The tendency for amount of pine seed eaten by quail to diminish from fall to spring is apparent in a few other investigations. Wycoff (1964) examined 85 quail crops from the longleaf pine belt, southwestern Louisiana, in winter 1963-64. Six or more crops were collected at about 10-day intervals between 30 November and 25 February. The amounts of longleaf and loblolly seed found in crops decreased after the second collection period ending 19 December. Although collections continued until 25 February, no more pine seeds were found in crops after 15 January.

Laessle and Frye (1956) collected 375 quail crops over a 3-year period in longleaf-slash pine habitat in south Florida, and found slash pine seed only in October and November; largest amounts occurred in October. Also, in flatwoods (flat pinelands of the Coastal Plain) in Georgia, Harshbarger and Buckner (1971), who collected 98 crops over a 2-year period, reported largest amounts of slash pine seeds eaten in fall and

smaller amounts ingested at other seasons.

Slash pine seedfall occurs in September and October, and seeds germinate soon afterward; dormancy is not common. These attributes tend to limit the time that slash pine seeds are available to quail.

Longleaf and loblolly pine seeds appeared as more important food for quail in our investigation than they did in other studies of shorter duration. Summarily, however, Davison (1958) and Landers and Johnson (1976) recognized pine seeds as either choice or high value foods for quail in Coastal Plain and Piedmont physiographic regions. Seeds from loblolly, longleaf, pitch (*Pinus rigida*), shortleaf, slash, spruce (*P. glabra*), and Virginia (*P. virginiana*) pines were also noted as choice foods.

Red bay drupes.—Fruit of red bay made up 10% or more of the volume of food and occurred in 20% or more of the quail crops in 5 of the 11 years. In other years, volume of red bay was 3% or less, and it occurred in 11% or less of the crops. Amounts and frequencies of red bay drupes tended to peak every 2nd or 3rd year, suggesting good seed production years (1947, 1949, 1952, 1954).

Red bay bears fruit in September. Drupes tend to persist on the trees from fall to spring, an attribute that would make them available for several months. Volume and frequency percentages of this fruit in crops in 1954, a good seed year, increased from November (17 and 35%) through February (54 and 50%; Table 4). In 1955-56, the good seed year for longleaf pine, red bay was a small-volume, low-frequency food item from November through February. In the good acorn year, 1953-54, amount and frequency of red bay in the crops tended to increase, November to February, as amount and frequency of acorns diminished (Table 3).

Fruit of red bay was a salient food for quail in our investigation; it did not appear as such in most other studies. Red bay was present in only 10 of 1,659 quail crops examined by Handley (Stoddard 1931). The crops came from several localities in the Southeast and from each month of the year. Amount of red bay drupes in the 5,189 crops reported on by Davison (1942) was shown as "trace." He later classified red bay as an inferior quail food, suggesting that these woody plants were not abundant enough to be an important source of food (Davison 1958). Laessle and Frye (1956) found red bay fruit present in August, September, and December in year-round collections of quail crops over a 3-year period in flatwoods of south Florida. Wycoff (1964) reported red bay fruit in only a few crops collected in December 1963, and found none in his 1957-58 and 1958-59 hunting season collections of quail crops from cutover pinelands in west-central Louisiana. Harshbarger and Buckner (1971) found red bay in only small amounts in fall from crops collected year-around from flatwoods in Georgia, and Landers and Johnson (1976) did not recognize red bay as having high importance value in their summary of 27 food habits studies of quail conducted in the Southeast.

Oak nuts.—Acorns, an important food in all but 1 winter, made up 10% or more of the food volume in 6 winters (Table 1). Volume (35%) and frequency (45%) were highest in winter 1953-54 (Table 3). Fall of 1953 was a good acorn year in southwest Louisiana and southeast Texas (Goodrum et al. 1971). Acorns of white (*Quercus alba*) and post (*Q. stellata*) oaks in the white oak group and water (*Q. nigra*), willow (*Q. phellos*), blackjack (*Q. marilandica*), sandjack (*Q. incana*), and southern red oaks (*Q. falcata*) in the black oak group were some of the species eaten by quail.

Volume and frequency of occurrence of acorns in the good seed year of 1953 decreased from November (46 and 64%) to February (26 and 34%; Table 3). Acorns of the white oak group usually germinate soon after seedfall; thus germination tends to decrease the supply of these acorns from fall to spring. Acorns of the black oak group do not germinate until spring, which extends the period of their availability. However, if seed dormancy is not broken, acorns from both groups may be available yearlong. Acorns occurred in some of the spring crops we examined, none in summer, and a few again in September and October at the beginning of seedfall.

Acorns are generally recognized as a choice quail food. The Cooperative Quail Study Association (Stoddard et al. 1961) reported that a bumper crop of acorns in 1939 provided food for quail all winter long, and that the birds moved to lowland sites to get them, even though a good crop of native legume seeds was available on upland sites. Further, Handley (Stoddard 1931) reported finding acorns in crops every month of the year except May and September. Davison (1958) listed acorns from several species of oaks as choice food for quail: live (*Quercus virginiana*), lowbush (*Q. pumila*), pin (*Q. palustris*), post, southern red, water, and willow.

Other woody plant seeds.—Ash, beech (*Fagus grandifolia*), black gum, and sweet gum seeds were in crops in 6 or more years, but in small amounts. The large volume (10.7%) in winter 1947-48 (Table 1) was due mostly to presence of black gum drupes (9.3%). In other years, black gum fruit was present in smaller amounts and in fewer crops.

In an occasional year, fragments of hickory nuts, and drupes of dogwood (*Cornus* spp.) and sweet bay were present in small amounts.

Seeds from shrubs included poison oak (*Rhus toxicodendron*), sumac (*Rhus* spp.), and wax-myrtle (*Myrica* spp.), primarily southern wax-myrtle (*Myrica cerifera*). Seeds of these plants usually occurred in

Table 1. *Percentage of aggregate volume and (in parenthesis) percentage of occurrence of food items in 7,147 crops of quail collected in the longleaf-slash pine forest type in winter by years.*

Food items		1941-42 46[a]	1945-46 68	1947-48 274	1948-49 138	1949-50 969	1950-51 774	1951-52 923	1952-53 807	1953-54 1,057	1954-55 560	1955-56 1,531
Woody plant seed												
Ash	*Fraxinus* spp.	—	—	0.7	—	2.5	—	<0.1	2.0	<0.1	—	<0.1
		(—)	(—)	(1.8)	(—)	(4.9)	(—)	(0.2)	(2.7)	(0.1)	(—)	(0.1)
Beech	*Fagus* spp.	—	—	—	0.4	0.3	0.1	0.1	3.4	—	—	0.1
		(—)	(—)	(—)	(1.4)	(0.9)	(0.1)	(0.3)	(3.1)	(—)	(—)	(0.1)
Blueberry and huckleberry	*Vaccinium* spp.	<0.1	—	—	—	1.1	1.5	1.9	2.9	<0.1	0.3	0.4
		(4.3)	(—)	(—)	(—)	(3.0)	(5.3)	(3.0)	(4.1)	(0.3)	(1.2)	(0.3)
Oak	*Quercus* spp.	43.0	—	7.2	10.5	5.1	9.1	12.0	24.8	35.0	8.2	11.9
		(65.2)	(—)	(11.3)	(18.1)	(11.6)	(16.3)	(12.6)	(28.7)	(45.3)	(15.2)	(17.7)
Loblolly pine	*Pinus taeda*	—	6.5	9.2	<0.1	<0.1	4.0	9.5	0.8	0.2	1.3	3.4
		(—)	(8.8)	(28.1)	(4.4)	(0.7)	(9.2)	(21.1)	(3.5)	(3.2)	(3.6)	(11.9)
Longleaf pine	*P. palustris*	0.1	3.9	21.8	8.5	<0.1	7.7	29.7	2.1	<0.1	6.5	46.1
		(6.5)	(7.4)	(34.3)	(7.2)	(0.3)	(15.1)	(47.4)	(1.9)	(1.0)	(10.5)	(60.2)
Shortleaf pine	*P. echinata*	—	—	—	—	0.1	0.1	<0.1	—	—	<0.1	<0.1
		(—)	(—)	(—)	(—)	(1.0)	(1.0)	(0.4)	(—)	(—)	(0.4)	(1.6)
Poison oak and Poison ivy	*Rhus toxicodendron* and *R. radicans*	20.7	0.6	0.3	1.0	0.7	1.0	3.6	0.9	0.2	0.6	0.8
		(30.4)	(1.9)	(4.4)	(7.2)	(5.6)	(4.0)	(6.5)	(3.1)	(1.0)	(6.8)	(3.7)
Red bay	*Persea* spp.	10.0	—	37.3	2.2	18.9	3.4	0.5	30.2	7.3	36.8	1.4
		(28.3)	(—)	(22.6)	(8.0)	(19.6)	(7.4)	(1.8)	(31.0)	(10.8)	(40.7)	(3.6)
Sumac	*Rhus* spp.	0.1	<0.1	0.2	0.1	1.2	4.9	0.3	0.5	0.2	0.1	0.3
		(6.5)	(1.5)	(1.5)	(1.4)	(5.6)	(9.7)	(0.9)	(2.5)	(1.2)	(2.1)	(1.6)
Sweet gum	*Liquidambar styraciflua*	—	—	2.0	2.8	1.8	5.5	0.1	1.9	<0.1	2.0	—
		(—)	(—)	(9.5)	(13.8)	(5.9)	(13.7)	(1.5)	(8.0)	(0.1)	(4.6)	(—)
Wax-myrtle	*Myrica* spp.	—	31.2	1.4	4.1	1.7	4.3	5.0	1.5	2.4	0.2	1.6
		(—)	(39.7)	(9.8)	(10.9)	(8.7)	(10.3)	(6.2)	(7.3)	(5.9)	(3.6)	(5.9)
Other		—	2.6	10.7	0.5	0.6	5.5	2.5	0.9	0.8	0.8	—
Subtotal		73.9	44.8	90.8	30.1	34.0	47.1	65.2	71.9	46.1	56.8	66.0
Legume seed												
Butterfly pea	*Centrosema* spp.	0.1	<0.1	0.1	0.1	2.9	1.4	0.7	0.2	0.6	1.1	0.4
		(19.6)	(2.9)	(12.4)	(13.0)	(42.6)	(18.4)	(10.0)	(5.4)	(10.8)	(8.9)	(8.4)
Cowpea	*Vigna* sp.	20.7	—	—	1.7	0.4	0.3	1.3	2.4	0.9	2.8	1.3
		(13.0)	(—)	—	(3.6)	(1.4)	(1.2)	(1.0)	(2.8)	(1.4)	(3.2)	(1.0)
Bush lespedeza	*Lespedeza* spp.	0.5	9.3	0.5	0.2	0.9	2.7	1.7	<0.1	4.3	0.3	0.1
		(32.6)	(86.8)	(21.2)	(13.0)	(26.7)	(18.7)	(10.9)	(1.7)	(1.5)	(4.6)	(3.6)
Common and kobe lespedeza	*L. striata*	<0.1	23.5	0.6	11.5	11.1	23.0	3.5	0.1	1.0	3.8	1.5
		(6.5)	(47.0)	(8.8)	(22.5)	(28.5)	(37.9)	(9.4)	(1.2)	(4.5)	(7.9)	(4.0)
Milkpea	*Galactia* spp.	1.0	2.0	<0.1	2.0	2.2	1.2	0.6	0.6	0.4	0.3	0.8
		(43.5)	(4.4)	(8.4)	(28.3)	(35.8)	(21.1)	(14.9)	(10.3)	(14.3)	(10.5)	(18.1)
Partridge pea	*Cassia* spp.	0.1	7.4	0.5	5.6	13.1	4.3	4.2	1.4	6.2	1.5	2.7
		(21.7)	(52.9)	(20.8)	(47.1)	(53.0)	(23.1)	(20.0)	(9.8)	(20.6)	(15.9)	(16.8)
Pencil-flower	*Stylosanthes biflora*	—	—	<0.1	<0.1	0.2	<0.1	0.1	0.1	0.1	<0.1	0.1
		(—)	(—)	(2.5)	(7.2)	(8.5)	(3.5)	(1.5)	(3.0)	(3.1)	(2.0)	(5.2)

Rhynchosia	*Rhynchosia* spp.	—	0.1	<0.1	0.1	0.3	0.1	0.1	0.2	0.1	<0.1	0.1
		(—)	(8.8)	(2.5)	(14.5)	(13.6)	(6.1)	(2.1)	(2.7)	(4.7)	(1.2)	(2.4)
Tephrosia	*Tephrosia* spp.	<0.1	<0.1	<0.1	2.6	0.8	0.2	3.4	0.3	0.2	1.1	0.7
		(17.4)	(7.4)	(2.2)	(23.9)	(19.3)	(9.4)	(16.0)	(7.8)	(7.6)	(12.0)	(11.6)
Tick-clover	*Desmodium* spp.	0.1	2.0	0.2	0.9	1.6	1.8	0.6	0.5	0.4	1.3	0.8
		(26.1)	(32.3)	(9.5)	(14.5)	(33.5)	(31.1)	(13.1)	(4.3)	(11.4)	(10.9)	(19.0)
Wildbean	*Strophostyles* spp.	—	<0.1	<0.1	—	<0.1	0.8	0.2	0.1	0.4	0.2	0.3
		(—)	(1.5)	(1.5)	(—)	(0.5)	(9.3)	(3.0)	(0.9)	(6.3)	(3.0)	(6.3)
Other		2.1	4.1	0.1	0.2	—	0.5	0.2	—	0.8	—	1.0
Subtotal		24.6	48.4	2.0	24.9	33.5	36.0	16.2	5.9	15.4	12.4	9.8
Grass seed												
Bristlegrass	*Setaria* spp.	—	—	—	<0.1	0.1	0.3	0.1	0.1	0.4	0.1	0.4
		(—)	(—)	(—)	(2.9)	(4.8)	(2.6)	(3.4)	(2.2)	(8.7)	(5.0)	(2.2)
Corn	*Zea mays*	—	—	—	0.1	0.2	0.7	0.9	0.7	1.3	0.3	0.4
		(—)	(—)	(—)	(0.7)	(0.6)	(1.3)	(1.1)	(0.7)	(1.8)	(0.2)	(1.2)
Panicum	*Panicum* spp.	0.1	0.1	0.6	17.8	9.2	1.0	0.8	2.8	7.1	1.6	6.3
		(13.0)	(20.6)	(12.4)	(52.9)	(36.8)	(24.8)	(16.5)	(10.5)	(30.6)	(17.3)	(40.1)
Paspalum	*Paspalum* spp.	<0.1	0.2	0.7	2.2	1.8	1.1	1.1	1.5	4.1	0.3	3.1
		(13.0)	(25.0)	(10.2)	(39.9)	(39.6)	(24.5)	(16.6)	(13.9)	(30.3)	(8.4)	(36.8)
Silkyscale	*Anthaenantia* spp.	—	—	—	—	0.1	<0.1	—	—	<0.1	0.1	0.1
		(—)	(—)	(—)	(—)	(1.2)	(0.1)	(—)	(—)	(0.1)	(0.5)	(1.7)
Uniola	*Uniola* spp.	—	0.1	<0.1	<0.1	0.2	0.3	<0.1	0.1	0.1	0.4	<0.1
		(—)	(13.2)	(0.4)	(0.7)	(2.9)	(7.4)	(1.1)	(2.1)	(0.8)	(3.0)	(2.5)
Other		<0.1	—	—	—	0.5	0.3	1.6	2.0	0.8	5.6	0.7
Subtotal		0.1	0.4	1.3	20.1	12.1	3.7	4.5	7.2	13.8	8.4	11.0
Spurge seed												
Croton	*Croton* spp.	—	0.4	0.4	10.5	5.7	2.4	4.2	3.9	12.4	10.7	1.9
		(—)	(2.9)	(5.1)	(15.9)	(15.6)	(13.4)	(7.4)	(4.7)	(16.8)	(15.5)	(9.1)
Nettlespurge	*Jatropha stimulosa*	—	—	<0.1	0.1	<0.1	<0.1	—	<0.1	—	—	0.1
		(—)	(—)	(0.4)	(1.4)	(0.2)	(0.1)	(—)	(0.1)	(—)	(—)	(0.1)
Noseburn	*Tragia urens*	0.1	—	<0.1	1.1	0.3	0.1	0.2	0.4	0.1	0.4	0.1
		(2.2)	(—)	(3.6)	(19.6)	(9.8)	(6.7)	(5.0)	(3.1)	(3.6)	(5.5)	(3.6)
Rush-foil	*Crotonopsis linearis*	—	—	—	—	0.5	0.1	0.3	0.1	0.2	0.4	1.3
		(—)	(—)	(—)	(—)	(1.7)	(1.0)	(0.7)	(1.2)	(1.5)	(2.3)	(2.4)
Stillingia	*Stillingia* spp.	<0.1	—	—	0.2	0.7	0.2	0.3	0.3	0.4	0.3	0.2
		(2.2)	(—)	(—)	(3.6)	(4.3)	(1.8)	(2.8)	(2.1)	(2.6)	(2.5)	(1.8)
Other		<0.1	0.1	—	—	0.1	0.4	0.1	0.1	0.1	—	—
Subtotal		0.1	0.5	0.4	11.9	7.3	3.1	5.1	4.8	13.2	11.8	3.6
Sedge seed												
Beak-rush	*Rhynchospora* spp.	<0.1	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1
		(10.9)	(—)	(0.7)	(2.2)	(3.8)	(0.9)	(1.3)	(0.4)	(2.5)	(1.8)	(2.4)
Nut-rush	*Scleria* spp.	—	0.2	0.1	4.5	2.5	0.4	0.6	5.5	5.8	0.6	4.1
		(—)	(19.1)	(14.6)	(26.8)	(35.9)	(18.5)	(17.5)	(20.0)	(20.3)	(1.5)	(20.9)
Other		—	—	0.1	—	0.4	0.2	—	0.1	0.1	0.1	0.1
Subtotal		<0.1	0.2	0.2	4.5	2.9	0.6	0.6	5.6	5.9	0.9	4.2

Table 1. (continued)

Food items		1941-42 46[a]	1945-46 68	1947-48 274	1948-49 138	1949-50 969	1950-51 774	1951-52 923	1952-53 807	1953-54 1,057	1954-55 560	1955-56 1,531
Other seed												
Buttonweed	*Diodia* spp.	0.2	<0.1	<0.1	0.2	0.4	0.6	0.2	0.1	0.2	1.1	0.2
		(10.9)	(1.5)	(3.6)	(8.0)	(7.1)	(8.9)	(4.5)	(3.1)	(3.9)	(6.2)	(4.7)
Ragweed	*Ambrosia* spp.	<0.1	<0.1	—	0.6	0.5	0.4	1.8	0.2	0.4	0.3	0.1
		(2.2)	(2.9)	(—)	(5.1)	(3.5)	(2.8)	(4.5)	(0.5)	(2.7)	(1.6)	(1.4)
Sunflower	*Helianthus* spp.	—	—	<0.1	<0.1	1.0	0.1	<0.1	<0.1	0.4	0.1	<0.1
		(—)	(—)	(0.4)	(2.9)	(14.9)	(2.7)	(0.6)	(1.5)	(0.2)	(4.1)	(3.2)
Other		0.1	—	—	1.0	0.8	—	0.2	—	—	0.6	0.2
Subtotal		0.4	<0.1	0.1	1.8	2.7	1.1	2.2	0.3	1.0	2.1	0.5
Green plant leaves		0.7	4.3	4.8	1.7	3.5	6.5	2.4	2.8	1.5	5.3	2.3
		(63.0)	(51.5)	(23.0)	(19.6)	(32.9)	(36.6)	(18.3)	(30.0)	(17.4)	(31.1)	(21.5)
Animal matter												
Ants	Hymenoptera	<0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	0.4	0.3	1.0	0.1
		(15.2)	(8.8)	(5.5)	(0.7)	(4.8)	(2.6)	(1.8)	(3.5)	(2.8)	(11.2)	(3.5)
Beetles	Coleoptera	0.1	0.2	<0.1	3.0	1.1	0.5	0.8	0.2	0.3	0.6	0.8
		(17.4)	(16.2)	(6.9)	(30.4)	(24.2)	(12.8)	(10.6)	(4.5)	(5.7)	(8.2)	(9.1)
Bugs, true	Hemiptera	<0.1	<0.1	<0.1	0.2	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
		(4.3)	(1.5)	(1.5)	(3.6)	(4.8)	(1.0)	(0.6)	(0.5)	(1.1)	(1.4)	(1.0)
Grasshoppers	Orthoptera	0.1	1.0	0.2	1.8	2.3	1.0	2.1	0.7	2.1	0.5	1.0
		(13.0)	(10.3)	(5.5)	(12.3)	(13.6)	(6.7)	(9.2)	(4.6)	(11.9)	(3.0)	(7.4)
Insect galls		<0.1	—	<0.1	—	0.1	0.1	0.2	0.1	0.2	0.1	<0.1
		(6.5)	—	(1.5)	—	(1.1)	(1.4)	(3.2)	(0.7)	(1.1)	(1.2)	(0.4)
Insect larva		—	0.1	<0.1	<0.1	0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1
		—	(4.4)	(1.1)	(0.7)	(1.6)	(1.3)	(2.6)	(0.2)	(1.0)	(0.9)	(0.1)
Leaf-hoppers	Homoptera	<0.1	—	<0.1	—	<0.1	0.1	0.1	—	<0.1	<0.1	0.1
		(6.5)	—	(0.7)	—	(1.6)	(1.7)	(1.1)	—	(0.1)	(0.4)	(0.6)
Spiders	Araneida	<0.1	—	—	—	0.1	0.1	0.1	—	<0.1	<0.1	<0.1
		(2.2)	—	—	—	(0.8)	(0.6)	(0.6)	—	(0.2)	(0.2)	(1.2)
Snails	Gastropoda	—	—	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	—	0.5
		—	—	(3.6)	(0.7)	(3.3)	(0.6)	(0.9)	(0.4)	(0.5)	—	(6.1)
Other		<0.1	0.1	—	—	—	—	—	<0.1	<0.1	<0.1	<0.1
Subtotal		0.2	1.4	0.4	5.0	4.0	1.9	3.8	1.5	3.1	2.3	2.6

[a]Number of crops.

Table 2. *Percentage volumes and frequencies of occurrence of selected food eaten by quail by months, winter 1955-56 (1955 was a good seed year for longleaf pine).*

	November		December		January		February	
	192[a]		663		527		149	
Food[b]	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.
Woody plant seed								
Oak	9.5	15.1	9.1	14.6	13.1	20.1	19.3	25.5
Loblolly pine	1.0	7.2	3.6	8.0	2.4	11.2	9.3	27.5
Longleaf pine	72.3	84.9	64.3	73.4	35.6	49.0	2.2	9.4
Red bay	0.9	1.6	0.8	3.4	2.1	4.9	1.0	2.0
Wax-myrtle	<0.1	0.5	0.3	1.8	3.2	14.2	0.8	2.0
Subtotal	83.7		78.1		56.4		32.6	
Legume seed								
Butterfly pea	0.3	5.7	0.2	4.4	0.2	9.1	1.6	26.8
Bush lespedeza	<0.1	0.5	<0.1	0.2	0.2	9.7	0.1	2.0
Common and kobe lespedeza	1.1	2.6	0.4	1.1	1.0	6.1	7.1	11.4
Partridge pea	1.5	11.4	0.4	5.6	1.8	26.9	15.1	37.6
Tick-clover	0.2	7.8	0.2	10.0	0.9	28.8	3.2	38.9
Subtotal	3.1		1.2		4.1		27.1	
Grass seed								
Panicum	3.9	25.0	4.3	23.4	8.6	33.0	6.3	36.9
Paspalum	0.3	17.7	2.2	19.0	3.5	34.7	3.7	45.6
Subtotal	4.2		6.5		12.1		10.0	
Sedge seed								
Nut-rush	0.1	8.3	1.0	11.6	8.1	34.7	2.7	29.5
Spurge seed								
Croton	1.3	4.2	0.9	3.9	—	—	5.9	18.1
Green plant leaves	0.1	1.0	0.1	2.0	3.7	50.3	6.5	33.5
Animal matter	5.1	23.4	2.0	20.8	2.3	41.3	2.9	38.4
Grand total	97.6		89.8		86.7		87.7	

[a]Number of crops examined.

[b]Small-volume, low-frequency food items are not shown in the table. The listed foods were chosen because of their constancy in the diet of quail over time, making up over 70% of the food volume in winter months.

crops each winter, but in relatively small amounts as did a few capsules of witch-hazel (*Hamamelis virginiana*).

Amount of wax-myrtle seed eaten by quail may vary locally, depending on the availability of other choice quail foods. Laessle and Frye (1956) found seeds of wax-myrtle and slough grass (*Scleria muhlenbergii*) to be major foods for quail in flatwoods of south Florida. The birds preferred slough grass seed, however, and fed on it until the supply was depleted. Then they fed on wax-myrtle nutlets, but shifted back to slough grass seed when it became available again.

Legume Seeds

Seeds of 22 genera of legumes were identified from the quail crops, but 10 genera were most commonly present. Leguminous seeds made up 24 to 48% of the total volume of food in 5 of the 11 years of sampling. In only 3 winters was the total volume of legume seeds below 15%.

Common lespedeza and partridge pea, mostly showy partridge pea (*Cassia fasciculata*), were large-volume food items. Common lespedeza made up 23% of the volume in 1945 and 1950, and partridge pea made up 13% in 1949. Although volume percentages of other legumes were usually smaller than those of common lespedeza and partridge pea, frequencies of occurrence tended to be nearly as high. The domestic legume, cowpea (*Vigna* spp.), was only a large-volume food item in 1 year (1941) when the number of crops in the sample was small.

Total volume of legume seed, and especially that of common lespedeza, was generally larger in the samples through 1950 than it was in later years. Abundance of legumes in the herbaceous ground mantle of the piney woods is dependent, in large measure, on the amount and frequency of burning; burning ground mantle vegetation favors legumes. Improvement in fire suppression during the later years of sampling may well have curtailed the general abundance of legumes.

Table 3. *Percentage volumes and frequencies of occurrence of selected food items eaten by quail by months, winter 1953-54 (1953 was a good seed year for oaks).*

	November		December		January		February	
	39[a]		447		417		154	
Food[b]	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.
Woody plant seed								
Oak	45.7	64.1	32.4	42.9	38.3	50.3	25.9	33.8
Loblolly pine	0.4	10.2	0.2	0.2	0.1	1.7	0.7	7.1
Longleaf pine	1.1	15.4	0.1	0.7	<0.1	0.2	<0.1	0.6
Red bay	—	—	4.2	8.7	9.8	14.4	12.3	9.7
Wax-myrtle	3.8	12.8	1.0	3.8	3.6	8.1	2.1	3.9
Subtotal	51.0		37.9		51.8		41.0	
Legume seed								
Butterfly pea	<0.1	5.1	0.9	17.7	0.5	6.2	0.3	4.5
Bush lespedeza	19.6	28.2	7.2	4.5	0.8	2.1	0.1	2.6
Common and kobe lespedeza	—	—	1.6	4.0	0.5	6.2	0.8	2.6
Partridge pea	18.6	41.0	9.0	20.3	2.4	22.8	5.3	10.4
Tick-clover	0.1	7.7	0.2	9.8	0.7	15.6	0.2	5.8
Subtotal	38.4		18.9		4.9		6.7	
Grass seed								
Panicum	<0.1	2.6	7.1	31.1	8.9	38.8	1.8	13.6
Paspalum	<0.1	17.9	3.4	30.9	5.0	29.5	4.8	33.8
Subtotal	<0.1		10.5		13.9		6.6	
Sedge seed								
Nut-rush	<0.1	5.1	8.0	22.4	3.6	20.6	9.6	16.9
Spurge seed								
Croton	—	—	10.5	14.5	13.9	20.1	20.7	18.8
Green plant leaves	0.1	15.4	0.5	8.3	1.7	19.2	6.0	39.6
Animal matter	6.8	79.5	3.9	25.7	2.0	20.1	2.3	22.7
Grand total	96.3		82.0		91.0		92.9	

[a]Number of crops examined.

[b]Small-volume, low-frequency food items are not shown in the table. The listed foods were chosen because of their constancy in the diet of quail over time, making up over 70% of the food volume in winter months.

In some years, volume and frequency of legume seeds increased from November to February (Tables 2-4). Availability of legumes and other choice foods undoubtedly had some effect on amount of legume seeds eaten by the birds in any given winter. For example, in 1955-56, volume and frequency percentages of longleaf pine seeds decreased from November through February as they became less available because of consumption by various wildlife species, including quail, and because of germination; seeds of common lespedeza and partridge pea increased in volume and frequency in the crops during the same period (Table 2).

In years when birds were eating large volumes of legume seeds at onset of winter (November), as in 1953-54, volumes decreased as the season advanced, presumably because fewer seeds were available (Table 3). During the same time frame, croton (*Croton* spp.) increased in volume and frequency of occurrence.

Haugen and Fitch (1955) and Ripley and Perkins (1965), in studies conducted to determine availability of legume seed (particularly partridge pea) in ground samples, measured decreased amounts, fall to spring. Speake (1966) noted a positive relationship between abundance of legume plants in late summer and volume of leguminous seeds found in quail crops in winter, suggesting that utilization of legume seeds was linked to amount of seed produced and available. Genera and species of legume seeds eaten by quail in Speake's Alabama study were similar to those ingested by the quail we examined.

Grass Seed

Volumes of grass seed in crops were mostly smaller than those for either woody plant or legume seeds. In only 2 of 11 winters (1952 and 1955) was the volume for grass seed larger than that of legume seed. In 4 years (1948, 1949, 1953, and 1955), total volume of grass seed ranged between 10 and 20%; in all others, it was less than 10%.

Seeds of 23 genera of grasses were eaten. Domestic corn (*Zea mays*) was a small-volume, low-frequency food item all years. Crops from birds collected from

Table 4. *Percentage volumes and frequencies of occurrence of selected food items eaten by quail by months, winter 1954-55 (1954 was a good seed year for red bay).*

	November		December		January		February	
	75[a]		156		212		117	
Food[b]	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.
Woody plant seed								
Oak	15.2	24.0	16.0	25.0	2.9	4.2	6.8	16.2
Loblolly pine	3.0	8.0	0.6	2.6	1.8	2.8	0.2	3.4
Longleaf pine	20.2	12.0	11.4	20.5	3.0	5.2	1.4	6.0
Red bay	16.6	34.7	23.3	34.0	39.9	42.5	54.1	50.4
Wax-myrtle	—	—	0.1	2.6	0.2	4.7	0.3	5.1
Subtotal	55.0		51.4		47.8		62.8	
Legume seed								
Butterfly pea	0.1	2.7	1.7	9.0	1.2	10.4	0.8	10.2
Bush lespedeza	—	—	0.2	1.9	0.5	8.0	<0.1	5.1
Common and kobe lespedeza	2.9	14.7	3.0	5.1	4.2	7.1	4.4	8.5
Partridge pea	0.5	9.3	0.6	12.8	2.6	18.4	0.6	19.6
Tick-clover	0.9	8.0	2.5	12.2	1.0	12.3	0.7	8.5
Subtotal	4.4		8.0		9.5		6.5	
Grass seed								
Panicum	4.7	22.7	2.5	25.6	1.1	13.7	0.4	9.4
Paspalum	0.6	10.7	0.4	13.5	0.2	5.2	0.1	6.0
Subtotal	5.3		2.9		1.3		0.5	
Sedge seed								
Nut-rush	0.1	6.7	0.1	10.2	0.7	18.9	1.4	20.5
Spurge seed								
Croton	12.4	16.0	6.7	8.3	13.3	21.2	9.1	14.5
Green plant leaves	1.1	14.7	1.0	15.4	6.8	42.9	9.1	41.0
Animal matter	1.9	25.3	1.4	13.5	2.5	32.1	10.2	36.8
Grand total	80.2		71.5		81.9		99.6	

[a]Number of crops examined.

[b]Small-volume, low-frequency food items are not shown in the table. The listed foods were chosen because of their constancy in the diet of quail over time, making up over 70% of the food volume in winter months.

"house place" coveys were most likely to contain this food. It was not uncommon for piney woods dwellers to have small patches of corn in the vicinity of their dwellings.

Panic and paspalum grass seeds had largest volumes and highest frequencies. Each winter, the percentage volume of panic grass seeds (range 0.1 to 18%) was larger than it was for paspalum seeds (range 0.1 to 4%). Frequencies, too, for seeds of panicums were slightly larger than they were for paspalums. These differences may be a direct reflection of actual abundance of the two genera in longleaf-slash pine habitat. There are about 70 species of panicums, and they make up about 10% of the plant composition on longleaf pine-bluestem ranges, whereas there are only about 7 important species of paspalums, and they make up only about 2% of the plant composition (Langdon et al. 1952; Grelen and Duvall 1966).

Chief kinds of panicums were narrowleaf (*Panicum angustifolium*), roundseed (*P. sphaerocarpon*), woolly (*P. lanuginosum*), and spreading (*P. rhizomatum*). Principal paspalum seeds were brownseed (*Paspalum plicatulum*), Florida (*P. floridanum*), and fringeleaf (*P. ciliatifolium*).

Trends in volumes and frequencies of panic and paspalum seeds in quail crops from November to February differed among years (Tables 2-4). Percentage volumes and frequencies increased from November to February, winter 1955-56 (the good longleaf pine seed year), but decreased from November to February in winter 1954-55 (the good red bay seed year). In winter 1953-54 (the good acorn year), volumes and frequencies of panic and paspalum seeds were largest in December and February.

Feeding trials with quail in Florida indicated that test birds preferred seeds of grasses over those of legumes including partridge pea and common lespedeza, and seeds of annual grasses over those of perennial grasses (Michael and Beckwith 1955). Annual grasses tested in trials were mostly agricultural varieties. In quail crops we examined, it did not appear that grass seeds were preferred over those of legumes, because

volumes and frequencies of occurrence of legume seeds were generally larger than those of grasses. Most grass seeds were from perennial plants.

Spurge Seeds

Seeds of eight genera of spurges were eaten. Croton (*Croton capitatus, C. glandulosus*), rush-foil (*Crotonopsis linearis*), noseburn (*Tragia urens*), and stillingia (*Stillingia sylvatica*) were principal representatives of the group. Woolly croton (*Croton capitatus*) and noseburn had largest volumes and were eaten most frequently. Croton seed is an important late winter and early spring food for quail. The seed is durable and germinates late. Percentage volumes and frequencies of croton in crops tended to be largest in January and February, indicating its availability in late winter (Tables 2-4).

Sedge Seeds

Seeds of five genera of sedges occurred in crops; two were commonly present. Of these moist site plants, nut-rush (*Scleria* spp.) was the principal representative of the group. Volumes were small, but frequencies were usually greater than 15%. The most common sedge was fringed nut-rush (*Scleria ciliata*). Percentage volumes and frequencies for this species tended to be largest in January and February, suggesting most use by quail in late winter (Tables 2-4).

Other Herbaceous Plant Seeds

Seeds representing 46 other plant genera were eaten. In this miscellaneous group, three species (annuals and early successional stage plants) were eaten most commonly: buttonweed (*Diodia teres, D. virginiana*), ragweed (*Ambrosia elatior*), and sunflower (*Helianthus angustifolius*). All were small-volume, low-frequency food items (Table 1).

Green Plant Leaves

Volume of green, herbaceous leaf material was usually less than 5% in winter. Frequency of occurrence, however, was always more than 17%. The definite trend for volume and frequency to increase from November to February (Tables 2-4) probably is associated with the bird's need of carotene, precursor of vitamin A, with approach of the reproductive season (Nestler 1940, 1946; Nestler et al. 1949; Lehmann 1953).

Animal Matter

Volume of animal matter was usually less than 5% in winter. Beetles (Coleoptera), grasshoppers (Orthoptera), ants (Hymenoptera), and snails (Mollusca) were principal kinds of animal food found in crops.

Volume Versus Frequency of Occurrence of Food Items

We examined the relationship between volume and frequency percentages for specific foods by regression analysis employing the model, volume = a + b (frequency). Only those foods occurring in 10% or more of the crops in one or more of the 9 winters of consecutive sampling were used in analyses. Except for winter 1950-51, when the percentage was 70, combinations of seeds shown in Table 5 made up 76% or more of the food found in quail crops each winter. Volumes were significantly related to frequencies for all but four of the food items used in the analyses (Table 5, Fig. 6).

If it can be assumed that frequency of occurrence of a food item in crops provides some expression of its availability as well as choice, then amounts of some seeds eaten by quail during winter sampling periods were dependent upon availability. This was most evident for seeds of plants that are common in the longleaf-slash pine belt and for which quail show some

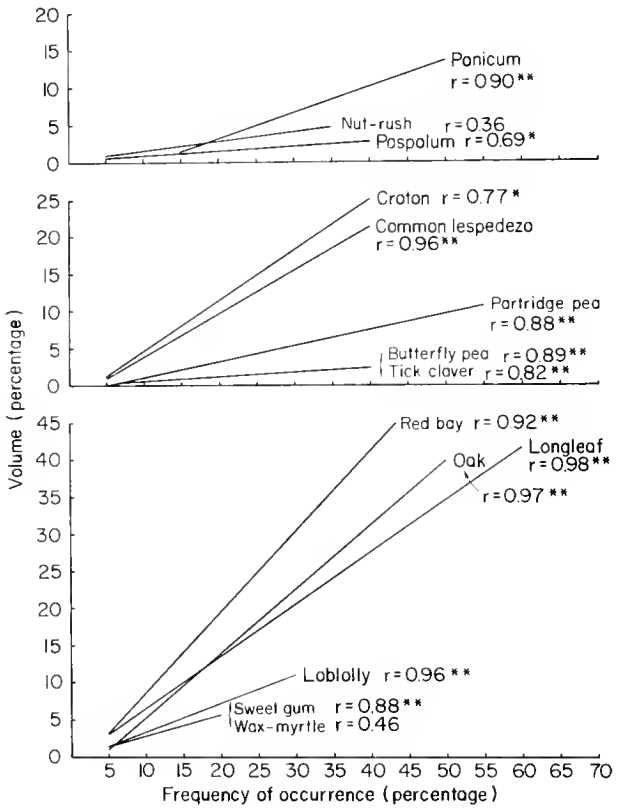

Fig. 6. Frequency with which some seeds appeared in crops was assumed to reflect some measure of their availability to quail over time within the forest type. As measured over 9 consecutive winters, volume percentages of some seeds found in quail crops were significantly related to frequency percentages (*P < 0.05; **P < 0.01).

Table 5. *Regression parameters relating volume to frequency of occurrence of specific food items in crops in nine observation years with the model: volume = a + b (frequency);* $*P < 0.05$; $**P < 0.01$.

Food	r	Std. error	F	Regression coefficients a	b
Woody plant seed					
Oak	0.971	0.827	116.58**	-3.219	0.864
Loblolly pine	0.964	0.354	93.92**	-0.528	0.389
Longleaf pine	0.985	0.939	243.35**	-0.268	0.701
Red bay	0.925	2.216	41.88**	-2.347	1.094
Sweet gum	0.887	0.283	25.83**	-0.017	0.286
Wax-myrtle	0.458	0.513	1.86	0.159	0.303
Legume seed					
Bush lespedeza	0.712	0.517	0.04	1.327	-0.011
Butterfly pea	0.893	0.144	27.47**	-0.199	0.071
Common and kobe lespedeza	0.965	0.713	94.75**	-1.178	-0.579
Milkpea	0.971	0.063	117.43**	-0.515	0.079
Partridge pea	0.819	0.778	14.30**	-0.981	0.213
Rhynchosia	0.465	0.022	1.94	0.097	0.006
Tephrosia	0.717	0.291	7.42*	-0.507	0.127
Tick-clover	0.820	0.113	14.38**	0.146	0.046
Grass seed					
Panicum	0.899	0.884	29.45**	-4.292	0.355
Paspalum	0.686	0.313	6.22**	0.170	0.065
Spurge seed					
Croton	0.769	0.993	10.11*	-2.038	0.681
Noseburn	0.875	0.055	22.78**	-0.048	0.053
Sedge seeds					
Nut-rush	0.361	0.775	1.05	0.008	0.127

selectivity. They include seeds or fruits of longleaf and loblolly pines, red bay, and several species of oaks in the woody plant group; annual and bush lespedezas, butterfly pea (*Centrosema* spp.), tick-clovers (*Desmodium* spp.), and partridge peas among the legumes; panicums and paspalums in the grass family; and croton and noseburn among the spurges.

Spring, Summer, and Fall Foods

Some of the same kinds of foods eaten in winter were also taken in spring, summer, and early fall. Quantities and frequencies of major categories, however, changed with the seasons (Table 6). The number of crops examined in warm seasons were fewer than those in winter. However, the number approaches or equates that of crops collected in warm seasons in most other investigations, and resulting data indicate seasonal shifts in principal foods.

Spring

About 30% of the food volume in spring was provided by woody plants (Table 6). Blackberries (*Rubus* spp.), blueberries and huckleberries (*Vaccinium* spp.), chiefly tree huckleberry (*Vaccinium arboreum*) and Elliott blueberry (*V. elliottii*), seeds of maple (*Acer* spp.), acorns, and wax-myrtle drupes were principal foods. Blackberries, Elliott blueberries, and maple seeds were foods produced in the current spring; tree huckleberries, loblolly seeds, acorns, red bay, and wax-myrtle drupes were residual foods of the previous growing season.

Legume seeds provided about 5% of the food volume and consisted of an assortment of residues left from the previous growing season. Seeds of grasses made up 17% of the food volume. Panic grass species that seed in fall and spring made up most of this volume. Volume of spurge seeds was less than 1% and that of sedge seeds, about 3%; they were residuary seeds from the previous growing season.

A miscellaneous assortment of herbaceous seeds grouped as "Other Plant Seeds" made up about 15% of the food volume in spring, the largest representation in volume for these kinds of seeds. The seeds were produced by a variety of herbaceous plants that flower and seed in spring, including buttercup (*Ranunculus* spp.), Geranium (*Geranium* spp.), oxalis (*Oxalis* spp.), gold star-grass (*Hypoxis* spp.), plantain (*Plantago* spp.), serinea (*Serinea oppositifolia*), and violet (*Viola* spp.).

In the year-round collection of quail crops examined by Handley (Stoddard 1931) and Harshbarger and

Table 6. *Percentage volumes and frequencies of occurrence of foods eaten by quail in spring, summer, and early fall.*

	Spring		Summer		Early fall	
	43[a]		35		14	
Food	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.
Woody plant seed						
Beautyberry	—	—	2.1	5.7	—	—
Blackberry	8.8	13.9	2.0	5.7	—	—
Blueberry and huckleberry	7.1	4.6	12.8	11.4	—	—
Maple	8.4	11.6	—	—	—	—
Oak	2.8	2.3	—	—	0.9	7.1
Red bay	0.4	2.3	—	—	—	—
Loblolly pine	1.0	2.3	—	—	—	—
Poison oak and poison ivy	—	—	2.9	5.7	0.9	14.3
Sumac	—	—	—	—	1.5	14.3
Wax-myrtle	2.6	7.0	—	—	—	—
Other	<0.1	4.6	—	—	—	—
Subtotal	31.1		19.8		3.3	
Legume seed						
Butterfly pea	1.5	7.0	4.4	20.0	0.9	21.4
Bush lespedeza	0.5	7.0	<0.1	5.7	—	—
Common and kobe lespedeza	1.6	4.6	3.1	8.6	<0.1	14.2
Milkpea	0.2	16.3	0.4	17.1	<0.1	14.2
Partridge pea	0.1	2.3	—	—	<0.1	14.2
Pencil-flower	0.4	7.0	3.6	28.6	<0.1	7.1
Rhynchosia	<0.1	4.6	0.1	5.7	—	—
Tephrosia	0.2	7.0	0.1	5.7	0.1	14.2
Tick-clover	0.1	4.6	—	—	7.1	21.4
Wildbean	—	—	—	—	0.9	7.1
Other	<0.1	7.0	—	—	—	—
Subtotal	4.6		11.7		9.0	
Grass seed						
Bristlegrass	0.1	4.6	1.6	17.1	0.1	1.9
Panicum	17.0	39.5	2.1	42.8	42.4	85.7
Paspalum	<0.1	9.3	3.9	31.4	8.0	50.0
Uniola	<0.1	2.3	<0.1	2.8	—	—
Other	<0.1	2.3	<0.1	2.8	—	—
Subtotal	17.1		7.6		50.5	
Spurge seed						
Croton	<0.1	2.3	2.9	17.1	1.9	1.9
Noseburn	—	—	3.6	8.6	0.5	7.1
Rush-foil	—	—	—	—	7.1	7.1
Spurge	—	—	<0.1	2.8	<0.1	7.1
Stillingia	0.2	2.3	—	—	6.1	21.4
Subtotal	0.2		6.5		15.6	
Sedge seed						
Beak-rush	<0.1	2.3	<0.1	5.7	<0.1	7.1
Flatsedge	1.4	2.3	—	—	—	—
Nut-rush	1.7	20.9	10.4	57.1	0.5	21.4
Sedge	0.1	2.3	—	—	—	—
Subtotal	3.1		10.4		0.5	
Other plant seed						
Buttercup	3.0	4.6	—	—	—	—
Buttonweed	<0.1	2.3	—	—	—	—
Geranium	0.8	2.3	—	—	—	—
Gold star-grass	0.1	2.3	0.8	2.8	0.9	7.1
Oxalis	2.7	7.0	<0.1	2.8	—	—
Plantain	3.4	7.0	—	—	—	—
Serinea	4.5	4.6	—	—	—	—
Violet	0.8	9.3	—	—	—	—
Other	<0.1	2.3	<0.1	5.7	<0.1	7.1
Subtotal	15.3		0.8		0.9	
Green plant leaves	14.4	48.8	2.0	20.0	<0.1	7.1
Animal matter						
Ants	0.2	13.9	2.4	17.1	<0.1	14.3
Beetles	5.9	39.5	4.7	31.4	4.2	28.5
True bugs	1.0	13.9	0.4	11.4	1.4	7.1
Grasshoppers	7.0	16.3	22.4	80.0	7.1	35.7
Leafhoppers	<0.1	4.6	0.1	2.8	—	—
Spiders	0.1	7.0	—	—	—	—
Other	<0.1	4.6	11.2	17.1	7.5	21.4
Subtotal	14.2		41.2		20.2	

[a]Number of crops examined.

Buckner (1971), seeds from a similar miscellaneous group of early flowering and seeding plants also had largest volume representations in spring.

In the annual food cycle, spring is probably the most difficult period for these forest-dwelling birds. The seed and fruit crop of the previous summer and fall is nearing depletion because of use, germination, or deterioration, and seed and fruit from the upcoming growing season is not yet available.

Summer and Fall

About 20% of the food volume in summer and 3% in early fall were provided by woody plants (Table 6). In summer, beautyberries (*Callicarpa americana*), blackberries, blueberries and huckleberries, and poison oak seeds were chief foods in this group. Although a few acorns began to appear in crops as seedfall began, amount of woody plant seeds was least in early fall.

Legume seeds provided about 12% of the food volume in summer and 9% in fall. New seeds produced by butterfly pea, common lespedeza, and pencil-flower (*Stylosanthus biflora*) were eaten in summer, and the summer crop of butterfly pea and tick-clover seeds were important early fall foods.

Seeds of grasses made up about 8% of the food volume in summer and 50% in early fall. Panic grasses were large-volume food items, particularly in fall. The volume of spurge seed was about 6% in summer and 16% in fall. Croton, noseburn, rush-foil, and stillingia were principal foods belonging to the spurge family. Sedge seeds provided 10% of the food volume in summer and less than 1% in fall; nut-rush was the principal food item in this group.

The volumes of other plant seeds eaten by quail were about 1% in summer and fall. Volume of green plant leaves was only 2% in summer and less than 1% in early fall.

Animal matter was consumed in greatest amount in warm seasons, when arthropods are normally most abundant and available. Volume was 41% in summer and 20% in fall. Grasshoppers were a large-volume food item.

Discussion

Quail tend to feed selectively; they make choices within confines of availability (Stoddard 1931; Nestler et al. 1945; Michael and Beckwith 1955; Laessle and Frye 1956; Bookout 1958). Throughout their range, quail feed on many kinds of seeds and fruits, depending on geographic location, local vegetational types, agricultural pursuits, 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). Thus, rank or importance attached to specific foods may change between locales, depending on what foods are available.

Many of the seeds we found in crops were the same kind as those reported by others who have investigated food habits of quail in the Southeast and Deep South (Judd 1905; Stoddard 1931; Martin 1935; Johnson 1940; Davison 1940; Lay 1940; Davison 1942; Wilson and Vaughn 1944; Baldwin and Handley 1946; Johnson and Pearson 1948; Lay 1952, 1954; Laessle and Frye 1956; Murray and Frye 1957; Davison 1958; Wycoff 1964; Speake 1966; Harshbarger and Buckner 1971; Dickson 1972). However, relative significance attached to specific foods based on amounts and frequencies in the above studies and in ours was not necessarily the same. Seeds and fruits of woody plants were salient winter food items in our study and seeds of herbaceous plants were major foods in most other studies. These differences reflect the type of habitat (a forest environment) from which our crop samples were drawn; these samples were also gathered over enough years to reveal annual and seasonal variability in food supply.

Shifts in major food items, winter to winter, month to month in winter, and season to season during the year, provide insight into the complexity of feeding habits of quail in a forest environment. Our results (1) show that it takes several years to obtain a good picture of important foods present and used in a forest environment, (2) attest to the bird's ability to adapt to a varying food supply in a forest environment, (3) stress that availability as well as choice determines what seeds become major food items in any given winter, (4) suggest limitations inherent in ranking or showing food preferences hierarchically from crop examinations in a single listing without consideration of season of year and availability of foods over time, and (5) attest to the need of a variety of seed- and fruit-producing plants in longleaf-slash pine habitat to lend stability to the food base for quail.

The yearlong food supply and its adequacy to fulfill dietary requirements of quail in longleaf-slash pine habitat are influenced by local distribution and abundance of food plants and their seeding or fruiting characteristics, i.e., frequency of seed crops, time of seeding, normal time of seed germination, durability or perishability of seeds or fruits, and nutritive quality of the seeds themselves.

A variety of seed- and fruit-producing plants in the forest environment is complementary to the nutritional requirements of the birds. Over the years, there have been several reports of proximate chemical composition of various seeds and fruits eaten by wildlife, including quail (Wainio and Forbes 1941; King and Titus 1943; King and McClure 1944; USDA 1948;

Moody et al. 1954; Beck and Beck 1955; Bonner 1971, 1974; Short and Epps 1976). Diversity in nutrient composition among various seeds and fruits that are recognized foods of quail is readily apparent (Appendix I). Pine seeds are high in protein and low in carbohydrates. Acorns are low in protein and high in carbohydrates. Fat content is high in acorns of the black oak group and in pine seeds. Legumes, grasses, and spurges tend to be high in protein. Mineral contents are variable, but legumes generally have a relatively high phosphorus content. With a variety of foods available, quail can readily obtain the nutrients needed for reproduction, growth, and maintenance (Nestler et al. 1945; Nestler 1949*a*, 1949*b*; Laessle and Frye 1956; Wycoff 1964; and Halls 1970).

When compared with total area of longleaf-slash pine habitat, the amount of intensive management undertaken for quail, particularly that of development of food plots, is negligible (perhaps 1 ha in 10,000). Similarly, the number of birds influenced by intensive management practices for quail is small compared with total population, total number of birds harvested, or total hunting opportunities afforded within the habitat type.

Intensive management in the longleaf-slash pine belt for forest and range products is the mode of the times (Arner 1972; Neel 1972; Barber 1976). Foresters and range managers have great influence on quality of habitat and general abundance of quail because of broad-scale activities throughout the vegetative type.

Abundance and availability of foods for quail in the longleaf-slash pine belt depend on several factors, including (1) age of stands, (2) type of timber management and harvesting method, (3) frequency of cutting cycles, (4) amount of cutting, (5) amount of site preparation for planting and direct seeding, (6) amount of burning by prescribed and wild fires, (7) amount of fire lane construction and maintenance, (8) extensiveness and intensity of timber stand improvement activities, (9) intensity of or absence of grazing, and (10) extensiveness and intensity of range management activities. Locally, any of the above will have some effect on food supply and stability of covey ranges within the sphere of their immediate influence.

Management criteria for quail in coastal plain habitats, together with information about how management practices either coordinate with or influence quail habitat (particularly that of food-producing plants), have appeared in many outlets in the last 4 decades (Stoddard 1931, 1935, 1936, 1939; Wahlenberg et al. 1939; Lay 1940; Wahlenberg 1946; Reid 1953; Lay 1954, 1956; Murray and Frye 1957; Stoddard 1957; Cushwa et al. 1966; Speake 1966; Stransky and Halls 1968; Buckner 1969; Rosene 1969; Cushwa et al. 1971; Harshbarger and Perkins 1971; Kellogg et al. 1972; Moore 1972; Neel 1972; Holbrook 1974; Grelen 1975; Hughes 1975; and others). Of those studies addressing supply and availability of food, much emphasis has been placed on that furnished by seeds from herbaceous plants and on intensive or extensive management of ground cover for this seed source by burning, ploughing, disking, and firebreak establishment and management. Fire also is an effective tool in management of herbaceous ground cover to increase abundance of arthropods that are so important in the diet of growing quail (Hurst 1972).

Seeds of a variety of trees and shrubs were important sources of food for quail in longleaf-slash pine habitat, particularly in winter and spring. Maintenance and enhancement of a great diversity and abundance of food-producing woody plants warrant attention where multiple-use forest and range practices are followed. Prescribed fire is a particularly useful tool for accomplishing multiple-use management. Fruiting in such species as beautyberry, blackberry, and blueberry may be stimulated in the years immediately following fire, whereas woody plants such as sweet gum, black gum, maple, various species of oaks, and winter huckleberry need to be protected from fire. Judicious use of fire lanes can accomplish this protection. Further, the more open-grown trees and shrubs tend to be the best producers of seed or fruit (Lay 1966; Halls and Alcaniz 1968; Halls 1973). A list of important food plants, along with seeding chronology, appear in Appendix II.

Forest and range management practices that work toward less complex plant communities or single species units will eliminate some important sources of food for quail within the habitat type and within covey ranges, particularly those produced by woody plants. It is a challenge to make use of existing indigenous tree, shrub, and herbaceous food plants to maintain a stabilized food base for quail.

Biotic communities are not static. Management activities progress and become more all-encompassing. Since the 1955 and 1956 forest surveys, fire management, direct seeding, extensive planting, timber stand improvement, and even-aged management have intensified and are part of current trends. Timber-growing stock in the longleaf-slash pine belt has increased. Refinements in range-livestock operations have also taken place. So, in addition to stressing need for a variety of indigenous, food-producing woody plants in forest habitat, this report provides a historical record of what kinds of foods quail were eating in longleaf-slash pine habitat sequentially over a period of years in a postlogging era when the habitat type was in a heavily cutover and a young age-class condition. Data presented here can be used to compare food habits of quail in contemporary times with an increased amount of growing stock and implementation of more intensive forest and range management activities.

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APPENDIX I.--Nutrient composition (in percentage) of selected seeds and fruits that are sources of food for bobwhite quail.[a]

Species	Protein	Fat	Nitrogen free extract	Crude fiber	Water	Ash	Ca	P	Mg	Collected: Location	Collected: Date	Reference
TREES												
Ash												
Fraxinus pennsylvanica	14.5	9.2	20.8				0.7	0.3	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
F. americana	8.5	8.7	23.9				0.2	0.2	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Beech												
Fagus grandifolia	7.8	10.6	6.5				1.2	0.3	0.2	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
Black gum												
Nyssa sylvatica	3.5	10.4	14.5				0.1	0.2	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Maple												
Acer rubrum	20.7	4.6	19.5				0.3	0.3	0.2	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
A. saccharinum	17.0	1.5	41.2				0.3	0.5	0.1	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
Oaks, Black												
Blackjack *Quercus marilandica*	8.1	26.4	48.4	11.6		2.9				Texas	1919	Fraps 1919
Blackjack *Q. marilandica*	5.1	5.6	50.4	22.8	13.7	2.4				Louisiana, Natchitoches Parish	1954	Moody et al. 1954
Blackjack *Q. marilandica*	6.3	10.7	60.1	20.9	14.6	2.0	0.4	0.1		Mississippi, Hattiesburg	1939-44	King and McClure 1944
Blackjack *Q. marilandica*	5.8	17.7	53.0	21.8	8.2	1.8	0.4	0.1		Missouri, Springfield	1939-44	King and McClure 1944
Cherrybark *Q. falcata* var. *pagodaefolia*	4.0	15.8	29.5				0.3	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Pin *Q. palustris*	3.8	15.4	45.4				Tr	0.1	0.1	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974

Pin Q. palustris	7.2	17.8	58.4	15.6	8.8	1.3	0.1	0.1		Illinois, Harrisburg	1939	King and McClure 1944
Red, southern Q. falcata	7.0	22.7	48.6	19.9		1.8	0.2	0.1		Texas Nacogdoches Co.	1971	Short 1976
Red, southern Q. falcata	5.1	17.0	23.0				0.3	0.1	0.1	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
Red, southern Q. falcata	7.3	20.7	58.6	2.6		2.7				Texas	1919	Fraps 1919
Red, southern Q. falcata	3.6	5.6	48.3	26.6	13.1	2.8				Louisiana, Natchitoches Parish	1954	Moody et al. 1954
Red, southern Q. falcata	4.2	15.6	57.7	20.6	10.6	1.9	0.4	0.1		Mississippi, Hattiesburg	1939-44	King and McClure 1944
Sandjack (Bluejack) Q. cinerea	5.9	13.8	49.5	14.9	13.7	2.2				Louisiana, Natchitoches Parish	1954	Moody et al. 1954
Sandjack (Bluejack) Q. incana	6.9	26.2	49.0	15.8		2.1	0.2	0.1		Texas, Nacogdoches Co.	1971	Short 1976
Water Q. nigra	4.9	21.1	54.0	17.6		2.4	0.2	0.1		Texas, Nacogdoches Co.	1971	Short 1976
Water Q. nigra	3.8	20.3	25.8				0.3	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Water Q. nigra	4.3	22.8	54.2	17.6	7.1	1.2	0.3	0.1		Alabama, Decatur	1939	King and McClure 1944
Water Q. nigra	4.0	21.8	54.2	18.9	7.7	1.2	0.2	0.1		Arkansas, St. Charles	1939	King and McClure 1944
Water Q. nigra	3.7	20.9	54.8	19.0	7.5	1.7	0.3	Tr.		Mississippi, Hattiesburg	1939	King and McClure 1944
Water Q. nigra	4.6	23.7	50.5	19.6	5.1	1.6				Mississippi, Hattiesburg	1939	King and McClure 1944
Water Q. nigra	4.7	21.4	45.7	5.0		1.8				Texas	1919	Fraps 1919
Willow Q. phellos	5.9	19.6	31.2				0.2	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971

APPENDIX I.--Continued

Species	Protein	Fat	Nitrogen free extract	Crude fiber	Water	Ash	Ca	P	Mg	Collected: Location	Collected: Date	Reference
Oaks, Black												
Willow Q. phellos	4.2	19.1	54.7	19.4	11.1	2.1	0.3	Tr.		Alabama, Decatur	1939	King and McClure 1944
Willow Q. phellos	5.1	18.5	55.9	18.8	13.4	1.7	0.3	0.1		Virginia, Fredericksburg	1939	King and McClure 1944
Willow Q. phellos	4.6	23.0	52.8	18.3	9.3	1.4	0.3	0.1		Arkansas, Monticello	1939	King and McClure 1944
Willow Q. phellos	4.9	21.9	52.8	18.6	11.3	1.8	0.3	0.1		Arkansas, St. Charles	1939	King and McClure 1944
Willow Q. phellos	5.5	29.8	54.4	5.7		2.5				Texas	1919	Fraps 1919
Willow Q. phellos	3.3	8.1	49.2	21.4	16.2	1.8				Louisiana, Natchitoches Parish	1954	Moody et al. 1954
Willow Q. phellos	5.5	20.0	53.5	18.9		2.1	0.2	0.1		Texas, Nacogdoches Co.	1971	Short 1976
Oaks, White												
Chinkapin Quercus muhlenbergia	4.4	6.6	34.5				0.2	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Live Q. virginiana	5.2	8.6	67.9	16.7	10.2	1.7	0.2	0.1		Mississippi, Hattiesburg	1939	King and McClure 1944
Live Q. virginiana	4.4	8.2	46.4				0.1	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Live Q. virginiana	5.6	1.8	44.0	16.5	29.0	3.5	0.9	0.2	1.5	Texas King Ranch	1950-51	Beck and Beck 1955
Live Q. virginiana	5.5	8.3	77.7	2.3		2.1				Texas	1919	Fraps 1919
Live Q. virginiana	5.8	6.1	71.7	14.6		1.8	0.1	0.1		Texas, Nacogdoches Co.	1971	Short 1976

Overcup *Q. lyrata*	4.6	0.9	49.8				0.2	0.1	0.1	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
Post *Q. stellata*	5.2	5.7	66.7	19.5	7.7	3.0	0.4	0.1		Virginia, Blacksburg	1939	King and McClure 1944
Post *Q. stellata*	4.8	7.6	65.2	19.6	8.2	2.8	0.4	0.1		Oklahoma, Cache	1939	King and McClure 1944
Post *Q. stellata*	3.8	5.2	37.9				0.2	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Post *Q. stellata*	8.0	6.8	74.8	3.8		2.5				Texas	1919	Fraps 1919
Post *Q. stellata*	4.7	4.2	60.0	14.3	14.3	2.5				Louisiana, Natchitoches Parish	1954	Moody et al. 1954
Post *Q. stellata*	6.8	6.7	65.3	18.1		3.1	0.2	0.1		Texas, Nacogdoches Co.	1971	Short 1976
Swamp chestnut *Q. prinus*	6.4	3.3	72.9	15.2	6.8	2.2	0.1	0.1		Virginia, Arlington	1939	King and McClure 1944
Swamp chestnut *Q. prinus*	3.6	14.0	60.4	20.3	7.4	1.8	0.1	0.1		Virginia, Elk Range	1939	King and McClure 1944
Swamp chestnut *Q. prinus*	4.4	2.9	67.6	22.3		2.8	0.1	0.1		Texas, Nacogdoches Co.	1971	Short 1976
White *Q. alba*	4.6	5.8	68.3	18.6		2.7	0.2	0.1		Texas, Nacogdoches Co.	1971	Short 1976
White *Q. alba*	4.6	2.9	46.6				0.2	0.1	0.1	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
White *Q. alba*	6.7	5.7	67.2	17.4	9.7	3.2	0.2	0.1		Virginia, Elk Range	1939	King and McClure 1944
White *Q. alba*	3.9	2.9	57.1	14.1	19.5	2.5				Louisiana, Natchitoches Parish	1954	Moody et al. 1954
White *Q. alba*	6.2	6.3	82.3	2.5		2.6	Tr.	0.2		Pennsylvania, Centre Co.	1938	Wainio and Forbes 1941
White *Q. alba*	7.4	6.8	58.4	24.8	65.4	2.6					1948	USDA 1948

APPENDIX I.--Continued

Species	Protein	Fat	Nitrogen free extract	Crude fiber	Water	Ash	Ca	P	Mg	Collected: Location	Collected: Date	Reference
Oaks, composite of Quercus alba, Q. nigra, Q. prinus, Q. virginiana, Q. incana, Q. falcata, Q. shumardii, Q. phellos, Q. stellata, Q. marilandica, Q. minima	5.9	11.7		18.5			0.2	0.1		Texas, East	1970	Short and Epps 1976
Pine												
Loblolly Pinus taeda	15.9	6.7	17.0	56.5	7.4	4.0	Tr	0.4		Open market		King and McClure 1944
Longleaf P. palustris	33.8	28.9	8.6	23.9	6.9	4.9	0.1	0.7		Mississippi, Hattiesburg	1939	King and McClure 1944
Longleaf P. palustris	35.2	31.7	4.5	23.2	6.9	5.4						USDA 1948
Shortleaf P. echinata	28.6	22.1	9.9	33.0	7.4	6.6	0.1	0.8		Missouri, Springfield	1939	King and McClure 1944
Sweet gum Liquidambar styraciflua	25.3	26.2	11.6				1.5	0.7	0.3	Mississippi, Oktibbeha Co.	1969-70	Bonner 1971
Blackberry Rubus spp.	5.8	4.9	64.4	21.5	3.5	3.5	0.3	0.2		Maryland, Beltsville	1940	King and McClure 1944
Huckleberry												
Tree Vaccinium arboreum	3.0	2.9	33.6				0.3	0.1	0.1	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
Sumac												
Dwarf Rhus copallina	8.2	17.2	42.9	28.5	5.6	3.3	0.2	0.2		Mississippi, Hattiesburg	1939	King and McClure 1944
Dwarf R. copallina	4.9	10.8	57.6	20.7	5.5	6.0	0.8	0.1		Alabama, Decatur	1939	King and McClure 1944
Dwarf R. copallina	13.4	12.9	41.9	29.7	7.1	2.2	0.1	0.4		Pennsylvania, Lancaster	1939	King and McClure 1944
Smooth R. glabra	5.3	10.0	46.4	35.1	8.6	3.2	0.5	0.2		Virginia, Fredericksburg	1939	King and McClure 1944

Smooth R. glabra	5.0	13.5	46.6	31.6	4.6	3.3	0.4	0.2		Washington, Wenatchee	1939	King and McClure 1944
Smooth R. glabra	5.2	17.2	45.8	28.8	5.3	3.0	0.5	0.2		Michigan, Washtenaw Co.	1940	King and McClure 1944
Smooth R. glabra	2.4	14.2	16.8				0.3	0.1	0.1	Mississippi, Oktibbeha Co.	1970-74	Bonner 1974
Wax-myrtle Myrica cerifera	5.6	21.8	29.0	42.1	6.8	1.5	0.3	0.0		Alabama, Thorsby	1939	King and McClure 1944
M. cerifera	5.9	31.0	21.2	40.3	7.4	1.6	0.1	0.1		Virginia Virginia Beach	1939	King and McClure 1944
M. spp.	2.8	17.6	12.6	4.5	6.2	2.3	0.0	0.3		Florida, Charlotte Co.	1946-49	Laessle and Frye 1956
					LEGUMES							
Bean, trailing wild Strophostyles helvola	32.9	0.6	51.9	11.0	9.1	4.0	0.1	0.6		North Carolina, Chapel Hill	1939	King and McClure 1944
S. helvola	33.2	0.6	51.5	11.2	6.8	4.4				North Carolina, Chapel Hill	1939	King and McClure 1944
S. helvola	31.8	0.6	52.5	11.5	10.4	4.3	0.1	0.6		Oklahoma, Mayes Co.	1937	King and McClure 1944
S. sp.	32.8	0.8	49.2	13.1	9.4	4.7	0.1	0.5		Virginia, Fredericksburg	1939	King and McClure 1944
Beggarweed, Florida Desmodium tortuosum	36.6	9.5	37.8	13.2	8.5	3.5	0.2	0.7		Open market		King and McClure 1944
Butterfly pea Centrosema virginianum	26.5	2.8	26.5	10.4	9.4	3.0	0.2	0.4		Virginia, Fredericksburg	1939	King and McClure 1944
Tick-clover Desmodium bracteosum	22.4	5.2	34.8	28.8	6.1	9.7	0.8	0.4		Illinois, Harrisburg	1939	King and McClure 1944
Lespedeza Lespedeza cyrtobotrya	35.6	12.3	35.6	12.6	7.2	5.0	0.2	0.6		Virginia, Chatham	1939	King and McClure 1944
L. juncea	42.7	6.6	36.9	11.2	8.7	3.4	0.1	0.5		Alabama, Thorsby		King and McClure 1944
L. virginica	33.2	4.5	42.0	16.7	7.6	4.6	0.6	0.5		Maryland, Beltsville	1939	King and McClure 1944
L. striata	43.9	7.0	43.9	12.0	7.7	4.6	0.3	0.8		Alabama		King and McClure 1944

Species	Protein	Fat	Nitrogen free extract	Crude fiber	Water	Ash	Ca	P	Mg	Collected: Location	Collected: Date	Reference
Lespedeza												
L. stipulacea	43.6	8.8	33.1	9.8	9.0	5.3	0.4	0.8		Open market		King and McClure 1944
L. stipulacea	40.7	8.4	35.7	11.0	7.2	4.6	0.4	0.9		Alabama		King and McClure 1944
L. stipulacea	43.7	8.2	33.0	11.8	5.7	5.3				Alabama		King and McClure 1944
L. cuneata	38.0	4.0	41.4	13.9	8.7	3.6	0.1	0.5		Open market		King and McClure 1944
L. cuneata	38.4	5.0	40.1	13.3	7.0	4.2	0.2	0.6		Maryland, Beltsville	1939	King and McClure 1944
L. cuneata	32.3	4.6	42.7	16.7	7.2	4.3	0.6	0.5		Maryland, Beltsville	1939	King and McClure 1944
L. bicolor	38.4	11.1	34.0	13.1	7.8	4.1	0.2	0.5		Virginia, Chatham	1939	King and McClure 1944
Partridge pea Cassia chamaecrista	36.2	6.6	45.5	8.0	9.2	4.3	0.6	0.5		Virginia, Richmond	1939	King and McClure 1944
C. chamaecrista	39.9	5.4	42.8	8.6	8.9	4.2	0.6	0.5		Oklahoma, Mayes Co.	1937	King and McClure 1944
C. sp	40.1	3.4	45.0	8.8	8.1	3.8	0.6	0.5		Illinois	1939	King and McClure 1944
Legumes, composite of Gleditsia triacanthos, Cassia fasciculata, C. marilandica, Dioclea multiflora, Desmodium spp., Erythrina herbacea, Cercis canadensis, Robinia pseudocacia, Albizzia julibrissin	31.2	6.7		15.6			0.2	0.5		Texas, East	1970	Short and Epps 1976
GRASSES												
Bristlegrass Setaria spp.	13.3	2.7	46.3	21.3	8.2	8.2	0.2	0.4	0.8	Texas, King Ranch	1950-51	Beck and Beck 1955
Dallisgrass Paspalum dilatatum	9.0	5.0	44.7	33.6	5.5	8.0	0.2	0.4		Louisiana, Shreveport	1939	King and McClure 1944

Panic Panicum dichotomiflorum	15.2	4.1	51.7	19.9	7.7	9.4	0.1	0.3		Oklahoma, Cache	1939	King and McClure 1944
P. agrostoides	12.9	0.9	54.0	23.2	11.4	9.1	0.2	0.3		Alabama, Decatur	1939	King and McClure 1944
P. anceps	11.8	2.1	51.5	29.0	5.6	5.7	0.2	0.2		Arkansas, Forest City	1939	King and McClure 1944
P. fasciculatum	14.4	3.0	43.5	29.6	7.0	10.0	0.3	0.2		Texas	1939	King and McClure 1944
P. texanum	17.4	4.4	50.6	23.2	6.6	4.9	0.1	0.3		Texas	1939	King and McClure 1944
Witchgrass P. capillare	12.8	3.1	54.1	19.7	9.1	10.6	0.3	0.4		Louisiana, Hamburg	1939	King and McClure 1944
Switchgrass P. virgatum	15.0	5.2	59.3	14.6	5.7	6.0	0.1	0.4		Texas, San Antonio	1939	King and McClure 1944
Paspalum Paspalum floridanum	9.2	1.8	56.0	28.4	9.0	4.7	0.1	0.1		Mississippi, Hattiesburg	1939	King and McClure 1944
P. boscianum	7.7	3.8	65.8	18.0	9.6	4.8	0.1	0.4		Georgia, Thomasville	1939	King and McClure 1944
P. lavae	6.2	1.0	44.8	43.3	6.7	4.9	0.1	0.1		Virginia, Fredericksburg	1939	King and McClure 1944
SEDGES												
Nutgrass Cyperus rotundus	17.0	2.9	45.9	10.4	9.9	13.9	1.7	0.4	1.8	Texas, King Ranch	1950-51	Beck and Beck 1955
Slough-grass Scleria muhlenbergii	16.2	15.9	7.4	13.0	10.5	37.0	0.5	0.4		Florida, Charlotte Co.	1946-49	Laessle and Frye 1956
SPURGES												
Croton Croton glandulosus	19.9	6.5	53.0	6.7	6.6	7.4	1.7	0.3	1.1	Texas, King Ranch	1950-51	Beck and Beck 1955
C. lindheimeri	20.9	9.4	43.6	14.7	5.8	5.6	0.8	0.4	0.9	Texas, King Ranch	1950-51	Beck and Beck 1955
C. texensis	19.3	18.0	32.7	17.8	8.8	3.3	0.5	0.4	1.3	Texas, King Ranch	1950-51	Beck and Beck 1955
Euphorbia Euphorbia spp.	17.5	6.9	36.2	23.3	5.8	10.3	1.7	0.4	1.1	Texas, King Ranch	1950-51	Beck and Beck 1955
Nettlespurge Jatropha spatulata	9.6	0.8	67.2	10.8	6.6	4.9	1.7	0.3	3.5	Texas, King Ranch	1950-51	Beck and Beck 1955

APPENDIX I.--Continued

Species	Protein	Fat	Nitrogen free extract	Crude fiber	Water	Ash	Ca	P	Mg	Collected: Location	Collected: Date	Reference
					MADDERS							
Buttonweed *Diodia teres*	12.4	3.6	28.3	44.9	5.6	11.0	0.6	0.2		Open market		King and McClure 1944
					COMPOSITES							
Ragweed *Ambrosia elatior*	15.1	8.9	23.2	36.5	12.2	4.1				Connecticut	1941-47	Spinner and Bishop 1950
A. aptera	21.1	22.1	24.6	27.6	3.8	5.0	0.7	0.6		Texas		King and McClure 1944
A. artemisiifolia	24.5	13.5	24.5	34.1	7.1	3.6	0.4	0.6		New York, Ithaca		King and McClure 1944
Sunflower *Helianthus scaberrimus*	18.7	17.9	27.0	28.0	5.8	2.7				Oklahoma	1941-47	Spinner and Bishop 1950
					OTHERS							
Plantain *Plantago* spp.	17.0	7.6	45.9	13.7	11.2	4.6				Connecticut	1941-47	Spinner and Bishop 1950

[a] Values have been rounded to nearest 0.1. Tr. = < 0.1.

APPENDIX II.--Selected list of plants occurring in the longleaf-slash pine belt that produce seeds or fruits eaten by quail, including comments on kind of plant and seeding or fruiting chronology.

Species		Comments
	TREES	
Ash	Fraxinus L.	Samara, available in June.
Carolina	F. caroliniana Mill.	Samara, available in June.
Green	F. pennsylvanica Marsh.	Samara, available in September.
White	F. americana L.	Samara, available in October.
Beech	Fagus grandifolia Ehrh.	Nut, available in September.
Black gum	Nyssa sylvatica Marsh.	Drupe, available in Septemnber, persistent.
Dogwood	Cornus L.	Drupe, available in late summer.
Hickory	Carya Nutt.	Nut, available in September.
Maple	Acer L.	Samara, available in March.
Chalk	A. leucoderme Small	Samara, available in September.
Red	A. rubrum L.	Samara, available in March.
Drummond	A. rubrum drummondii (Hook. & Arn.) Sarg.	Samara, available in March.
Trident	A. rubrum tridens Wood	Samara, available in March.
Silver	A. saccharinum L.	Samara, available in April.

APPENDIX II.--Continued

Species		Comments
Oak	Quercus L.	Acorn, available in September.
Black		Acorns mature biannually, seedfall in October, germinate spring.
Blackjack	Q. marilandica Muenchh.	
Laurel	Q. laurifolia Michx.	
Pin	Q. palustris Muenchh.	
Red, Southern	Q. falcata Michx.	
Sandjack (Bluejack)	Q. incana Bartr.	
Turkey	Q. laevis Walt.	
Water	Q. nigra L.	
Willow	Q. phellos L.	
White		Acorns mature annually, seedfall in September and October, germinate fall and winter.
Chestnut	Q. prinus L.	
Live	Q. virginiana Mill.	
Overcup	Q. lyrata Walt.	
Post	Q. stellata Wangenh.	
Running or lowbush	Quercus pumila Walt.	
White	Q. alba L.	

APPENDIX II.--Continued

Species		Comments
Pine	Pinus L.	Seed, shed fall to spring, germinate fall or spring.
Loblolly	P. taeda L.	Seed, shed fall to spring, germinate spring, tendency to dormancy.
Longleaf	P. palustris Mill.	Seed, shed October-November, germinate November-December, dormancy not common.
Pitch	P. rigida Mill.	Seed, shed in the fall or after a fire, germinate spring, tendency to dormancy.
Shortleaf	P. echinata Mill.	Seed, shed November-December, germinate spring, tendency to dormancy.
Slash	P. elliottii Engelm.	Seed, shed October, germinate spring, dormancy not common.
Spruce	P. glabra Walt.	Seed, shed October-November.
Virginia	P. virginiana Mill.	Seed, shed October-November.
Red bay	Persea Mill.	
Red bay	P. borbonia (L.) Spreng.	Drupe, available in September, persistent.
Sweet bay	Magnolia virginiana L.	Drupe, available in September.
Sweet gum	Liquidambar styraciflua L.	Seed, available in October, persistent.

APPENDIX II.--Continued

Species		Comments
	SHRUBS	
American beautyberry (French mulberry)	Callicarpa americana L.	Berry, available in August.
Blackberry (Dewberry)	Rubus L.	Berry, available May-August.
Blueberry	Vaccinium L.	Berry, available in May.
Elliott blueberry	V. elliottii Chapm.	Berry, available in May.
Tree huckleberry	V. arboreum Marsh.	Berry, available in July, persistent.
Ink-berry	Ilex glabra (L.)	Drupe, available in July.
Poison ivy	Rhus radicans L.	Drupe, available in September.
Poison oak	Rhus toxicodendron L.	Drupe, available in September.
Sumac	Rhus L.	Drupe, available in September, persistent.
Poison	R. vernix L.	Drupe, available in September, persistent.
Smooth	R. glabra L.	Drupe, available in September, persistent.
Wing-rib	R. copallina L.	Drupe, available in September, persistent.

APPENDIX II.--Continued

Species		Comments
Wax-myrtle	Myrica L.	Nutlet, available in June, persistent.
Bayberry	M. carolinensis Mill.	Nutlet, available in June.
Dwarf	M. pumila Michx.	Nutlet, available in June.
Southern	M. cerifera L.	Nutlet, available in June.
Witch-hazel	Hamamelis virginiana L.	Capsule, available in October.
	LEGUMES	
Butterfly pea	Centrosema (DC) Benth.	
Coastal	C. virginiana (L.) Benth.	Perennial.
Lespedeza (Bush clover)	Lespedeza Michx.	Annual or perennial.
Common and kobe	L. striata (Thunb.) H.&A.	Annual, available in August.
Hairy	L. hirta (L.) Hornem.	Perennial.
Korean	L. stipulacea Maxim.	Annual, available autumn.
Round-head	L. capitata Michx.	Perennial.
Shrub	L. bicolor Turcz.	Perennial, seed available in October.
Slender	L. virginica (L.) Britt.	Perennial.

APPENDIX II.--Continued

Species		Comments
Milkpea	Galactia P. Br.	
Downy	G. volubilis (L.) Britton	Perennial.
Shapely	G. regularis (L.) BSP	Perennial.
Partridge pea	Cassia L.	Annual or perennial.
Sensitive	C. nictitans L.	Annual.
Showy	C. fasciculata Michx.	Annual, seed available in September.
Pencil-flower	Stylosanthes biflora (L.) BSP	Perennial, available in June.
Rhynchosia	Rhynchosia Lour.	
Broadleaf	R. latifolia Nutt.	Perennial.
Dollarleaf	R. reniformis (Pursh.) DC	Perennial.
Erect	R. tomentosa (L.) H.&A.	Perennial.
Hairy	R. difformis (Ell.) DC	Perennial.
Tephrosia	Tephrosia Pers.	
Virginia	T. virginiana (L.) Pers.	Perennial.
Weak	T. onobrychoides Nutt.	Perennial.

APPENDIX II.--Continued

Species		Comments
Tick-clover	*Desmodium* Desv.	
Little	*D. ciliare* (Willd.) DC	Perennial, seeds available autumn.
Rigid	*D. rigidum* (Ell.) DC	Perennial.
Wildbean	*Strophostyles* Ell.	
Amberique	*S. helvola* (L.) Ell.	Perennial.
Pink	*S. umbellata* (Willd.) Britt.	Perennial, available in July.
Small	*S. pauciflora* (Benth.) S. Wats.	Perennial.
	GRASSES	
Bristlegrass	*Setaria* Beauv.	Annual.
Dropseed	*Sporobolus* R. Br.	
Pineywoods	*S. junceus* (Michx.) Kunth	Perennial.
Dallis grass	*Paspalum dilatatum* Poir.	Perennial, seed available in late summer.

APPENDIX II.--Continued

Species		Comments
Panic grasses	Panicum L.	
Narrowleaf	P. angustifolium Ell.	Perennial, seed spring and late fall.
Roundseed	P. sphaerocarpon Ell.	Perennial, seed spring and late fall.
Short-flowered	P. brachyanthum Steud.	Annual.
Spreading	P. rhizomatum Hitch. & Chase	Perennial.
Woolly	P. lanuginosum Ell.	Perennial, seed spring and late fall.
Paspalum	Paspalum L.	
Brownseed	P. plicatulum Michx.	Perennial.
Florida	P. floridanum Michx.	Perennial.
Fringeleaf	P. ciliatifolium Michx.	Perennial.
Silkyscale	Anthaenantia Beauv.	
Green	A. villosa (Michx.) Beauv.	Perennial.
Uniola	Uniola L.	
Longleaf	U. sessiliflora Poir.	Perennial.
Spike	U. laxa (L.) BSP	Perennial.

APPENDIX II.--Continued

Species		Comments
	SPURGES	
Croton	Croton L.	
Croton	C. glandulosus L.	Annual.
Prairie-tea	C. monanthogynus Michx.	Annual.
Woolly	C. capitatus Michx.	Annual.
Euphorbia	Euphorbia L.	Annual or perennial.
Euphorbia	E. cordifolia Ell.	Annual.
Nettlespurge	Jatropha stimulosa Michx.	Perennial.
Noseburn	Tragia urens L.	Perennial.
Rush-foil	Crotonopsis linearis Michx.	Annual.
Stillingia	Stillingia L.	
Queen's delight	S. sylvatica L.	Perennial.
Three-seeded mercury	Acalypha virginica L.	Annual.
	SEDGES	
Beak-rush	Rhynchospora Vahl. (corr. Willd.)	
Big	R. cephalantha Gray	Perennial.
Nodding	R. glomerata (L.) Vahl.	Perennial.
Pinehill	R. globularis (Chapm.) Small	Perennial.

APPENDIX II.--Continued

Species		Comments
Flatsedge	Cyperus L.	
Nut-rush	Scleria Berg.	Annual or perennial.
Carolina whip-grass	S. pauciflora Muh.	Perennial.
Fringed	S. ciliata Michx.	Perennial.
Slough grass	S. Muhlenbergii Steud.	Annual or perennial.
Whip-grass	S. triglomerata Michx.	Perennial.
Sedge	Carex L.	Perennial.
	COMPOSITES	
Ragweed	Ambrosia L.	
Common	A. elatior L.	Annual.
Sunflower	Helianthus L.	
Swamp	H. angustifolius L.	Perennial.
	MADDERS	
Buttonweed	Diodia L.	
Rough	D. teres Walt.	Annual.
Virginia	D. virginiana L.	Perennial.

APPENDIX II.--Continued

Species		Comments
	OTHERS	
Buttercup	Ranunculus spp.	Annual or perennial.
Geranium	Geranium spp.	Perennial.
Gold star-grass	Hypoxis spp.	Perennial.
Oxalis	Oxalis spp.	Perennial.
Plantain	Plantago spp.	Perennial.
Serinea	Serinea oppositifolia (Raf.) Kuntze	Annual.
Violet	Viola spp.	Perennial.

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