Habitat utilization in relation to time of day was also analyzed. Days were divided into four time periods: (1) roost, (2) early morning (before 0900) (3) midday (0900 until 1500), and (4) late afternoon (1500 until dark). Chi-square analysis indicated that the types of habitat utilized by gobblers varied with the time of day ($P > .02$).

Fifty-four percent of the roost observations made were in mixed pine-hardwood habitats, 29 percent were in pine habitats, and 17 percent were in hardwood habitats (Figure 9). Loblolly pine was the species most often observed as a roost tree. Only on two occasions was a turkey observed roosting in hardwood trees - white oak and sweetgum *(Liquidambar styraciflua)*. The data showed that the use of pastures peaked during the early morning and again during late afternoon (Figure 9). These two periods were reported by Mosby and Handley (1947) to be the major feeding periods for turkeys. Although adult gobblers were observed to feed little, they often followed hens into the pastures. While hens fed, gobblers remained in the pastures, often gobbling and strutting.

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SEASONAL FLUCTUATIONS OF A BOBWHITE POPULATION IN THE GEORGIA PIEDMONT

by

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ABSTRACT

A Bobwhite population in the Georgia Piedmont was censused periodically throughout the year by bird dogs, baiting and sightings, and trapping. The population (on a 100 acre basis) varied from a late summer high of 15.3 birds to the year later figure of 2.7 adult quail. Average weekly losses calculated for each different interval were: 1 September to 1 November-2.8 percent, 1 November to 1 April-2.0 percent, 1 April to 1 July-3.2 percent, and 1 July to 1 September-3.3 percent (summer figure for adult birds only).

INTRODUCTION

Funds for the research were provided by the McIntire-Stennis Act 1963. Thanks go to Dr. James H. Jenkins of the University of Georgia for advice and direction during the project, and to Dr. Robert E. Noble of Louisiana State University for reviewing the manuscript.

While substantial information has been gathered on fall Bobwhite populations, less is known about seasonal population fluctuations and the differences in these annual changes between physiographic regions. In the present study, a non-hunted Bobwhite population was followed, as closely as possible for 17 months, in order to better understand the seasonal population dynamics and the variables associated with these changes.

MATERIALS AND METHODS

Description of Study Area

The study was conducted on the Whitehall Forest of the University of Georgia School of Forest Resources, which is located in the Georgia Piedmont approximately three miles south of Athens. Land use varied with different experiments being conducted by University personnel. The total area was 778 acres, of which pine and hardwood forest comprised 87 percent, pasture and idle land 5 percent, arboretum 3 percent, power line 3 percent, and railroad right-of-way 2 percent (Simpson 1966). Ground cover on the area was generally light in winter but relatively dense in some of the younger pine stands, on the railroad right-of-way, and on parts of the power line. The woods of pine and hardwood forest occurred mostly in extensive tracts. The open areas and pasture were mostly in one location, thereby limiting "edge" between cover types on the land.

Populations

Population censusing was conducted on the Whitehall Forest from 12 November 1965 to 15 April 1967 by a combination of techniques. During this 17 month time span, periodic censusing and covey location was accomplished by trapping, sightings, spot baiting and subsequent observations, cock call counts, scratch indications, and the use of bird dogs.

Traps (patterned from Schultz 1950) were two feet square by one foot high, constructed of one-inch poultry netting with a half-inch hardwood cloth entrance tunnel. Sixty-four days of trapping using 5 to 22 traps (923 trap days) resulted in a catch of 113 Bobwhites. Trap shyness or proneness of individual coveys rendered the Schnabel and Lincoln index useless in estimating populations.

Population censuses were mainly determined from 116 quail sightings and covey locations (mostly scratchings). Most of these observations were made while checking traps and feeders on the area (a separate feeder investigation was being conducted on the study area). Bird dog censuses of the area were conducted once in fall and once in winter. Nine cock call counts were conducted on the area between 16 June and 20 August 1966. Year to year differences for the different seasons were too minute to be detected, so data for two years were combined.

RESULTS AND DISCUSSION

Seasonal Populations

There were inherent limitations in the absolute accuracy of any one of the census techniques at any given time. In reference to bird dog censusing, Stoddard (1931) stated, "The accurate determination of the quail population of an area is difficult in the Southeast quail territory because of prevailing cover conditions and absence of snows. Observation of the performance of high class shooting dogs on many preserves has convinced us that under average conditions only a portion of the coveys are found at any one search over the ground." Loveless (1958) noted the same problem in his South Florida censusing. Because of the inability of any one method to give exact data at any given time, the results from several techniques were used to acquire a reasonably accurate picture of seasonal populations.

Table 1. Whitehall forest Bobwhite population dynamic life table.

	Population	Population per 100 acres	Percent of Sept. 1 population	Percent loss from previous period	Percent loss per week
Sept. 1	119	15.3	100		
Nov. 1	90	11.6	76	24	2.8
Apr. 1	52	6.7	44	43	2.0
July 1	30	3.9	25	42	3.2
Sept. 1*	21*	2.7	18	30	3.3

*Population figure is adults, based on fall age ratio.

Seasonal populations are pictured in Table 1. The population varied from a high of about 15.3 total birds per 100 acres on September 1 to 2.7 adult quail per 100 acres a year later. The average weekly loss rates calculated separately for each time interval varied from 2.0 to 3.3 percent. The population high of 15.3 quail per 100 acres was obtained from trapping and sightings during August and September and averaged for September 1.

Trapping and sighting censuses during October and November showed a November 1 Whitehall Forest population of 90 birds, or 11.6 per 100 acres. These results are similar to numbers found by Reeves (1954) in Indiana and Rosene (1950) in Alabama.

The calculated population loss between September 1 and November 1 was 24 percent, or an average 2.8 percent per week on the Whitehall Forest. This loss represented adult as well as juvenile quail. Ageing and back dating fall captures revealed the bulk of the summer hatch was in July and August. Therefore, this loss represents mostly brood mortality. From 55 brood observations, Fatora *et al.* (1966) found a mortality of three percent per week after the initial high mortality immediately after hatching. Kabat and Thompson (1963) considered a mortality rate of 2 percent per week from hatching to four months of age in their Wisconsin study.

April trapping and sightings showed an April 1 population of approximately 52 birds (6.7 per 100 acres), indicating an over-winter loss from 90 to 52 birds or 43 percent. This decline over a five month period represented the average weekly loss rate of 2.0 percent. I did not determine fall and winter mortality factors but I suspected that field mowing and vegetation dieback reduced winter habitat, thereby facilitating the population decimation from weather, starvation, and predation.

Other workers have reported quite a variation in winter loss between and within Bobwhite populations. In the northern portion of the Bobwhite's range, winter weather seems to be the main factor correlated with over-winter loss. In a six year study in Virginia, Mosby and Overton (1950) found winter loss fluctuated between 33 and 82 percent, averaging 44.5 percent, and was correlated with number of days with snow accumulation. Kabat and Thompson (1963) reported that a Wisconsin winter population declined by annual differences of 7 to 84 percent, and averaged 3.8 percent per week. Snow accumulation was the main cause of mortality. Stanford (1972) reported that a "snow-cold" late winter in Missouri severely decimated over-wintering quail. Roseberry and Klimstra (1972) studied a hunted Illinois Bobwhite population. They observed a November to April loss of 66 percent. Although two thirds of these were hunter harvested, the authors felt the hunting mortality was mainly acting in a compensating manner with weather related natural winter mortality.

Studies in the more southern portion of the Bobwhite's range also showed substantial and extremely variable over-winter loss. Lay (1952) calculated over-winter loss to range from 10 to 62 percent on one study area in Texas and attributed it to winter habitat change. Hood (1955) observed over-winter loss in Mississippi to vary from 7 percent to 46 percent in five years of censusing. A South Florida population (Loveless 1958) decreased by 50 percent over-winter. Rosene (1969) published winter loss data from four Alabama and South Carolina plantations where declines varied between 10 and 67 percent and averaged between 13 and 57 percent. It appears that weather, vegetation die-back, and decrease of seasonal habitat operate together in a relatively subtle fashion in the less extreme climates of the Bobwhite's range as the main causes of winter mortality.

A maximum of 15 cock quail were calling on the Whitehall area in late June. These were probably most, but not all, of the males on the area. Because all the males were probably not counted, and males constituted a majority of the population ($P > .1$, chi square test), the population was estimated at twice the number of calling males on July 1.

The April 1 population was 52 birds, and the July density was approximately 30 adult birds. This indicates a spring loss of 42 percent, or 3.2 percent average mortality per week between April and July. This spring and the later summer mortality were the highest of the year in this non-hunted Bobwhite population. Kabat and Thompson

(1963) estimated their spring losses at 5 to 29 percent. Buss *et al.* (1947), from observations in Dunn County, Wisconsin, concluded that spring, not winter, was the critical seasonal period. They found that the highest seasonal losses occurred during spring. Increased vulnerability due to covey break up, increased spring mobility (and associated unfamiliar surroundings), and nesting effort seem to be the most plausible explanations for most spring mortality. Kabat and Thompson (1963) and Buss *et al.* (1947) in separate investigations in Wisconsin, found quail to be extremely mobile during the spring period of adjustment, although quail in the south may not be as mobile.

The September 1 adult population, estimated at 21 birds, was based on the 1966 fall age ratio (18 percent adults) for the Whitehall Forest. There was a high weekly loss of 3.3 percent of the mature birds from July first to September first. This was probably linked with nesting loss and physiological weakness from the summer reproductive efforts. Kabat and Thompson (1963) in their investigation stated, "the primary factor influencing late summer and fall quail loss appears to be the physiological stress of reproduction.

Age Ratios

Fall and spring Whitehall Forest trapping (Table 2), showing age ratios of 77 and 79 percent young respectively for the two seasons, revealed a steady fall to spring age ratio and a non-selective age loss. These figures were considered as representative population samples. August and September trapping showed 32 juvenile to 2 adult captures. This was considered non-representative due to trap susceptability of the young broods. Late summer observations of quail on the area also revealed a larger portion of adults in the total population than the trapped birds.

Table 2. Bobwhite seasonal sex and age ratios determined from trapping on the Whitehall Forest, November 1965 to April 1967.

	Number	Percent young	Males	Percent males	Females
NOV-DEC					
Young	30	77	12	40	18
Adult	9		5	56	4
Total	39	77	17	44	22
APRIL					
Sub-Adult	22	79	15	68	7
Adult	6		4	67	2
Total	28	79	19	68	9
AUG-SEP					
Young	32	94	10	59	7
Adult	2		1	50	1
Total	34	94	11	58	8

The fall to spring non-selective age loss (steady adult to immature age ratio) was in contrast to winter drops in the percentage of young as found in several investigations. Emlen (1940) found a progressive decline of young in a population of California quail *(Lophortyx californica)* from fall to summer. Bennitt (1951) analyzed data from an eight week hunting season. He stated, "The percentage of young birds goes down during the hunting season about 0.6 percent a week." Loveless (1958) found a decrease of 20 percent in the juvenile proportion of the population from fall through spring in a South Florida Bobwhite population.

In contrast, the steady over-winter age ratio was consistent with findings from most similar studies. Haugen and Speake (1958), analyzing hunting season data in Alabama,

observed no age ratio change. Marsden and Baskett (1958) in a seven year trapping study in Missouri found young and adults dying at the same rate during winter, based on pooling data for bi-monthly periods. Kabat and Thompson (1963) deducted, "Data obtained from repeat trapping of the same coveys and fall collections showed no change in sex and age ratios between fall and spring."

Sex Ratios

Sex ratios for Whitehall Forest trapped birds are presented in Table 2, and are compared to those found by other investigators. The lowest percentage of young cocks (49 percent) among birds of the year in a substantial sample was found by Murray and Frye (1964) in Florida. The high was 58 percent males observed in Virginia (Mosby and Overton 1950). Whitehall Forest trapping revealed 47 percent males of the young birds for the August-September and the November-December periods. This small sample (47 birds) was not significantly different (P .05) from the expected 50:50 ratio.

In every Bobwhite population study reviewed, findings showed that males constituted a majority of the adult segment of the population. Adult males per 100 females in substantial samples (1,000 minimum) varied from a low of 114 observed by Lay (1952) in Texas, to peaks of around 160 males to 100 females reported by Kabat and Thompson (1963), Marsden and Baskett (1958), and Reeves (1954), and the highest (249 males) reported by Mosby (1950). The adult sex ratio of Whitehall Forest birds for fall was 54 percent males. Spring sex ratios were close to 2 males per female in sub-adult and adult birds.

Fall sex ratios were comparable to most other studies, in that the sexes of juvenile birds were approximately equal, while the adult segment contained largely males. Close to a 50:50 sex ratio among young birds would be expected. A differential sex mortality between the first and second fall accounts for the distorted adult sex ratio.

The spring sex ratio of 68 percent males on Whitehall suggests an over-winter sex selective loss. Stoddard (1931) suggested a greater over-winter hen loss and this was also suggested by Emlen (1940) in his California quail investigation. Latham (1947) in an experiment on penned quail found that climatic extremes and periods of fasting took a heavier toll on females than on males.

Spring trapping results suggested sex differential winter loss. I also believe the summer nesting and rearing period contributed to the universally found unbalanced adult sex ratio. Studies by Leopold (1945) and Bennitt (1951) pointed to hen nesting and brooding losses as the causative agent in the distorted adult sex ratio. Wagner (1957) reported that stress brought about by reproduction reduced the resistance of hen pheasants (*Phasianus colchicus*). Case (1972) found Bobwhite egg laying energy requirements nearly equaled existence energy requirements at 25 C, but did not believe this was a physical strain on the females. Marsden and Baskett (1958) and Kabat and Thompson (1963) have shown no age selectivity or differential over-winter mortality, but high summer hen losses.

CONCLUSIONS

A few tentative conclusions may be drawn concerning this small Bobwhite population. There were substantial losses in the population throughout the year. It appeared that summer loss was more severe than over-winter loss. An equal sex ratio in immature birds and a male-heavy sex ratio in adult birds indicated a sex selective mortality. A constant over-winter age ratio showed no age selective loss in this non-hunted population.

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