EFFECTS OF CONTROLLED BURNING ON BOBWHITE QUAIL POPULATIONS AND HABITAT OF AN EXPERIMENTAL AREA IN THE ALABAMA PIEDMONT [1]

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ABSTRACT

Fall quail population censuses were conducted on a 257.6-acre study area of the Auburn University Agricultural Experiment Station extending over a period of 23 years. Spring quail censuses were conducted for 15 years.

In 1940 the land had just been retired from intensive corn and cotton cultivation, and the quail population was very low (5.0 birds per 100 acres). In 1944 the fall quail population reached 40.8 birds per 100 acres and it was about the same in 1945. By 1944 abandoned cropland on the area had reached a stage very favorable to quail, and some wildlife plantings made in 1942 were producing seed. In 1950 the area was divided for study into two parts: (1) a burn-area covering 124.2 acres, and (2) a check-area covering 133.4 acres.

During a six-year period (1950-55) when approximately one-fourth of the burn-area was burned each year in late winter, the fall quail population averaged about the same as the check-area. During the next four years when approximately one-half of the burn-area was burned in late winter each year, the fall quail population of the burn-area dropped below that of the check-area. A final period of six years (1960-65) was characterized by annual late winter fires over the whole burn-area, except for 1961 when there was no fire. The fall quail population during this period averaged 50.1 birds per 100 acres on the burn-area, which was about twice that of the check-area for the same period and four times the population of the burn-area for the preceding four-year period. This six-year average population figure was higher than any previous annual figure.

Examination of crop contents of 45 quail killed on the burn-area during three fall and winter seasons revealed that *Lespedeza bicolor* and native legumes constituted important food items.

Analysis of vegetation on the burn- and check-areas made during four years revealed a much higher coverage of important quail food plants on the burn-area as compared with those on the check-area. There was an additional large increase in quail food plant coverage where fire and fertilizer were used together. Percentage of coverage by quail food plants on the burn-area was similar to that found occurring naturally on old fields in the most favorable stage of plant succession.

Burning had little or no detrimental effects on growth and survival of planted slash pines on the burn-area. The planted pines were nine or 10 years of age when the burning program was begun.

Management of Piedmont pine stands for quail with fire and fertilizer is discussed.

INTRODUCTION

Changing land use has been responsible for a general scarcity of good habitat for bobwhite quail (*Colinus virginianus*) in the Alabama Piedmont. Since the 1930's much of the former agricultural land of this region has been changed from cotton and corn production to planted pines or allowed to revert to forest. These young planted or natural pine forests became very poor quail habitat when the canopies closed.

Fire is seldom used effectively for quail management in the Alabama Piedmont forests of slash pine (*Pinus elliotii*), loblolly pine (*Pinus taeda*), and shortleaf pine (*Pinus echinata*). Well established

[1] A contribution of the Alabama Cooperative Wildlife Research Unit, Auburn University, the Alabama Department of Conservation, the U. S. Fish and Wildlife Service, and The Wildlife Management Institute, cooperating.

pines of the above species can stand controlled winter fire, and prescribed burning is sometimes used in their management (Hodgkins, 1958; Lotti *et al.*, 1960; McCulley, 1950; Hodgkins and Whipple, 1963; and Garin, 1965).

Stoddard (1935) called attention to the importance of native legumes to quail in the pine forest of the Coastal Plain, and he recommended controlled burning to maintain the legume flora in pine forests. Others have published on use of fire in the management of Coastal Plain pine forest for quail, but little experimental work has been reported from the Piedmont relating to fire and quail populations and to the importance of wild legumes in Piedmont pinelands.

Arner (1960) reported on the effects of fire and fertilizer on utility line rights-of-ways; some of his plots were in the Alabama Piedmont and some in the Coastal Plain. He concluded, that, "a greater amount of nutritious wildlife food can be obtained through the use of mechanical equipment (bulldozer and cultivator) or controlled burning when these treatments are combined with the application of fertilizer and seed, than any other technique now in current use."

Speake (1960) concluded that the attractiveness of old fields in the Alabama Piedmont to quail was associated with the abundance of wild legumes, which was largely determined by plant succession. Cushwa and Brender (1966) found that legumes were significantly more abundant on burned plots than on unburned controls in a Georgia Piedmont study area

This paper is based on a study of quail populations and habitat changes primarily resulting from controlled burning on a 257.6-acre study area, the North Auburn area of the Auburn University Agicultural Experiment Station, which is in the Alabama Piedmont, Lee County. Data were obtained from this area by a number of workers during a period of 23 years and include the following: fall and spring quail population figures; history of land use including late winter and early spring burning; vegetation analysis of burned, burned and fertilized, fertilized only, and check areas; analysis of 45 quail crops collected on the burn-area; and results of a study on the effects of fire on slash pine on the area. Some supplemental data on plant succession, quail cover preference, and quail food habits from an ecologically similar but unburned area are also included.

HISTORY

Prior to 1940 the North Auburn experimental area supported a cotton-corn economy. It was intensively cultivated and terraced. In 1940 this land was purchased by the Agricultural Experiment Station, and a series of significant land-use changes took place. All farming families except one moved off the area. The one remaining family continued to work part of the land until 1945. When cultivation ceased, much of the land was left in an eroded condition.

This study area lies about five miles north of Auburn in Lee County, Alabama, and is near the southern edge of the Piedmont Soils Province. The topography is gently rolling and approximately 85 per cent of the area is composed of various phases of the Cecil soil type, one of much importance in the Piedmont.

In 1941 and in 1942 some tree plantings, mainly slash and loblolly pine, were made on the area. These plantings were in old fields that were in early stages of plant succession. In all cases the seedlings were spaced six feet apart. The new tree plantations occupied 29 acres in five different locations.

The first wildlife plantings were made in the spring of 1942 by Dr. A. M. Pearson and members of the staff of the Alabama Cooperative Wildlife Research Unit. A number of patches consisting primarily of large partridge pea (*Cassia fasciculata*) and bicolor (*Lespedeza bicolor*) were established. Approximately three-and-one-half acres were planted to bicolor and four-and-one-half acres to partridge peas. More bicolor was planted in 1945 increasing the total planted area to about 28 acres. Of this acreage 21 acres were on what later became the check-area (see below), and seven acres were on what later became the burn-area.

From October, 1946, until July, 1949, the project was inactive. Quail research was resumed in the fall of 1949 and has been continuous since.

By the fall of 1949, plant succession on the area had progressed to an unfavorable stage for maximum quail production. Woody vegetation had extended its coverage and was crowding and invading the food plantings. The vegetation on the area was so "rough" that dog-census and hunting were difficult.

In 1950 the area was divided for study into two parts: (1) a burn-area of 124.2 acres, and (2) a check-area of 133.4 acres.

At the time of the first burn (mid-February, 1950) roughly two-thirds of the burn-area consisted of rolling upland with old terraces. Most of the old fields were covered with pines resulting from natural seeding by loblolly and shortleaf pines, and there were some pine plantations, mainly slash pine.

The plantation pines provided a complete canopy, and herbaceous ground cover was practically nonexistent by 1950. There was a thick layer of needles and some hardwood sprouts. The volunteer stands of pine did not form a complete canopy at this time. Wild legumes were reported scarce on the area.

After the 1950 burn, which was nearly complete but spotty, there was a five-year period (1951-55) when about one-fourth of the burn-area was burned each February or March. From 1956 when there was no burn, until 1959 when most of the burn-area was burned over, burns were conducted in alternate years during February or March. Almost all of the 124.2 acres was burned each time. From 1960 through 1966, there were virtually complete burns each March except for 1961 when there was no burning on the area.

PROCEDURE

Census of Quail Populations

From 1940 through 1945 and from 1949 through 1966, the quail populations were censused each fall using dogs. The check-area was not censused after 1962, however, because thick cover made accurate censusing impossible. From 1955 through 1959 it was necessary to open large blocks of bicolor on the check-area with plowed strips to conduct the census.

From 1952 through 1966 quail populations were censused on the burn-area just before burning. The check-area was censused at the same time of year from 1952 through 1963.

Controlled Burning Methods

After controlled burning was begun in 1950 and up until 1955 burning was irregular and spotty with about one-fourth of the area being burned each February or March—usually with a slow back fire. From 1956 through 1959, burning was in alternate years and strip head fires were often used. In 1960 and through 1966, except for 1961, an attempt was made to burn the entire area each March using back fires and strip head fires. The result was a condition in which most of the area was burned over, but because of lack of fuel, scattered small patches escaped fire for up to one year. By 1963 fairly large pines had become numerous and well distributed over the area so that increasing needle cast, along with the herbaceous vegetation, made it possible to have a complete, even, annual burn with few spots remaining unburned. This type of burn was conducted in 1963, 1964, 1965, and 1966.

Analysis of Vegetation

In the late summer of 1957 upland old fields and forests on the Piedmont Substation, near Camp Hill, Alabama, were sampled for coverage and frequency of vegetation by systematically placed 100-foot line intercepts (Canfield, 1941). These line intercepts were located to measure canopy intercept of plants in the herbacous stratum similar to the manner of Moore (1957). A calibrated tape was stretched, and plant coverage along it was measured to the nearest one-tenth inch.

Data were recorded by five-foot segments, and frequency was calculated on that basis. After the herbaceous stratum was measured, the line was traversed again, and woody canopy projection upon the line was estimated with the aid of a straight stick. Canopy was recorded as one of the following two classes: (1) understory (three to eight feet high) and (2) tree canopy (above eight feet high). Bare ground and litter were likewise measured.

In the late summers of 1957 and 1962 a series of line intercepts as described were systematically distributed to sample vegetation on the North Auburn burn-area and check-area. Vegetation analysis at the North Auburn area was made on two slash pine plantations of the same age on the same soil type (Cecil). One plantation was on the burn-area, and one was on the check-area. By the time vegetation analysis was begun (1957), the pine plantations appeared to be fairly representative of the young pine types on the check- and burn-areas, respectively; it was concluded that comparisons would be more meaningful between areas with the same histories except for fire. The slash pine plantation on the burn-area was burned in 1950, 1957, 1959, 1960, 1962, 1963, 1964, and 1965 and 1966.

Five one-tenth acre plots were staked out systematically on the burn- and check-area slash pine plantations in 1963. Basic slag at the rate of 2,000 pounds per acre was broadcast on these plots in early June of 1963. In the late summers of 1963 and 1966 line intercepts were systematically placed from randomly selected starting points to sample vegetation on these plots as well as on the unfertilized burn- and check-areas.

In these vegetation analyses all wild legumes except coffeeweed (*Cassia tora*) and *Crotalaria* spp. were considered quail-food-producing legumes. Common lespedeza (*Lespedeza striata*) and bicolor which had escaped from plantings were also included in that category.

The following non-leguminous herbs were considered potential quail-food-producing plants and are included in the totals of this category: panic grasses (*panicum* spp.), paspalum grasses (*Paspalum* spp.), goat weeds (*Croton* spp.), and common ragweed (*Ambrosia artemisiifolia*).

Names of plants appearing in this paper are after Fernald (1950) except for a few plants not listed by him; these follow Small (1933).

Quail Cover Preference

During a nine-year period, 1955 through fall of 1963, fall and winter records were kept on cover types from which quail coveys were flushed at the Piedmont Substation. When coveys were flushed within 50 feet of an edge of cover types, all cover types within a 50-foot radius were recorded.

Records were kept separately for the following classes of old fields: (1) idle field or fields lying fallow for one and two years since cultivation (2) old field or broomsedge stage (three years since last cultivation and until the following stage), and (3) old field pine or the stage of essentially closed-canopy pine. Of course, distinction between the last two stages involved an element of subjectivity.

Food Habits

Crops were collected from 45 bobwhites that were shot on the North Auburn burn-area during the fall and winter periods of 1962-63, 1963-64, and 1964-65. All were collected during the months of November through February, stored separately under refrigeration, and analyzed at the end of each season. The analysis was made by or under the supervision of the writer. Crop contents were sorted according to item and percentage of dry volume and frequency of occurrence were computed.

Effects of Fire on Growth and Survival in a Slash Pine Plantation

In 1966 a research report on the effect of prescribed burning on slash pine was prepared by an Auburn University undergraduate student. This study was conducted in the same two slash pine plantations on the

North Auburn area that were used in the vegetation analysis reported here by the investigator.

Systematic sampling for selection of closest dominant slash pine was used. Once individuals were selected, they were measured for d.b.h. and height. Approximately 20 per cent of the sampled trees were bored for increment readings. The number of trees per row were counted in rows of equal length on both areas.

RESULTS

Quail Populations

In the fourth and fifth years after quail census had begun, there were high fall quail populations (40.8 and 38.4 birds per 100 acres) on the North Auburn area (Fig. 1). By 1944 abandoned cropland on the area had probably reached a stage favorable to quail, and some wildlife plantings made earlier were producing seed. During a three-year period 1946-48, no quail census was made on the area. When census was resumed in 1949, the quail population of the entire area was found to be 21.4 birds per 100 acres.

From 1950 through 1955 when the annual burns covered on the average about one-fourth of the total burn-area each year, fall quail populations were similar on the burn- and check-areas. From 1956 through 1959 when burning was virtually complete in alternate years, fall quail populations averaged 12.7 birds per 100 acres on the burn-area and 22.3 on the check-area.

The fall quail population on the burn-area greatly increased during the years of intensified burning (1960-65). During this six-year period, the fall quail population averaged 50.1 birds per 100 acres on the burn-area, and for three of these years (1960-62) the check-area population averaged 27.5 birds per 100 acres.

The highest fall population that was measured on the burn-area was 66 birds per 100 acres in 1964, which was the 15th year after burning was begun. This was considerably higher than the figure of 40.8 birds per 100 acres, which was the best fall population measured when most of the entire area was in a favorable stage of plant succession (four years after the abandonment of agriculture).

Spring populations were measured from 1952 until 1966 on the burn-area and from 1952 until 1963 on the check-area. The spring population trend was about the same as the fall population trend, except that spring populations averaged higher on the burn-area than on the check-area during all periods.

The highest spring population on the burn-area (61.2 birds per 100 acres in 1966) was much higher than any measured spring population on the check-area. The highest spring population on the check-area was 24.0 quail per 100 acres in 1961.

Food Habits

Legumes are a very important part of the bobwhites' fall and winter diet in the Alabama Piedmont. Lett (1946) examined 1,176 quail crops from this region and found that legumes comprised 65.95 per cent by volume of the total winter foods.

Wild legumes were the most important group of fall and winter wild foods of quail at the Piedmont Substation during three seasons (Speake, 1960).

The analysis of 45 crops from the North Auburn burn-area revealed 28 different items. Animal matter (insects) made up 1.0 per cent of the diet by volume, and vegetable matter (mostly seeds), the remainder.

The seeds of bicolor and beggarweeds constituted the most important food items, comprising 34.1 and 34.0 per cent, respectively, of the total food volume. The respective percentages of occurrence were 73.3 and 62.2. Bicolor was planted originally in eight patches or fields on the burn-area and has spread progressively through the influence of fire. Its importance as a food can probably be attributed in part to burning.

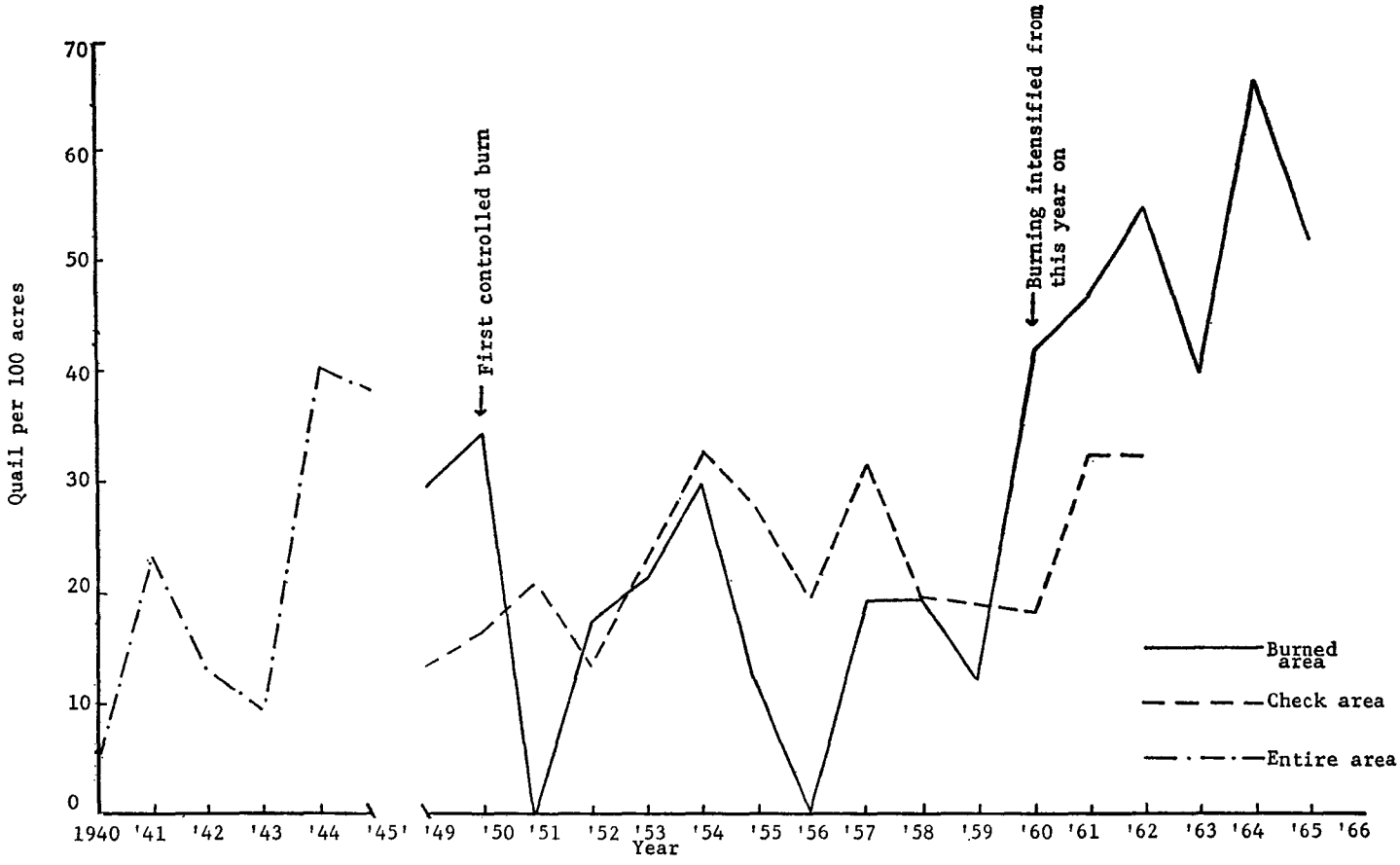

Figure 1. Fall quail populations of the North Auburn Area of the Auburn University Agricultural Experiment Station.

Several species of native perennial beggarweed (*Desmodium*) were involved; the seeds were not identified to species.

Other vegetable items considered of importance (making up as much as 1.0 per cent of the total volume) are as follows: pine (*Pinus* spp.), 7.6 per cent; vetch (*Vicia* sp.), 5.0 per cent (this was all from an experimental vetch of new variety that was available only in one year and in one place); sweetgum (*Liquidambar styraciflua*), 2.8 per cent; Japanese honeysuckle (*Lonicera japonica*), 2.2 per cent; wild perennial lespedezas (*Lespedeza* spp.), 2.0 per cent; common ragweed (*Ambrosia artemisiifolia*), 1.6 per cent; Japanese wisteria (*Wisteria floribunda*), 1.6 per cent; butterfly-peas (*Centrosema virginianum*), 1.6 per cent; unidentified vegetable materials (loose hulls, debris and other fragments), 1.6 per cent; and downy milk-pea (*Galactia volubilis*), 1.3 per cent.

There were 15 additional items that made up less than 1.0 per cent of the total volume of foods. Of these, partridge peas (*Cassia* spp.) are worthy of mention since they occurred in 37.8 per cent of the quail, although their percentage of the total volume was only 0.7.

The diet of this sample of quail, collected from November through February, was then predominantly seeds of legumes (81.5 per cent by volume), with native wild species (which would have been scarce without fire) comprising a total of 39.9 per cent of the total volume of food taken.

A correlation is indicated between coverage of wild legumes and percentages of their seeds in quail crops at the North Auburn area and the Piedmont Substation (Table 2). From these data it appears that the wild legume seeds were taken mainly on the basis of availability, although beggarweeds seem to be preferred over the others.

At the Piedmont Substation a higher percentage of partridge peas than might be expected judging from plant coverage occurred in the crops. This is explainable since the crops contained a large but undetermined amount of large partridge pea obtained from food patches rather than from natural situations.

On neither area did a legume species comprise as much as 1.0 per cent of the food volume when it made up less than 1.0 per cent coverage of the herbaceous stratum.

Analysis of vegetation

At the Piedmont Substation it was observed that the one- to two-year classes of old fields were dominated by grasses or composites. Native legumes were scarce, so no detailed vegetation analysis was made on this group.

Three fields three to five years from cultivation were sampled by line intercept. They had a total per cent coverage of quail-food-producing legumes of 22.43 (Table 3). Most of this coverage consisted of two annuals, common lespedeza, and small partridge pea, but some perennial beggarweeds and a trace of milk pea were present. This age group had the highest per cent coverage of quail-food legumes of all age groups studied.

Three fields from 11 to 12 years past cultivation were sampled; in these, total coverage of quail food legumes was only 13.97 per cent. Annual quail-food legumes had decreased greatly, while perennial legumes had increased more than three-fold in coverage; more perennial species were present than in the three- to five-year-old fields. From this point on in the three additional age groups sampled (15 years, 17-18 years, and 23-25 years), there was a steady decrease in legume coverage. As legumes decreased and woody understory increased, quail use greatly declined. Somewhere between 15 and 17-18 years, the point was reached where quail use practically ceased. It should be pointed out that there is, of course, considerable variation in the age at which fields cease to support wild legumes.

Table 2. Comparison of Percentage Coverage by Upland, Wild, Quail - Food - Producing Legumes and Per Cent by Volume of Upland, Wild Legume Seed in Diet of Quail at the North Auburn Burn-Area and Piedmont Substation of the Auburn University Agricultural Experiment Station.

	North Auburn Burn Area[1]		Piedmont Substation[2]	
	Average per cent coverage on line intercepts	Per cent by volume in 45 quail crops	Total per cent coverage in 80 100-foot line intercepts, 1957	Per cent by volume in 111 quail crops
Beggarweeds *Desmodium* spp.	8.59	34.0	1.91	6.06
Downy milk pea *Galactia volubilis*	1.52	1.3	0.65	0.90
Wild lespedezas *Lespedeza* spp.	1.29	2.0	1.43	4.22
Butterfly pea *Centrosema virginianum*	1.10	1.6	0.31	trace
Partridge peas *Cassia* spp.	0.70	0.7	1.24	5.97
Hoary peas *Tephrosia* spp.	0.25	—	0.06	—
Wild bean *Strophostyles umbellata*	0.18	—	trace	—
Erect rhynchosia *Rhynchosia erecta*	0.12	—	0.03	—
Butterfly pea *Clitoria mariana*	0.03	0.3	0.21	trace
Pencil flower *Stylosanthes biflora*	0.03	—	—	—
Common lespedeza *Lespedeza striata*	0.02	trace	2.53	3.05

[1] Average per cent plant coverage is from line intercepts run during three late summers: 1962, 1963 and 1966. Quail crops were collected during fall and winter periods of 1962-63, 1963-64, and 1964-65.

[2] Plant coverage is based on 80, 100-foot line intercepts run in late summer, 1957, in all available upland old field and forest types on the area. Crops are from quail collected in fall and winter between 1955 and 1958.

Table 3. Effects of Burning, Fertilization, and of a Combination Thereof, and of Ecological Succession on Extent of Coverage by Various Plants in the Albama Piedmont.

Plants	Piedmont Substation (3,900 feet of line intercept) Type & No. of yr. since last cultivation					North Auburn Experimental Area (5,100 feet of line intercept) Treatment and years measured					
	Old fields			Old field pine		Unburned & unfertilized	Fertilized[1] only		Burned only	Burned & fertilized[1]	
	3-5 Yr.	11-12 Yr.	15 Yr.	17-18 Yr.	23-25 Yr.	4-Yr. Av.	1963	1966	4-Yr. Av.	1963	1966
Lespedeza striata	14.48	6.30	1.05	0.50						0.04	
Cassia nictitans	6.18	1.50	1.17	1.60		0.12	0.26	2.46	0.91	4.72	2.78
Cassia fasciculata		0.13	0.02	0.04					0.61	0.42	3.14
Desmodium spp.	1.67	2.89	1.98	0.35	1.20	0.76	2.20	3.52	9.93	10.00	17.60
Lespedeza spp.		2.16	1.30	0.12	1.35	0.17	0.10	0.20	1.42	2.72	0.90
Galactia volubilis	0.05	0.50	0.93	0.37	0.10	0.08	0.02	0.02	1.29	2.58	3.72
Centrosema virginianum		0.36	0.27	0.66		0.01		0.02	1.25	0.30	3.02
Clitoria mariana			0.01						0.03	0.52	1.28
Strophostyles umbellata			0.04						0.17	1.62	0.22
Lespedeza bicolor						0.01		0.16	0.73		0.60
All other quail-food legumes	0.05	0.13	0.17	0.01		0.04			0.30	0.10	0.20
Total quail-food legumes	22.43	13.97	6.94	4.15	2.65	1.19	2.58	6.38	16.19	23.00	33.46
Ambrosia artemisiifolia & Croton spp.	0.35	0.24		0.27	0.13		0.02		0.67	0.66	0.58
Panicum spp. & *Paspalum* spp.	2.72	1.41	2.03	1.10	0.60	0.11	0.04	0.04	0.50	0.24	0.18
Total quail-food plants	25.50	15.62	9.24	5.38	3.25	1.30	2.64	6.42	17.36	23.90	34.22
Total grasses	20.60	13.92	18.88	10.55	1.65	3.52	4.68	5.18	8.75	7.68	9.80
Total composites	19.79	12.30	9.19	5.87	0.90	0.95	1.34	0.66	4.81	3.36	4.20
Total other herbs	3.13	6.36	2.00	0.76		0.14	0.06	0.24	0.90	0.20	1.30
Total woody ground cover	2.38	8.59	8.79	15.73	8.45	7.80	8.28	7.82	8.47	10.94	10.30
Total woody understory	1.27	3.49	4.66	7.02	26.15	15.68	16.42	*	0.77		*
Total tree canopy		14.48	30.30	41.50	90.00	74.33	62.86	*	55.51	59.01	*

* Not measured during this year.
[1] Fertilizer applied in June 1963 only.

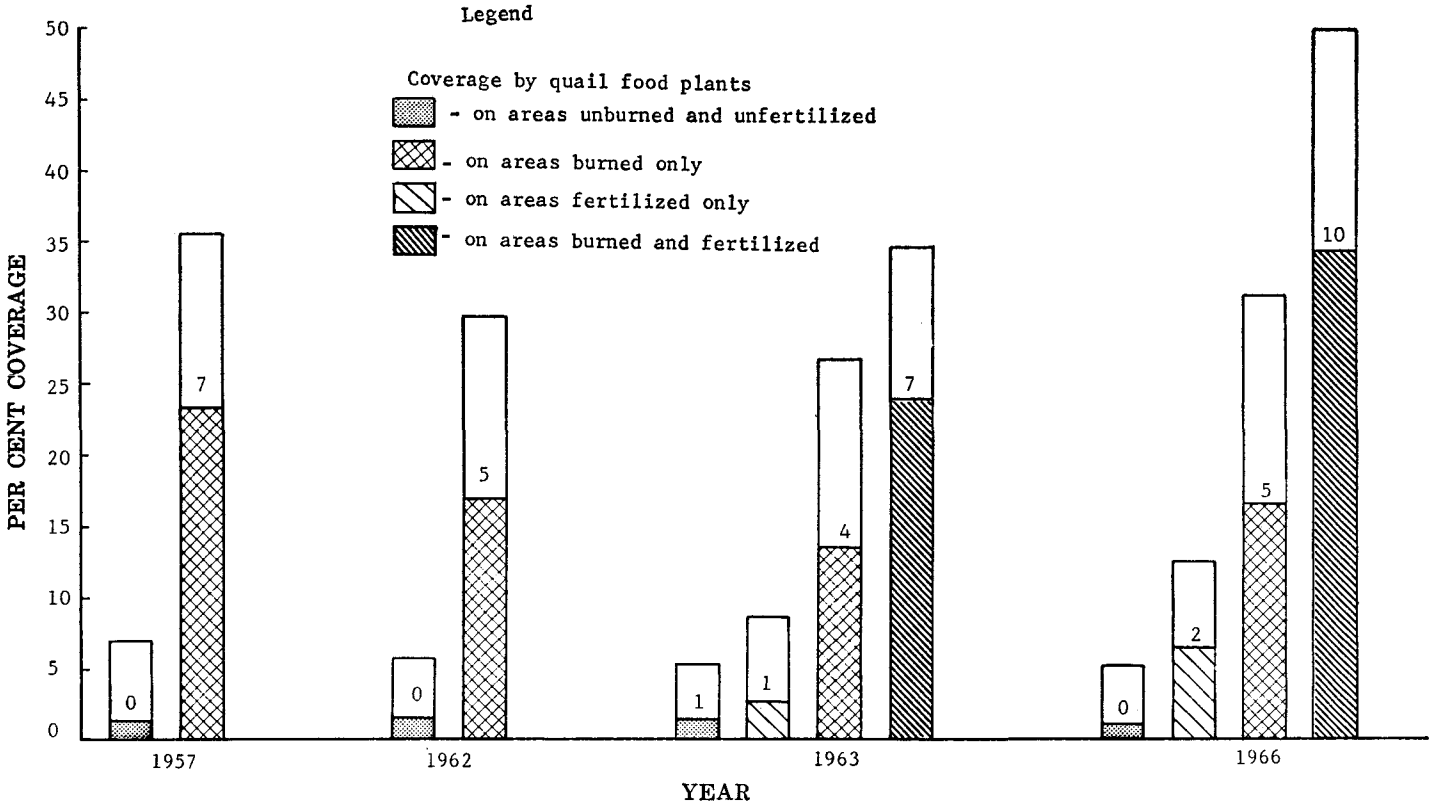

Figure 2. Effects of fire, fertilization, and a combination of both on herbaceous plants found in 5,100 feet of line intercepts in slash pine plantations at the North Auburn Area of the Auburn University Agricultural Experiment Station. Numbers within bars indicate the number of species of quail food plants making up 1.0 per cent or more of the total vegetative ground cover. Height of bars indicate coverage by all herbaceous plants. Shaded portions of bars indicate coverage by quail food plants.

Annual burning on the North Auburn area resulted in wild legume coverage slightly better than that in the relatively open old fields of 11 to 12 years after last cultivation at the Piedmont Substation (Table 3). The main difference was that perennial legumes made up the bulk of the coverage on the burn-area, while annual legumes were predominant on the old fields. Also, as Stoddard (1935) has pointed out, quail could be expected to find the legume seed much easier on a burned area than on an unburned one because of removal of thick litter. Old fields and the burn-area were both preferred fall and winter quail habitat judging from flush records at the Piedmont Substation (see below) and population figures on the North Auburn burn-area (Fig. 1).

The addition of basic slag broadcast on the burn-area brought the coverage by legumes up to that of the best stage of old field succession in the growing season of slag application. The legume coverage exceeded that of the best old field stage by one-third in 1966 (Table 3). In 1966 total quail-food-plant coverage exceeded that of the area that was burned only by better than 100 per cent (Figure 2).

Beggarweed coverage increased more than coverage of other legume types on the burn-area in the semi-shade of pines. With the addition of basic slag, downy milk peas, butterfly peas (*Centrosema virginianum*), partridge peas, and beggarweeds were greatly increased (Table 3).

The general aspect of unburned and unfertilized, burned only, and burned and fertilized slash pine plantations at the North Auburn Area are illustrated in Figures 3, 4, and 5.

Figure 3. Undisturbed slash pine plantation on the North Auburn area of the Auburn University Agricultural Experiment Station as it appeared in late summer 24 or 25 years after being planted. (Photo, July 1966.)

Figure 4. Slash pine plantation on the North Auburn Area of the Auburn University Agricultural Experiment Station as it appeared in late summer 24 or 25 years after being planted. This area was burned over in February or March of 1950, 1957, 1959, 1960, 1962, 1963, 1964, 1965 and 1966. (Photo, July 1966.)

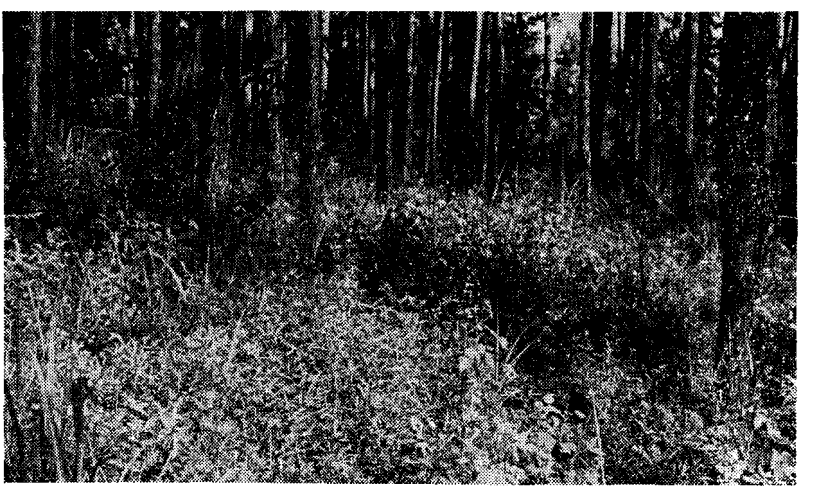

Figure 5. Slash pine plantation on the North Auburn area of the Auburn University Agricultural Experiment Station as it appeared in late summer 24 or 25 years after being planted. This area was burned over in February or March of 1950, 1957, 1959, 1960, 1962, 1963, 1964, 1965, and 1966 and had 2,000 pounds per acre of basic slag broadcast in summer of 1963. The dominant herbaceous plants in the picture are *Desmodium paniculatum* and *Desmodium laevigatum.* (Photo, July 1966.)

Cover preferences of quail

The relative use by quail of the three important old field types at the Piedmont Substation in terms of the average number of covey flushes per 10 acres of type per year was as follows: old field, 8.68; idle field, 4.26; and old field pine, 0.59. Idle fields were important to quail even though they were somewhat lacking in quantity and variety of wild legumes. Food habits analysis on the area showed that items

commonly dominant on some idle fields (crabgrass and common ragweed) were taken in important amounts, at least seasonally.

Old fields were used about twice as much as idle fields when use was measured by covey-finds per 10 acres per year. Old field pine areas were used only about one-fifteenth as much as old fields. Quail practically ceased using old fields on the Piedmont Substation when the coverage of legumes dropped to about five per cent.

Effects of fire on growth and survival in a slash pine plantation

In 1965 the sample mean d.b.h. in the burned plantation was 8.51 inches compared to 8.12 inches in the unburned plantation. Mean height was 57.86 feet in the burned plantation and 54.18 in the unburned plantation. The number of trees per row was higher in the unburned plantation (13.3 trees compared with 10.2). This is explainable partially by the fact that badly diseased trees sometimes caught fire and burned. This plantation was burned over first in 1950 when it was in its ninth or 10th year. It was not burned again until 1957. From 1959 through 1966 it was burned every year except 1961.

DISCUSSION

Perennial legumes are characteristic members of the herbaceous strata in old-field pine stands, especially in the more mature pine stands that have been cut over with consequent soil disturbances and opening of the tree canopy.

Using fire and the proper fertilizer to stimulate legumes, it should be possible to create attractive fall and winter quail habitat on many acres of Piedmont soils that are now in young stands of pine. Control of hardwood understory would enchance quail hunting. This also is a good forestry practice.

It seems likely that fertilizer could be applied to burned areas in a pattern that would produce beggarweed patches for concentration of quail. This possibility should receive further study. Native perennial legumes do not have the serious disadvantage of growing so tall as to interfere with shooting. This disadvantage is a major objection to the widely used bicolor patches. Seed of some promising types of native legumes such as clanton tick clover, a strain of *Desmodium perplexum* developed by the Soil Conservation Service, should be made available commercially for planting in patches. Much more research is needed on the effect of fertilizers on native legumes. It would be desirable to have information on the most economical mixture for the prevalent species on various soil types and on the effect of fertilization on seed production.

All soil tests made on the two study areas showed low phosphorus and low pH. Fertilizer recommendations always called for lime or slag for any planted legume. Slag was used here because it supplied both phosphorus and lime. It was thought that potash would be supplied by ash from the burning. Previous experience with use of complete fertilizers on legumes usually gave undesirable results since grasses appeared to be stimulated to the detriment of legumes. Slag was found by experience to give good results on bicolor and partridge pea patches. Native legumes around the edges of these patches were more vigorous than on the unfertilized area.

Bicolor is showing a disturbing tendency to spread into the woods as a result of regular burning on the North Auburn Area and on a large Piedmont private quail preserve familiar to the writer. On these areas it has become the dominant understory in spots. This is an undesirable development, since shooting is difficult in tall, extensive stands of this plant. Plant breeders should be able to produce a more desirable, shorter strain of bicolor. Other well known quail food plants could be used instead of bicolor on areas that are regularly burned.

As Stoddard (1935) brought out, late burning is detrimental to common lespedeza since it often sprouts early and is killed by spring fires. Early burning (February or earlier) in the Piedmont, however, leaves some slopes exposed to erosion for an excessively long period. Since common lespedeza is a valuable quail food and a "natural" for the Piedmont, it might be advisable to broadcast the seed on freshly

burned areas along with fertilizer, as advocated by Arner (1960) for utility line rights-of-way.

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