ATTRITION RATES OF NONHUNTED BOBWHITE QUAIL FROM BAND RECOVERY RATES WITH NOTES ON THE FUNCTION OF THE "BOBWHITE" CALL

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Most publications on mortality of nonhunted populations of bobwhites, Colinus virginianus, have been from per cent replacement by an age group (Marsden and Baskett, 1958), or from census data (Baumgartner, 1944, Errington, 1945). Errington described one difficulty of censusing as determining the fate of coveys along the border of the census area. From census data, it is nearly impossible to determine age-differential mortality because of the difficulty in distinguishing full-grown immatures from adults. Per cent replacement by an age group can only be used to measure annual mortality.

The primary purpose of this study was to test a mark-recapture technique for measuring seasonal attrition rates in a nonhunted population. The technique involves marking a sample of the population and then subjecting the sample to a series of retrapping periods. The number captured during each retrap period, expressed as a per cent recovery (recovery rate) of the marked sample is assumed to be dependent on the number of birds still alive to be trapped, Hickey (1955). The per cent difference in the recovery rates from two retrapping periods is assumed to measure attrition from the middle of the first retrap period to the middle of the second.

The second objective of the study was to determine seasonal age-differential attrition using the age ratios from four trapping periods.

Age-differential mortality is not uncommon in wild avian populations (Robel, 1965).

Limited observations on cocks whistling "bobwhite" were made to determine the function of the bobwhite call. Stoddard (1931) held that the "bobwhite" call is used to attract a mate and is given only by the unmated male. Bennitt (1951) agreed with Stoddard. Robinson (1957) and Kabat and Thompson (1963) noted that the "bobwhite" call is also given by the mated male.

CHAPTER II

METHODS

Description of Study Area

The present study was conducted on Sections 16, 17, and 21, T19N, R1E, Payne County, Oklahoma. This area is adjacent to the south shore of Lake Carl Blackwell, 10 miles west of Stillwater, Oklahoma. This area is owned by Oklahoma State University and serves as a wildlife refuge. Hunting is prohibited on the area and this rule is enforced by a lake patrolman. The study area is managed for bobwhite quail, since the area is used for field trials. Food plots of maize are distributed about the area and winter feeders are operated during periods of ice and snow.

Marking Periods

During the interval July 9, 1966 to April 4, 1967, four trapping operations were conducted. Quail were banded during the first three trapping periods. Since two recovery periods are necessary to calculate attrition rates, bobwhites banded only during the first two periods can be used to measure population attrition. Bobwhites banded during the third trap period are reported in the section on age ratios.

Recovery rates are reported for two marked samples. The first sample consisted of quail banded during the first trap period, July 9 to September 15. The first sample was retrapped October 10 to November 2, December 10 to February 10, and March 12 to April 4. The second

sample included all birds marked during the first trap period plus those marked during the second trap period, October 10 to November 2. The second trap period is considered as an effort to increase the original sample size. The second sample was retrapped December 10 to February 10, and March 12 to April 4. Table I shows an outline of the marking and retrapping periods and the number of trap days (number of traps X number days trapping) in each retrap period.

TABLE I

MARKING AND RETRAPPING PERIODS

	Marking Periods	Retrapping Periods		
First Sample	Jul. 9- Sept. 15	Oct. 10- Nov. 2	Dec. 10- Feb. 10	Mar. 12- Apr. 4
Second Sample	Jul. 9- Nov. 2		Dec. 10- Feb. 10	Mar. 12- Apr. 4
Trap Days		336	234	236

Trapping Techniques

Two trapping methods, cock-and-hen and bait trapping, were used during the study. A modified Stoddard quail trap described by Schultz (1950) was improvised into a cock-and-hen trap and used during the first week of the study. Converting the Schultz trap to a cock-and-hen trap involved inserting a cylinder of poultry wire eight inches in diameter and one foot high into the middle of the trap opposite the end of the funnel. The Schultz trap is bottomless to allow captured birds a better chance to escape if harassed by predators. Since it was difficult to keep the funnel of the Schultz trap stapled to the ground, bottoms were put in all the traps.

During the months of June and July, an effort was made to locate all cock birds whistling "bobwhite" on the study area. These locations were plotted on a map which was then used as a trap site map during the cock-and-hen trapping period.

The cock-and-hen traps were baited with immature pen-reared bobwhites. The decoy birds were banded with either numbered aluminum leg bands or colored plastic leg bands. Each trap was marked with plastic tape on which was written "Oklahoma State University."

The decoy birds were watered with plastic watering devices of the type used in household bird cages and were fed whole maize once a day. The traps were covered with limbs and leaves to provide shade and to break the outline of the trap. Decoys were taken out at night and replaced the following morning. The traps were checked twice a day, at noon and sundown.

Cock-and-hen trapping was discontinued and bait-trapping initiated when fully-feathered young were observed in the field.

Trap sites for bait-trapping were selected by walking over the study area looking for coveys or signs of their presence, working the area with a bird dog, from the trap site map used during cock-and-hen trapping, and from the basis of the appearance of habitat. Sites selected from the appearance of habitat were based on Davis's (1964) description of different habitats used by bobwhite quail in north central Oklahoma.

Trap sites were prepared by clearing debris and vegetation from a three-foot square. Approximately a two-foot square was cleared in front of the funnel. The traps were baited with whole maize, concentrating

the bait inside the trap with lesser amounts scattered in front of the funnel and about the trap. The traps were not prebaited.

The study area was sampled in segments during the first trapping period. If a trap site was unsuccessful after a week it was abandoned unless there were signs of recent use nearby. Successful traps were lifted when most of the birds in a family group had been marked. The maximum trapping time at any site was three weeks.

During trapping periods two, three, and four the entire study area was sampled. During these periods, trap sites were set in known covey ranges. If a covey's range had shifted, a search was made for the new location.

Data Recorded

All birds captured were marked with numbered aluminum leg bands. The age, sex when possible, date and place of initial capture, and date and place of recapture were recorded for each individual bird.

Techniques for Aging and Sexing

Bobwhites captured were aged as adults or immatures depending on the presence or absence of white-tipped primaries (Petrides and Nestler, 1943).

Sex of adults and immatures with adult plumage was determined by coloration of the throat and eyestrip. Prior to the development of adult plumage, immatures were sexed according to the extent of development of melanophores on the posterior dorsal edge of the lower mandible. According to John Steele (pers. comm.), this region is black in males and pink or gray in females depending on age. Because of inexperience

in using this technique, only the sex of immatures which had begun to attain their adult plumage is reported.

Periodicity of Hatch

The magnitude and time of hatching was determined by backdating the age of 170 birds. The backdating technique described by Petrides and Nestler (op. cit.) is based on the molt sequence of juvenile primaries and the growth of their replacements. The periodicity of hatching was compared with times and amounts of rainfall during the summer. Information on precipitation was obtained from the Oklahoma State University Hydrology Laboratory located approximately one mile north of the study area.

Trap Selectivity

To determine whether trapping was selective with respect to age, an analysis of repeat records was made using the technique of Marsden and Baskett (1958). Their analysis was based on Borror's (1948) paper on the white-throated sparrow, Zonotrichia albicollis. A bird was considered a repeat if it was recaptured anytime during the study, July 9 to April 4.

For comparison, regression lines were plotted for the number of times adults and immatures were recaptured during the study.

Source of Bobwhite Call

The western one-half of Section 16 was used as a study area for determining the source of the "bobwhite" call. Two methods were used to study the origin of this call, viz: walking the area, and driving the access roads in an automobile. While walking the area, a calling

male would be selected and watched, in order to determine if he was mated. After a period of observation he would be flushed and the surrounding area searched for the presence of a mate.

Roads were driven primarily during the early morning hours, from sunrise to approximately 8:00 a.m., but observations made in late afternoon, 7:30 p.m. to sunset, while checking traps are also included. A male was considered mated when observed with a hen.

CHAPTER III

RESULTS

Mortality Due to Trapping

During the course of the study, 410 quail were marked. Sixteen of the marked birds died as a result of trapping, causing a 3.9 per cent mortality among the marked sample. Fourteen unmarked quail died as a result of having been trapped, causing a total mortality due to trapping of 7 per cent.

Trapping mortality was caused primarily by dog predation, with the birds flushing and injuring themselves against the walls of the traps. Hawks may have caused a portion of the trap mortality.

Sex and Age Composition of Marked Sample

Quail were marked during three of the four trapping periods. The sex and age composition of the marked sample is presented in Table II. During the first two trapping periods, July 9 to September 15 and October 10 to November 2, young quail were caught which could not be sexed accurately. No dubious cases were used in the final tabulations.

Sex and Age Composition of Recovered Birds

Bobwhites banded during the first two trapping periods were considered to constitute two marked samples. The first sample consisted of the 300 birds banded July 9 to September 15. The second sample was composed of the same 300 birds plus 76 birds banded October 10 to

November 2. The recovery of each of the marked samples is shown in Table III.

TABLE II

SEX AND AGE COMPOSITION OF MARKED SAMPLE

	Adult		Immature		Unsexed	Total
	Male	Female	Male	Female	Immatures	
Trap Period 1 July 9-Sept. 15	46	19			247	312
Trap Period 2 Oct. 10-Nov. 2	9	3	23	13	28	76
Trap Period 3 Dec. 10-Feb. 10	3	5	9	5		22
Total	58	27	32	18	275	410

TABLE III

SEX AND AGE COMPOSITION OF RECOVERED SAMPLE

Banded Jul. 9-Sept. 15	Adult		Immatures		Total
	Male	Female	Male	Female	
First Retrap Period Oct. 10-Nov. 2	5	3	8	10	26
Second Retrap Period Dec. 10-Feb. 10	9	2	9	7	27
Third Retrap Period Mar. 12-Apr. 4	9	2	5	1	17
Banded Jul. 9-Nov. 2					
Second Retrap Period Dec. 10-Feb. 10	12	4	21	15	52
Third Retrap Period Mar. 12-Apr. 4	11	4	12	8	35

Recovery Rates

The per cent recovery of each of the marked samples is assumed to reflect the number of birds alive to be retrapped. These percentages are presented in Table IV. The recovery rate for each retrapping period was calculated by dividing the number of birds retrapped, Table III, by the size of the marked sample. Birds known to have died during the period of marking have not been included in the marked sample. Birds which died during a retrapping period have been included in the recovery rates.

TABLE IV

RECOVERY RATES OF MARKED SAMPLES

Marking Period	Number Marked	First Retrap Period Oct. 10-Nov. 2	Second Retrap Period Dec. 10-Feb. 10	Third Retrap Period Mar. 12-Apr. 4
Sample 1 July 9-Sept. 15	300	.087	.090	.057
Sample 2 July 9-Nov. 2	376		.138	.093

Attrition Rate

The attrition rate of each marked sample, determined by calculating the percentage difference in recovery rates between two retrapping periods, is presented in Table V. Calculation example for October 10 to April 4: $\frac{.087 - .057}{.087}$ = 35 per cent attrition. It is recalled that attrition is measured from the middle of each retrap period. Thus the 35 per cent attrition represents total losses to the population between October 21 and March 23.

TABLE V

SEASONAL ATTRITION RATES FOR THREE TIME INTERVALS

	Oct. 21-Jan. 10	Jan. 10-Mar. 23	Oct. 21-Mar. 23
First Sample	0.00	.37	.35
Second Sample		.33	

Age Ratios

The age ratios obtained during each trapping period and the sample size on which they are based are presented in Table VI. Birds which died during the trapping periods are included in the sample size.

TABLE VI

SEASONAL CHANGES IN AGE RATIOS
BASED UPON TRAPPED SAMPLES

Trapping Period	Sample Size	Number Adults	Number Immature	Per Cent Adult	Per Cent Immature	Immature Per Adult
July 9-Sept. 15	312	65	247	.21	.79	3.80
Oct. 10-Nov. 2	102	20	82	.20	.80	4.10
Dec. 10-Feb. 10	74	24	50	.32	.68	2.08
Mar. 12-Apr. 4	41	16	25	.39	.61	1.56

Inspection of the age ratios reveals that more immatures were dying than adults. The increase in immatures per adult from 3.80 to 4.10 between periods one and two was accompanied by an increase in the number of unsexable birds banded during the second trapping period.

Of the 64 immatures banded during this period, 28 were not sexable, Table II. Figure 1 shows that a late hatch occurred during late August and early September. The decrease from 4.10 to 2.08 immatures per adult was related to a decrease in covey size. From two census drives in October over approximately 150 acres of the study area, and aggregations of birds flushed while checking traps, a decline was noticed in size of aggregations from an average of 17 in November to 12 in February.

Periodicity of Hatch

The date of hatch of 170 birds, as determined by the technique of Petrides and Nestler (op. cit.), is shown in Figure 1. In the same figure, data for the number of bobwhiting males and date and amount of significant rainfall in July is presented. The data are presented in one figure so that the times and amounts of rainfall can be compared with the times and numbers of calling males and the date of the secondary hatch. A detailed account of July rainfall is presented in Table VII.

TABLE VII

RAINFALL DURING MONTH OF JULY

Date	Amount
July 15	1.33 inches
19	.14
20	.04
21	1.33
22	1.32
23	2.18

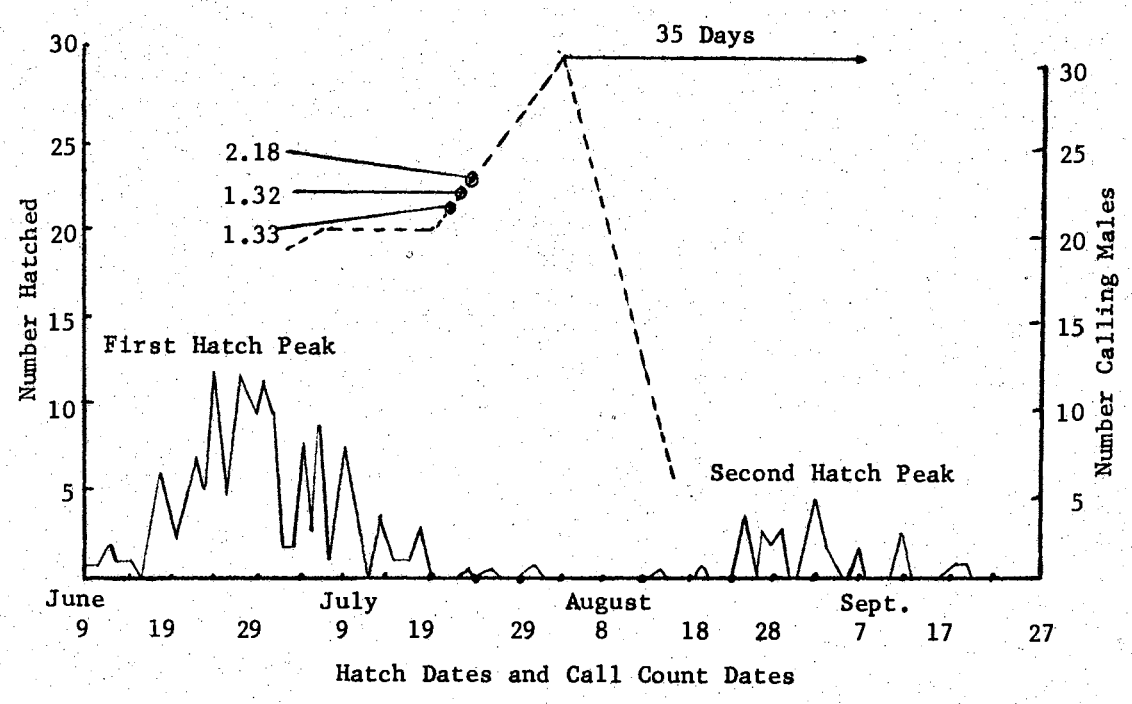

Figure 1. Relationship Between Hatching Frequency, Bobwhite Calls, and Rainfall. Hatch Date = ——, Call Count = ----, and Rainfall = θ.

Rainfall of 4.99 inches fell July 19-23. An increase in the number of calling males was recorded on August 3. Thirty-five days after the peak in calling, approximately the time required for quail to build a new nest and incubate a new clutch of eggs (Robinson, 1957), a second-arey hatch occurred.

Trap Selectivity

The hypothesis that young and adult bobwhites are equally subject to recapture was tested by means of Chi square, using the recapture data in Table VIII. There was no significant difference between the two groups (Chi square = 6.40 with 3 df. at .05 level). This indicates that trapping is not selective with respect to age.

TABLE VIII

ANALYSIS OF REPEATS TO DETERMINE TRAP SELECTIVITY

Number of Repeats	Immature	Adult
0	99	40
1	70	18
2	48	12
3 or more	96	19

Chi square test assumes that adults and immatures have the same opportunity to be recaptured. If differential attrition occurs among adults or immatures, Chi square would not seem to be an appropriate test because a different rate of decrease would affect the number available to be recaptured. The Chi square test has been made so that the present data could be compared with that of Marsden and Baskett (1958).

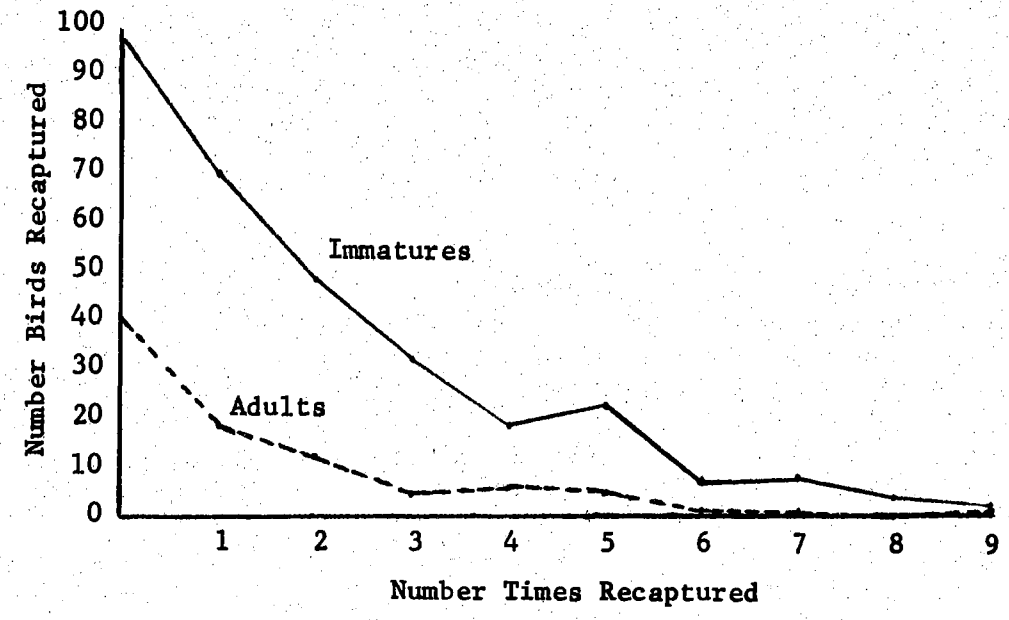

Figure 2. Susceptibility of Adults and Immatures to Repeated Recapture

Recapture frequencies of adults and immatures are compared graphically in Figure 2.

The Bobwhite Call

Observations of paired and unpaired bobwhites show the "bobwhite" call to be given primarily by unmated males, Table IX.

TABLE IX

LATE SPRING AND EARLY SUMMER OBSERVATIONS OF WHISTLING BOBWHITES

Paired		Unpaired	
Whistling	Silent	Whistling	Silent
1	12	30	7

CHAPTER IV

DISCUSSION

Attrition Based Upon Recovery Rate Comparisons

Of 300 bobwhites marked July 9 to September 15, 8.7 per cent were retrapped during the first recovery period and 9.0 per cent during the second, indicating that no attrition occurred between October 21 and January 10. This does not correspond with the observations on covey size which dropped from approximately 17 in November to 12 in February. The census data were inconclusive, however, since sizes of broods and coveys were not checked systematically, and counts were only made sporadically of birds flushed while the traps were being checked.

In each of 5 years, from November 1 to January 1, 1939-1943 Baumgartner (1944), using census data, reported an average decrease of 6 per cent on a nonhunted population and 42 per cent on a hunted population in Payne County, Oklahoma. Robinson (1957) reported an average decrease of 25.5 per cent in a hunted population during the same period in 1952-1953 at Ft. Riley, Kansas. The apparent absence of attrition from October 21 to January 10, in the present study is no doubt in error.

The present study was conducted in the same locale as Baumgartner's study. It is possible that small losses as reported by Baumgartner could have occurred during the present study and not have been detected by the technique used.

Weather conditions were mild until mid-December, but snow and ice were prevalent in late December and early January. Supplemental food patches on the study area, and feeders maintained during periods of snow and ice, may have mitigated early winter losses. Failure to detect any losses from October 21 to January 10 does not necessarily invalidate the technique under study, but indicates it is a poor technique for measuring small losses in small populations. More evidence is needed on early fall survival of bobwhites before the validity of the mark-recapture method for estimating attrition during this period can be accepted.

A late fall and winter loss of 35 per cent for a sample of 300 birds is within the expected range for this period. Winter losses of 37 per cent for a sample of 300 birds, and 33 per cent for a sample of 376 birds, is also within the range of expectancy. Kabat and Thompson (1963) reported an average winter loss of 50 per cent in Wisconsin based on 22 years of data. Winters in Wisconsin are much more severe than those in Oklahoma.

In the writer's opinion, the results in the present study, although within the range of expectancy as reported by other authors, may have been biased by certain uncontrolled factors.

Trap success seemed to be affected by weather conditions, food availability, movements of the birds, and possibly, trap selectivity. During the first retrap period the weather was hot and dry and trapping was poor. From Rick Martin (pers. comm.), manager of the Canton Game Management area, Canton, Oklahoma, it was learned that his trapping success during the same period was below that of previous years. It is possible that the low recovery rate during the first retrap period

could have resulted from birds not utilizing bait at trap sites, because of an adequate supply of natural food. If the winter losses from January 10 to March 23 are assumed to be representative, then the recovery rate for the first retrap period was too low. If the recovery rate for the first retrap period was too low, then this may explain the lack of coherency between the recovery rates of the first and second retrap periods and, changes in covey size between November and February.

Movements of birds between recovery periods made it difficult to maintain equality in trapping effort during each recovery period. Failure to find coveys at the beginning of each recovery period reduced the number of coveys being trapped or exposed to trapping.

Consistent quality in trap effort may have been affected by seasonal changes in susceptibility to capture, although I have not been able to prove this. The data indicate that adults and immatures had approximately the same likelihood of being retrapped, even though one immature bird was captured thirteen times.

Age Ratios

Age Differential Attrition

Age differential attrition is not uncommon in wild avian populations; however, little supporting data are available for its existence in bobwhite quail. Lack (1954) described higher juvenile mortality for blackbirds, Turdus merula, with yearlings comprising about 74 per cent of the population in autumn, but only 40 per cent in spring. For the Song Sparrow, Nice (1937) indicated that the yearlings survive about as well as the older individuals after they are about six months old. Marsden and Baskett (1958) noted that in their nonhunted population of bobwhite quail, once a bird reached its first October, its chances of

survival apparently did not change, and young in their first winter were dying at the same rate as adults, 82 per cent per year.

The age ratio in the present study progressively declined from 4.10 the last of October to 1.56 the last of March and first of April. Attrition seemed to be higher among immatures than adults. The number of immatures present in the trapped samples decreased from 80 per cent in October to 61 per cent in April, while the adults increased from 20 to 39 per cent during the same period. This is similar to what Robel (1965) found in Kansas. Emlen (1940) described a similar situation for California quail. Richardson (1941) found a higher adult mortality for a population of California quail.

In the present study, the 80 per cent immatures obtained during the October 10 to November 2 trapping period, indicates good survival from time of hatching in summer until time of trapping in the fall. Buss, Mattison, and Koslik (1947) report 83 per cent immatures in a nonhunted winter-trapped sample in Wisconsin.

Yearly mortality of bobwhites estimated from hunter kill has been reported by several authors, and varies from 77-84 per cent for juveniles, (Leopold 1945, Mosby and Overton 1950, Bennitt 1951). Stoddard (1931) estimated that juvenile bobwhites had a mortality 6-8 per cent greater than adults.

Hickey (1955) reported on the age ratios in a hypothetical population. He showed that age ratios obtained from trapping and from hunter returns were based on a similar idea, that band returns from shooting and recovery from trapping are time-specific, representing the number of birds alive to be shot or trapped.

Time of Hatch

The increase in age ratio for the trapped samples from September 15 to November 2 of 3.80 immatures per adult to 4.10 immatures per adult, corresponds to the hatch curve shown in Figure 2. The late hatch probably represents a renesting effort stimulated by rain in late July, Table VII. Lehmann (1946) reported that in southwest Texas, rainfall was important in stimulating nesting in 1942. From March to June, 1.37 inches of rain fell. Quail congregated into nonbreeding associations of 6-16, and breeding was not resumed until the drought was broken by July rains. Robinson (1957) reported poor productivity in south central Kansas with less than 14 inches annual rainfall and good productivity with 16 inches. Lay (1949) indicated that breeding success was scarcely affected by wet or dry years in east Texas; however, he reported that one of the driest years he experienced during his project was 36 inches annual rainfall. Parmalee's (1955) study in Texas indicated that with average-to-heavy winter or early spring rainfall, a successful hatch and rearing season will usually result.

Stanford (1952) indicated that the peak of hatching in Missouri occurred in mid July. He did not show a secondary hatch on his study area. Robinson and Baker (1952, 1953) reported secondary hatching peaks in mid August in Kansas. The secondary peak of hatching in the present study occurred approximately September 1, about 65 days after the major hatch.

The Bobwhite Call

Different opinions have been presented on the function of the "bobwhite" call, as whether or not it is primarily a call for a mate.

Table IX shows the "bobwhite" call to be given mainly by the unmated males.

The increase in number of whistling bobwhites noted on August 3, Figure 2, probably represented males seeking mates. If 35 days are allowed for nest building, egg laying, and incubation from the August 3rd calling peak, a secondary hatch could be expected about September 7. A secondary hatch was noted at this time as shown in Figure 2. Thus it seems from observations of whistling and silent males, and an increase in number of calling males corresponded to a secondary hatch, that the "bobwhite" call, is given primarily by unmated males seeking a mate. It is not contended that mated males do not give the "bobwhite" call, but that the call is given most often by unmated males. Kabat and Thompson, (op. cit.) and Robinson (op. cit.), give good evidence that the "bobwhite" call is also given by mated males.

CHAPTER V

SUMMARY

1. No attrition was detected from October 21 to January 10.
2. Attrition for a sample of 300 birds was 35 per cent from October 21 to March 23 and 37 per cent from January 10 to March 23.
3. Attrition for a sample of 376 birds was 33 per cent from January 10 to March 23.
4. The mark-recapture technique is a poor technique for detecting small losses in small populations.
5. The mark-recapture technique measured within the realm of expectability over winter loss.
6. Immatures had a higher attrition rate than adults.
7. Age ratios from trap sample indicated that attrition of immatures was greater than that of adults from October to March.
8. The secondary hatch seemed to be related to July rains.
9. Adults and immatures showed approximately the same tendency to be retrapped.
10. The "bobwhite" call is given most often by the unmated male calling to attract a mate.

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Major Field: Zoology

Biographical:

Personal Data: Born in Calloway County, Murray, Kentucky, January 19, 1943, the son of Mr. and Mrs. R. D. May of Pembroke, Kentucky.

Education: Attended Pembroke Grade School, Pembroke, Kentucky; attended Pembroke High School, 1957-1959 and graduated from Christian County High School, Hopkinsville, Kentucky, May, 1960; attended Murray State College, Murray, Kentucky, 1960-1963; received Bachelor of Science degree from the Oklahoma State University, with a major in Zoology, in May, 1965; completed requirements for the Master of Science degree in May, 1968.

Professional Experience: Served as a reporter for Agriculture Stabilization Conservation Committee in Calloway County, Kentucky, summers of 1962 and 1964; summer of 1965, worked for Oklahoma Department of Wildlife Conservation as an assistant fishery biologist; served as graduate assistant in ichthyology, fish management, comparative anatomy and invertebrate zoology laboratories in 1966; presently employed as a wildlife biologist by the Texas Parks and Wildlife Department.