METHODS OF PREDICTING QUAIL POPULATION CHANGES

by

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INTRODUCTION

The success of game management depends largely on the understanding of population conditions, characheristics and requirements.

In an effort to determine some of the factors affecting the bobwhite quail in Southwestern Virginia, the quail investigation on the V. P. I. Farms was initiated by Preston Newman (1937) in the fall of 1935. After completion of this study by Newman in the spring of 1937, the problem was undertaken by Chester F. Phelps (1942). George A. Gehrken (1948) renewed the investigation in the fall of 1946 and completed his study in the spring of 1948. Overton (1950) carried the investigation from the fall of 1948 and terminated it in the spring of 1950. Overton made many of the valuable conclusions that resulted from the investigation to date and for this reason, the present investigation was outlined to follow it rather closely. Mosby (1950) continued the study from the fall of 1950 through the spring of 1951. The present investigation was begun in the fall of 1951 and was terminated in the spring of 1952.

The investigation had begun as a study of over-winter survival; however, analysis of the data by Overton (1950) indicated that over-winter survival was not the limiting factor of the quail population on the V. P. I. Farms, but that some other factor was lowering the population. These factors became evident during the present investigation when analysis of population losses revealed that early fall losses in the quail population were as large on the study area as the losses occuring during the ctitical winter months.

Overton (1950) expanded the investigation to include the summer months in an attempt to study more closely the mechanisms operating against the V. P. I. quail population. The summer study, during the present investigation, was further expanded with a summer trapping program using marking devices on the birds to study male quail movements on the study area.

The controlled harvest was initated by Gehrken in 1947 to determine the effect of conservative shooting on over-winter survival. This phase of the problem was based on work reported by Errington and Hamerstron (1935). This phase of the problem was continued by Overton (1950) during the period of 1948-1950. Mosby (1951) continued the work during the fall of 1950. The controlled harvest was continued during the present investigation from the fall of 1951 through the spring of 1952.

While the controlled harvest was an essentially important phase of the investigation which yielded much valuable information, it was also important for the opportunity it presented the writer to apply open-season sex and age ratio figures as applied by Petrides (1949). Petrides found it possible to study virtually all of the population conditions and characteristics with the use of information secured from quail taken from the typical open-season bags.

WINTER POPULATION STUDY

Methods of Census

Trained bird dogs were used to perform the bulk of the census work. Other workers have found this method very satisfactory once the dogs and handler become familiar with the census area.

Well trained bird dogs can be a great asset, but are not essential to the census method employed in this study. Dogs show a wide degree of hunting ability and style, many ranging rapidly over a large area while others tend to hunt close to the handler and cover the ground thoroughly. A slow-moving, cautious dog works fine in areas where ground cover is heavy, but will consume a lot of time when it becomes necessary to hunt a large area. A wide-ranging, fast moving dog will cover a large area rapidly but is inclined to miss birds in brush and areas with heavy ground cover. Obviously, it would be ideal to have a number of dogs showing both hunting tendencies to cover ground adequately.

Staunchness is not required so long as the dog remains close to the handler. However, this quality is desired in dogs being used for censusing.

Tracking in snow is a reliable census method when conditions are favorable. Little practice is needed once the observer has become familiar with the individual covey ranges. The many random movements of quail quickly reveal their presence on an area andwith ideal conditions several days of activity on the range will allow an observer to become familiar with quail habits.

Infrequent snow on the V. P. I. Study Area presented few occasions to practice this census method. Therefore, little information was gained

in population estimates from this technique.

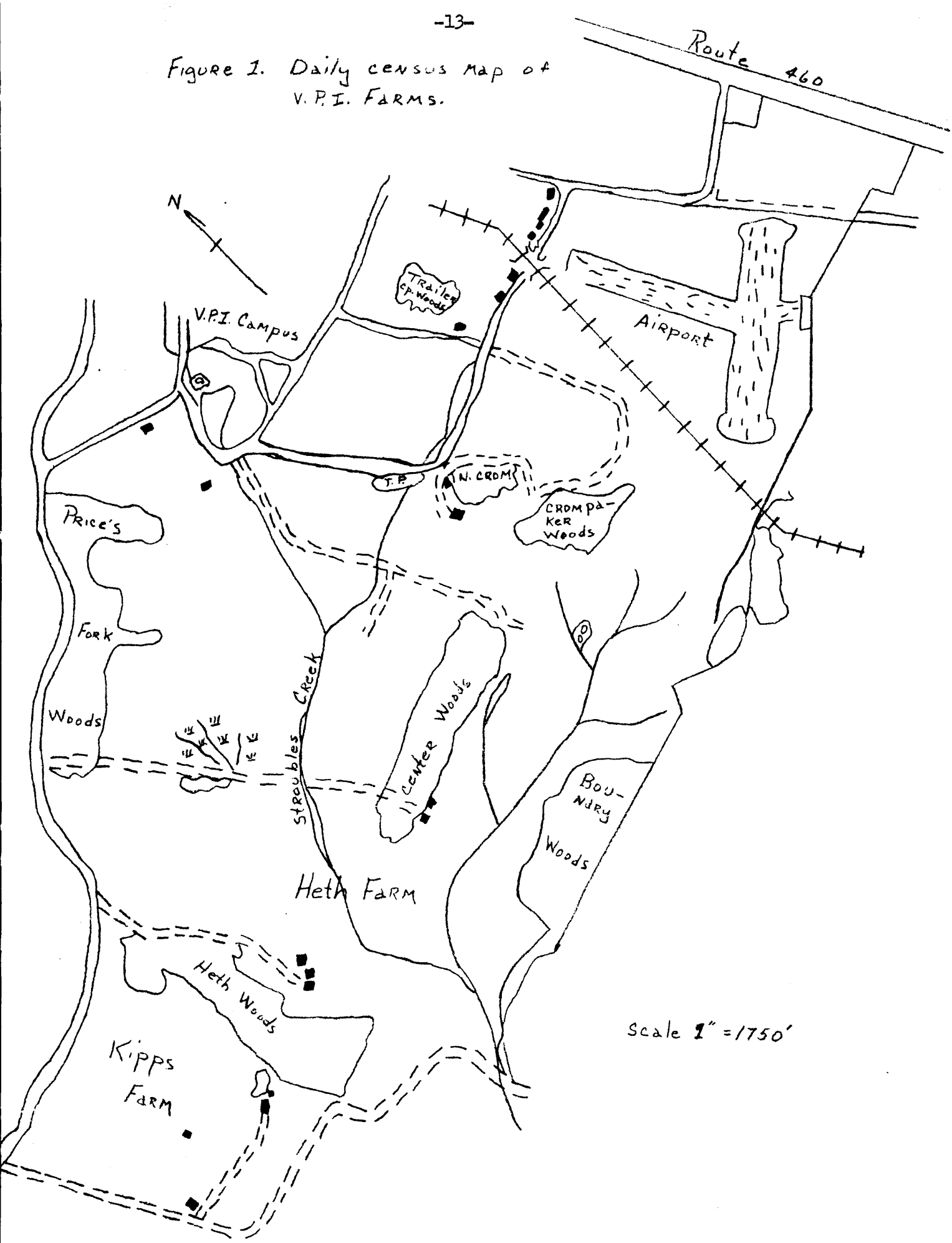
Permits to run bird dogs on the study area were issued upon request. In return for these permits, sportsmen were given census maps of the a area and asked to put down all information they had on covey locations and number. Results were very poor and little information was received. Very few maps were returned and these had only meager inaccurate figures. Most of these sportsmen were interested mainly in training young dogs, and once several coveys were located, they worked these birds constantly. This method would probably have worked satisfactorily if better orientation had been given the sportsmen at time of issuing the permits and if the permits had been requested at determined intervals along with the census map. Then it would have been possible to reissue permits only to individuals willing to cooperate.

Daily census records were kept for each census trip made over the area. All covey finds, (with number of quail in each covey), course taken, and other data of interest of quail populations were plotted on a mimeographed map of the study area. The location and covey sizes were plotted each month on a single "daily census map" (Figure 1) and from these data, the population for each month was estimated.

Transfer of daily census maps to a monthly map also gave accurate estimates of the individual covey ranges which was very helpful at times in locating coveys difficult to find.

Monthly population estimates were made from the information taken from the daily census maps. It would be wise to point out that the population estimate for any month is only the probable population and

Figure 1. Daily census map of V. P. I. Farms.



at best is simply an estimate.

In many instances a covey that was known to be present one month could not be located the next, but was found in the following or third month. In such cases the covey was included in the population estimate in the month it was not found due to its presence during the preceding and succeeding months. The observer should be careful to examine all data thoroughly in forming a monthly population estimate.

Results of Census

The 1950 fall population was estimated November 1, 1950 to be 248 quail in 19 coveys. By April 1, 1951 the population had decreased to 83 birds in nine coveys, an over-winter survival of 33.4 per cent.

Activity on the project during the fall of 1950 and the spring of 1951 was carried out by the Unit Leader of the Virginia Cooperative Wildlife Research Unit and the help of several graduate students. This observer spent much of the time on the area censusing with dogs when classes permitted. Monthly population estimates are available from existing records and are presented in Table 1.

Table 1. Monthly estimates of the quail population on the V. P. I. Farms from November 1950 to April 1951 (Mosby, 1950)

Date	Coveys	Quail	Percentage of Survival
November 1	19	248	100
December 1	16	196	79
January 1	10	116	46.8
February 1	9	91	36.7
March 1	9	91	36.7
April 1	9	83	33.4

A brief review of these data indicates that nine of the original 19 coveys either moved off the study area or joined with other coveys nearby and that four coveys increased beyond their original early fall number. These figures, together with data collected the following year indicate that segments of the quail population on an area may move considerable distances in their adjustments to winter range conditions and that the change or interchange of members between coveys may be rather common throughout the winter. It is possible that these movements may have been hastened by a 14-inch snowfall on November 25.

The 1951 fall population was estimated November 1 to be 279 quail in 19 coveys. By April 1, 1952 the population had decreased to 88 birds in 12 coveys, an over-winter survival of 35.1 per cent. The population decreased from an average of 14.6 birds per covey in the early fall to 7.4 quail per covey the following spring. This loss in covey size indicates that there is a sharp decrease in individual covey carrying capacities as the winter progresses on the study area.

Monthly population fluctuations are presented in Table 2.

Table 2. Over-winter losses in the V. P. I. College Farm quail population from November 1951 to April 1952.

Covey No.	Nov. 1	Harvested	Dec. 1	Jan. 1	Feb. 1	March 1	April 1
I	16	0	16	12	12	12	12
II	12	6	6	6	6	6	6
III	17	6	7	7	7	6	6
IV	14	0	14	14	8	6	6
V-VI	22	5	6	6	5	5	5
VII	15	0	15	6	6	0	0
VIII	16	0	17	16	14	14	14
IX	16	0	16	9	[illegible]	8	8
X	19	5	7	5	5	5	5
XI	14	0	14	14	0	0	0
XII	15	0	12	5	5	5	5
XIII	17	5	11	11	[illegible]	0	0
XIV	15	0	15	6	0	0	0
XV	17	8	9	9	8	8	8
XVI	16	0	12	12	0	0	0
XVII	16	8	8	7	5	5	5
XVIII	8	0	8	8	8	8	8
XIX	14	0	14	14	14	14	0
Total	279	43	207	167	112	102	88

Results of Preceding Seven Years of Census

The 1935-36 fall-spring population as estimated by Newman (1937) and taken from Overton (1950) decreased from 195 to 79 quail. The 13 coveys that survived the winter were originally composed of 172 quail, for which Newman calculated a survival of 45 per cent. However, these data indicate a survival of only 40.5 per cent. The detailed field records on each individual covey do not lend themselves to analysis of the population for each month.

The 1936-37 population as estimated by Newman (1937) taken from Overton (1950) decreased from 146 to 99 quail, a survival of 68 per cent. This population estimate includes only those coveys that survived throughout the winter. Included in this number was a covey of 10 pen-reared birds. Newman listed 106 birds in six coveys that could not be followed throughout the winter. If these are added to the number in the surviving coveys, a total of 252 quail is obtained. This figure is not considered to be the true fall population as several of the surviving coveys were not located until after a number of the others had disappeared.

The 1937-38 population estimated by Phelps consisted of 293 quail of which 176, or 60 per cent survived the winter. The list of coveys does not include the detailed data necessary to determine the monthly fluctuations of the population.

The 1946-47 population was estimated by Gehrken (1948) to consist of 204 quail in 14 coveys on October 1. This population decreased to 63 quail in eight coveys by April, a survival of 30.9 per cent. The

periodic population fluctuations as given by Gehrken are presented in Table 3.

It should be pointed out that the 1935-38 and 1946-47 estimates apply to an area of 2,000 acres. In 1948 the college leased an additional 265 acres and the size of the study area was about 2,265 acres.

Table 3. The periodic fluctuations of the quail population on the Virginia Polytechnic Institute Farms from October 1946 to April 1947 (Gehrken, 1948).

	Area A		Area B		Total	
Date	Coveys	Quail	Coveys	Quail	Coveys	Quail
October 1	6	73	8	131	14	204
November 20	6	73	8	127	14	200
January 10	5	52	8	104	13	156
February 19	5	48	8	86	13	134
April 1	3	21	5	42	8	63

Examination of Table 3 reveals that the study area was broken down into two separate areas. This division was made in order to have two areas to carry out a controlled harvest of quail. This division of the area into Section A and Section B have no bearing on the information being presented in this portion of this study and only the total number of coveys and quail will be considered.

For reasons of comparison of the monthly decreases, the dates of estimation were changed by Overton (1950). Examination of field records by Overton revealed that the January 1,1947 population figures were satisfactory for inclusion of this population estimate for January 1,1947. The estimate of 200 quail for the November 20,1946 population was found

by Overton to be too high for the December 1,1946 population but was used as a means of comparison. The population of 134 quail on February 19,1947 was found to be satisfactory for the inclusion of this data as the February 1,1947 population.

Overton stated that field personnel had little time for census work in the early fall of 1946 and that therefore, the estimated population decreases during October and November of that year should not be considered accurate.

The 1947-48 population was estimated by Gehrken (1948) to be 232 quail in 17 coveys on October 1,1947 and 41 quail in eight coveys on April 1,1948, a survival of 17.7 per cent (Table 4).

Table 4. The periodic fluctuations of the quail population on the Virginia Polytechnic Institute Farms for October 1947 to April 1948 (Gehrken, 1948)

Date	Area A		Area B		Total	
	Coveys	Quail	Coveys	Quail	Coveys	Quail
October 1	11	164	7	83	18	247
December 1	7	95	5	71	12	166
January 1	7	53	5	57	12	110
April 1	5	29	4	21	9	50

As in Table 3, the division of Area A and B has no bearing in this study and only the total number of coveys and quail will be considered.

The 1948-49 population estimated by Overton (1950) was 247 quail in 20 coveys. By April 1,1949 the population had decreased to 118 quail

in 13 coveys, a survival of 47.8 percent. The monthly fluctuations of the population are given in Table 5.

Table 5. Monthly decreases in the quail population for the fall and winter season of 1948-49 from the Virginia Polytechnic Institute Farms (Overton 1950)

Month	Population First of Mo.	Population Decrease Number	Per Cent
October	247	34	13.8
November	213	24	9.7
December	189	33	13.4
January	156	18	7.3
February	138	16	6.5
March	122	4	1.6
April	118		

The 1949 fall population estimated by Overton (1950) as of October 1, was 263 quail in 21 coveys. This population decreased by April 1,1950 to 81 quail in nine coveys, a survival of 30.7 per cent. Monthly fluctuations of the population are given in Table 6.

Table 6. Monthly decreases in the quail population for the fall and winter season 1949-50. Virginia Polytechnic Institute Farms (Overton, 1950).

Month	Population Estimate First of Mo.	Population Decrease Number	Per Cent
October	263	52	19.8
November	211	51	19.4
December	160	24	9.1
January	136	38	14.4
February	98	13	5.0
March	85	4	1.5

Conclusions of the Winter Population Study

Analysis of the census data for the nine years of population study indicates that only six years of these data are comparable. Overton (1950) and Gehrken (1948) found that the data for 1935-47 were not comparable to data for the following years that the intensive management done by Rucker (1937) did not represent the same conditions found during 1946-50. A thorough check of these records was undertaken and the conclusions drawn by Overton and Gehrken were found to be satisfactory.

Weather in relation to overwinter loss of quail has received considerable attention and most of these studies were made in an attempt to determine the effect of weather on overwinter survival of quail populations. The V.P.I. quail population investigations have included a search for factors which might explain the observed fluctuations revealed in the overwinter survival data. Weather apparently is a factor in the overwinter survival of the bobwhite, but an actual measure of its effect is difficult. Gehrken (1948) attempted to correlate the size of the spring population with the number of days with snow on the ground to the depth of one inch or more. Data for nine years have been compiled and are presented in Table 7.

Table 7. Number of days of snow to depth of 1 inch or more and the over-winter survival of the quail population of the V.P.I. College Farms.

Year	Days of Snow	Percentage Over-Winter Survival
1937-38	0	60
1949-50	3	31
1951-52	7	36
1948-49	8	48
1936-37	12	68
1935-36	13	45
1946-47	24	32
1947-48	26	18
1950-51	27	33

Examination of Table 7 and of Figure 2 indicates an inverse relation between the overwinter survival percentage and the length of time that snow remains on the ground to a depth of one inch or more.

However, while the correlation between overwinter survival and the length of time that snow covers the ground generally holds true, these figures should be accepted with reservation until more overwinter survival data are collected.

The inverse relation found by Errington (1945) between summer increase and winter non-emergency loss was also observed by Overton (1950) to apply to the population on the V.P.I. Farms. The relationship between summer increase and winter non-emergency decrease found by Errington occurred principally in those years where the density of the population was below the normal carrying capacity or in the depression phase of the cycle as shown in Wisconsin. On the V.P.I. Farms apparently this relationship was found in those fall populations that approached or exceeded the carrying capacity of the area (Table 8).

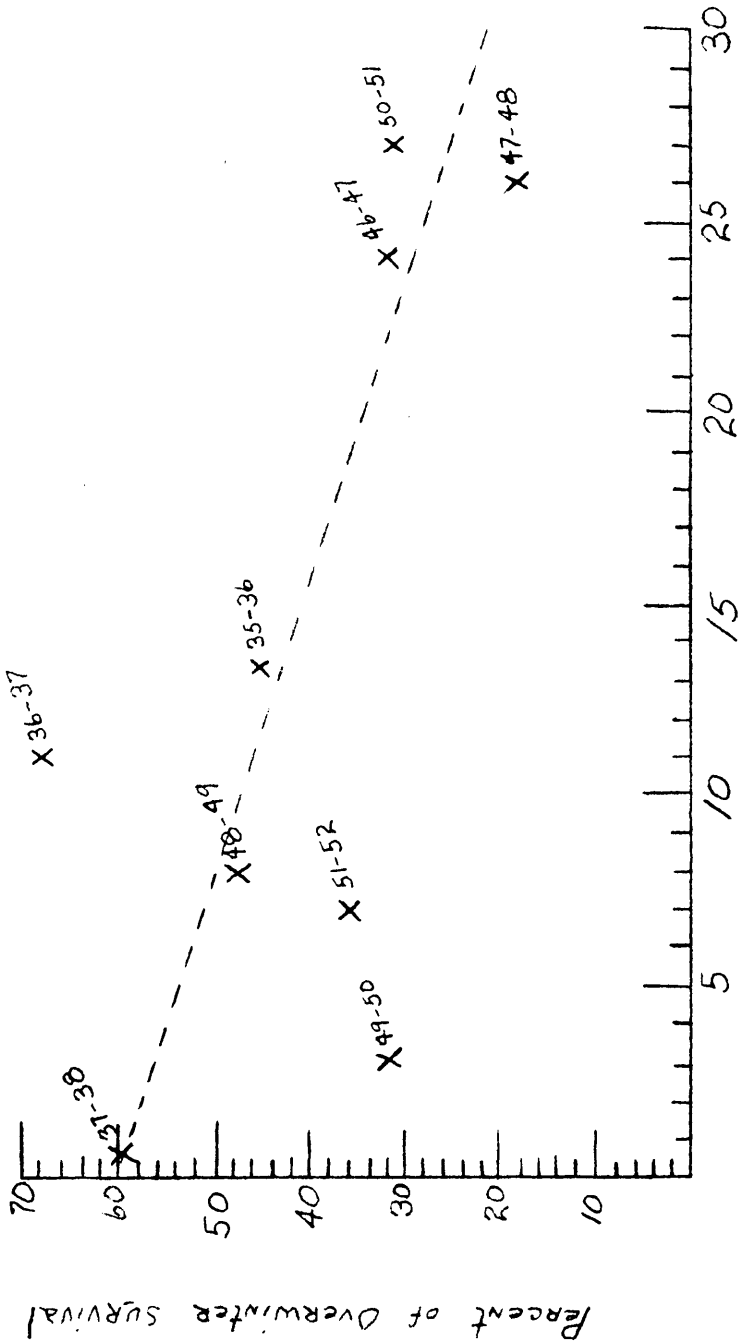


Figure 2. Number of days snow Remained on the ground to depth of one inch or more and the percent overwinter survival of the Quail population on the V.P.I. College Farms, 1936-37 and 1946 through 1952.

Figure 3. Spring to fall increase as compared with the fall and winter decrease in quail/100 acres on 2,200 acre V.P.I. Farms, 1947 through 1952.

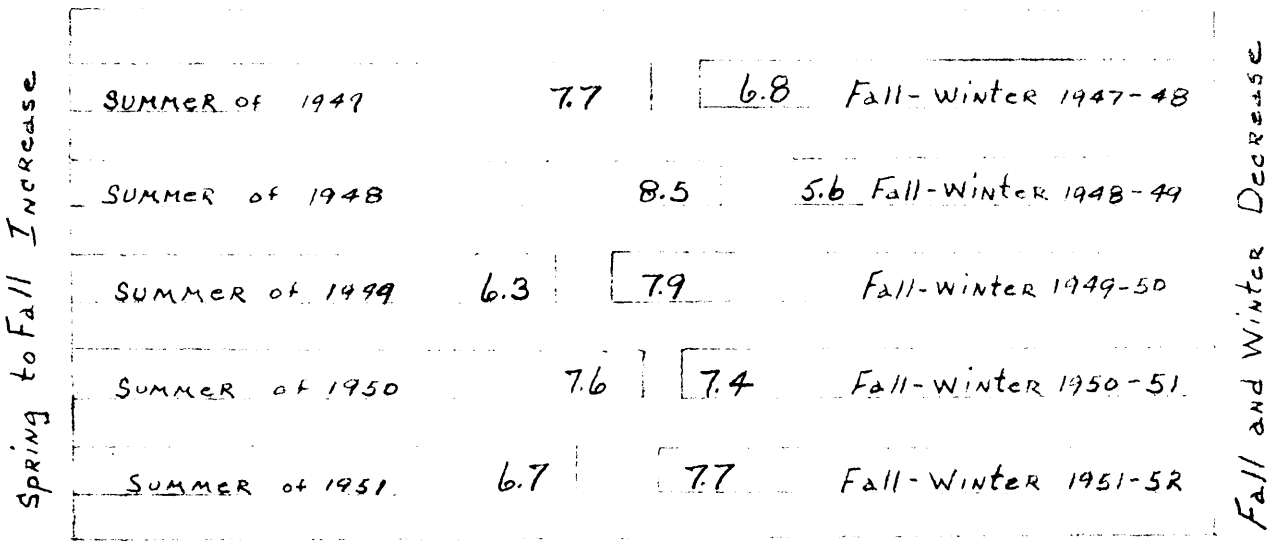


Table 8. Spring to fall quail population fluctuations, Virginia Polytechnic Institute Farms, Virginia

Year Spring-fall	April 1 population Number of quail	October 1 population Number of quail	Per cent inc. spring-fall
1936	88	146	66
1937	99	293	196
1947	63	232	268
1948	41	247	501
1949	118	263	123
1950	81	248	306
1951	91	279	292

The agricultural practices on the V.P.I. Farms place heavy pressure on quail populations, but it is usually possible for the spring population on the area to result in a fall population equal to the carrying capacity regardless of the number of quail present the preceding spring. In view of the population fluctuations on this area, the relationship of summer increase to winter non-emergency decrease could well be a population characteristic which tends to stabilize the population by acting against the action of abnormally low or high populations as shown in Figure 3.

Overton (1950) in explaining the relationship between summer increase and winter non-emergency decrease stated that, " A year with very high overwinter losses (due to weather, hunting pressure or other causes) would be followed by a very high increase during the summer. The following fall population would suffer very low non-emergency losses and would enter the critical period (if such occurred) with a high population. Should no critical period and no emergency losses occur,

the spring population would be very high, the summer increase would be low and non-emergency losses of the following year would be high." This explanation follows closely the interpretation of the available data by this observer. Since these non-emergency losses occur principally in October, November and December, they would exert pressure on the early fall population and could have an effect on the hunting season population.

Non-emergency losses in October and early November have been high in the V.P.I. Farms quail population. These losses have averaged 23 per cent of the total quail lost annually. Early fall losses will be discussed in more detail in another section.

SUMMER POPULATION STUDY

The summer population study was initiated in 1949 by Overton (1950) and was continued again in 1951 during the present study. The summer study was the outcome of analysis of the open season sex and age ratio data. Analysis of sex and age ratio data on the V.P.I. College Farms indicated that there was a high post-nesting mortality among adult females and that the nesting season and the subsequent hatching of young was extended over a prolonged period. It was believed that a summer population study would possibly reveal some of the influence involved in these two limiting factors of the V.P.I. quail population.

Methods

Methods employed in the summer study were a hen and cock trapping program, direct field observation and interrogation of the V.P.I. Farm workers.

The hen-and-cock trap consisted of modifying the standard Stoddard Covey Trap so that a hen quail could be confined inside the trap and thus act as "bait" for unattached male quail. All trapped birds were banded and marked with the "Wint" plastic bow tie. The trapping program was begun in May and extended to the latter part of July. This trapping technique is explained in detail under the section "Trapping and Banding".

Direct field observations consisted of many trips into the field for both direct observation of breeding pairs and the hope of locating nests. Many direct observations were made of breeding pairs while tending the hen and cock traps. Other information was recorded while interviewing the farm workers and making over maps of cropland.

Interrogation of the farm workers was done throughout the summer. The mowing and harvesting crews were interviewed periodically and the workers were asked to report the observation of any nests and young broods.

Results

As a result of the trapping program 19 cock birds were trapped and tagged with both "Wint" plastic bow ties and metal leg bands. Observations were made on nine pairs of quail all of which were acting in such a manner as to indicate nesting or brooding. Only one nest was located. The summer trapping presented some interesting data on whistling territory of cock birds, movements of whistling cocks and defense of the nesting grounds. Age ratio data were taken from all trapped cock birds.

The Whistling Territory of Cock Birds

It is believed that unmated cock birds do maintain a definite whistling territory and this belief is drawn from the following observation.

In setting and maintaining the cock traps, it was found that traps had to be set within one-eighth mile radius of the whistling cocks or the cocks could not be called up by the hen bird and trapped. One must consider that these observations took place in the earlier part of the nesting season, May and June, when there was a possibility that all hen birds had not been mated.

If the traps were left within an individual whistling territory, the tagged cock would either be retaken or observed loafing close to the trap. Cock 53018 was trapped at Station 9. Three days later he was again taken at the same station and thereafter for four consecutive days at which time the trap was removed. Cocks 53023, 53017, 53019, 53009 and 53040 were taken when traps were placed within the radius of their whistling territory.

The observations of fighting cocks also seems to support the belief that whistling, unmated cocks do show a tendency toward a definite, confined whistling territory. Three observations of fighting cocks were recorded.

The first observation of quail cock fighting occurred as the observer was listening to a whistling cock, just prior to placing a hen and cock trap in the area, when a second cock flew into the immediate area of the whistling bird. A few seconds passed before the whistling bird emerged into the open with wing-tip dragging the ground. The visiting cock then emerged and the two birds circled twice before two passes were made at each other. A chase followed for a few seconds in the open before they entered ground cover too high for the observer to follow their movements. In approximately one minute, both birds were observed to take wing in opposite directions; both birds began to whistle immediately upon alighting. These birds were later trapped.

At two trap positions, cock birds could always be found loafing, but would not enter the trap. Droppings indicated that these two males remained at the traps throughout the day and roosted about six inches

away at night. One of these birds was trapped on the sixth day and the other on the eighth day. The cock at station eight was observed fighting a male bird that had entered the immediate vicinity of the trap, presumably in defense of the bait hen, on two occasions. The cock at station four was observed fighting an intruding cock on one occasion. Although observations of fighting cocks were limited, it does seem to indicate the aggressive nature of unmated cock birds in defense of their whistling territory.

Operation of the hen and cock traps showed that birds trapped a number of times were inclined to become trap addicts, apparently losing all fear of the trap and handling. The tendency among trapped birds to become trap addicts undoubtedly limited the number of retakes in traps and handicapped the attempt to learn the duration of a cock's stay in his whistling territory. But it is believed that cock quail remain within a well fixed territory during the earlier part of the nesting season. As the nesting season progresses, they seem to become rather loosely associated to the whistling territory and begin random movements.

Movements of Whistling Cock Birds

Some individuals show a tendency to make random movements. Only one such movement was actually recorded, but a number of tagged birds were observed outside of known whistling territories during the nesting season. Cock 53040 was trapped at Station 11; two days later he was taken at Station 10, a distance of one-half mile. A trap was replaced at Station 11 and three days later he was retaken at this station.

Numerous other observations were made on birds tagged with "bow-ties" which were outside of their breeding grounds. All of these observations, as with the case of cock 53040, were made well into the latter half of the nesting season.

Apparently as the nesting progresses and chances of becoming mated lessen, cocks begin random movements in search of a mate.Observations show that their attempts are not always futile as two cocks were seen mated with hens well outside of their original whistling territory.The two tagged cocks observed mated were wearing white plastic bow ties.One was observed in an area where birds had been tagged with red bows only, and the other was observed in an area where all cocks had been tagged with only yellow bow ties.

Nesting Pairs

Nine pairs of quail were observed acting in such a manner as to indicate nesting or brooding. Numerous field observations were made on several pairs over a prolonged period. Each time these pairs were seen,a thorough search was made of the area in the hope of locating the nests. The nests of these birds were never located,and even though the observations were made over a good part of the nesting season,they never displayed any mannerisms which would indicate that they were caring for a young brood.In view of these observations,it would seem that these pairs were forced to make more than one nesting attempt.They were last observed on July 21.

Only one nest was located. This nest was reported when it was mown over by one of the V. P. I. Farms mowing crew. A mound of hay was placed over the nest by the worker, but the birds never returned.

Nesting Season Success

Conditions of the nesting season may be studied from other phases of the problem. Size of the breeding population, the spring and fall sex ratios of the population and the age in weeks of the immature quail killed during the season, or in case of this problem those killed during the controlled harvest, are all factors influencing the ultimate test of the success of the nesting season.

Progress of the nesting season of 1951 was determined by examination of the immature wings collected during the controlled harvest. The wings were aged by the method described by Petrides and Nestler (1943) through examination of the post-juvenile molt of the primary wing feathers.

It was determined from the analysis of the sex and age ratio data that 69 per cent of the 29 immature quail collected had been hatched prior to July 31 which was considered the mid-point of the nesting season. As a basis of comparison, a sample of 34 immature quail was taken from the Piedmont Region of Virginia. Examination of this sample of 34 immature birds revealed that 100 per cent had hatched prior to the mid-season nesting point as established above. The figure of 69 per cent when compared with the figure of Overton (1950) for the year 1949 seems more satisfactory, for Overton found that of a sample of 24 birds, that only 33 per cent had hatched prior to July 31. Possibly the higher percentage of hatching before July 31 in 1951 can be explained by the fact that the weather for the nesting season was considered unusually favorable to a prolonged dry spell from the first

week in June through the latter part of July.

The wide dispersion of the hatching dates throughout the nesting season is unexplained. It is highly possible that this wide dispersion of hatching dates on the V.P.I. quail may be due to disturbances during the hatching season as a result of the above-normal amount of activity on the Farms and the intensive grazing.

Post nesting mortality of adult females in relation to the 1951 sample was high. Analysis of available data indicate that the number of young per adult female per covey was 4.1 immature quail in November. The immature adult female ratio per covey was found to be 22.1 for the same November period. Overton (1950) found the 1949 November brood size to be 6.5 per adult female and the immature adult female per covey ratio was 18.1.

These data would indicate that in both cases there was only one adult female per three broods in November, or a loss of two out of three adult females between nesting and the November harvest. However, analysis of data taken from quail in the Piedmont Region indicated that a high post-nesting mortality occurred throughout that large section of the state also.

In consideration of the intensive farming and grazing program and the above-normal activity carried out in experimental plantings on the V.P.I. Farms, it is conceivable that a high loss of adult females could occur. However, if these small samples were applied to statistical confidence limits, it is believed that the number of immature quail per adult female data would more closely resemble the sex and age ratio

data found in Missouri and other states having larger samples.

Table 9. Hatching events, as determined by aging of immature quail, collected on the V.P.I. Farms during November, 1951 (Age determination by the method described by Petrides and Nestler, 1943).

Date Collected	Age (Days)	No. of days Collected	No. of day Hatched	Date Hatched
11-13-51	127	317	190	7-9-51
11-9-51	127	313	186	7-5-51
11-11-51	150*	315	—	———
11-13-51	121	317	196	7-15-51
10-30-51	55	303	248	9-5-51
10-29-51-	150	302	152	6-1-51
10-30-51	150*	303	—	———
11-13-51	150	317	167	6-16-51
10-30-51	119	303	184	7-3-51
11-18-51	A	322	—	———
10-30-51	119	303	184	7-3-51
11-13-51	150*	317	—	———
11-19-51	A	323	—	———
11-19-51	A	323	—	———
11-19-51	150	323	173	6-22-51
11-31-51	A	335	—	———
11-19-51	127	323	196	7-15-51
11-17-51	126	321	195	7-14-51
10-30-51	57	303	246	9-3-51
11-13-51	A	317	—	———
11-9-51	150*	313	—	———
11-6-51	65	310	245	9-2-51
11-51-51	73	309	236	8-24-51
11-11-51	150*	313	—	———
11-19-51	105	323	217	8-5-51
11-13-51	127	317	190	7-9-51

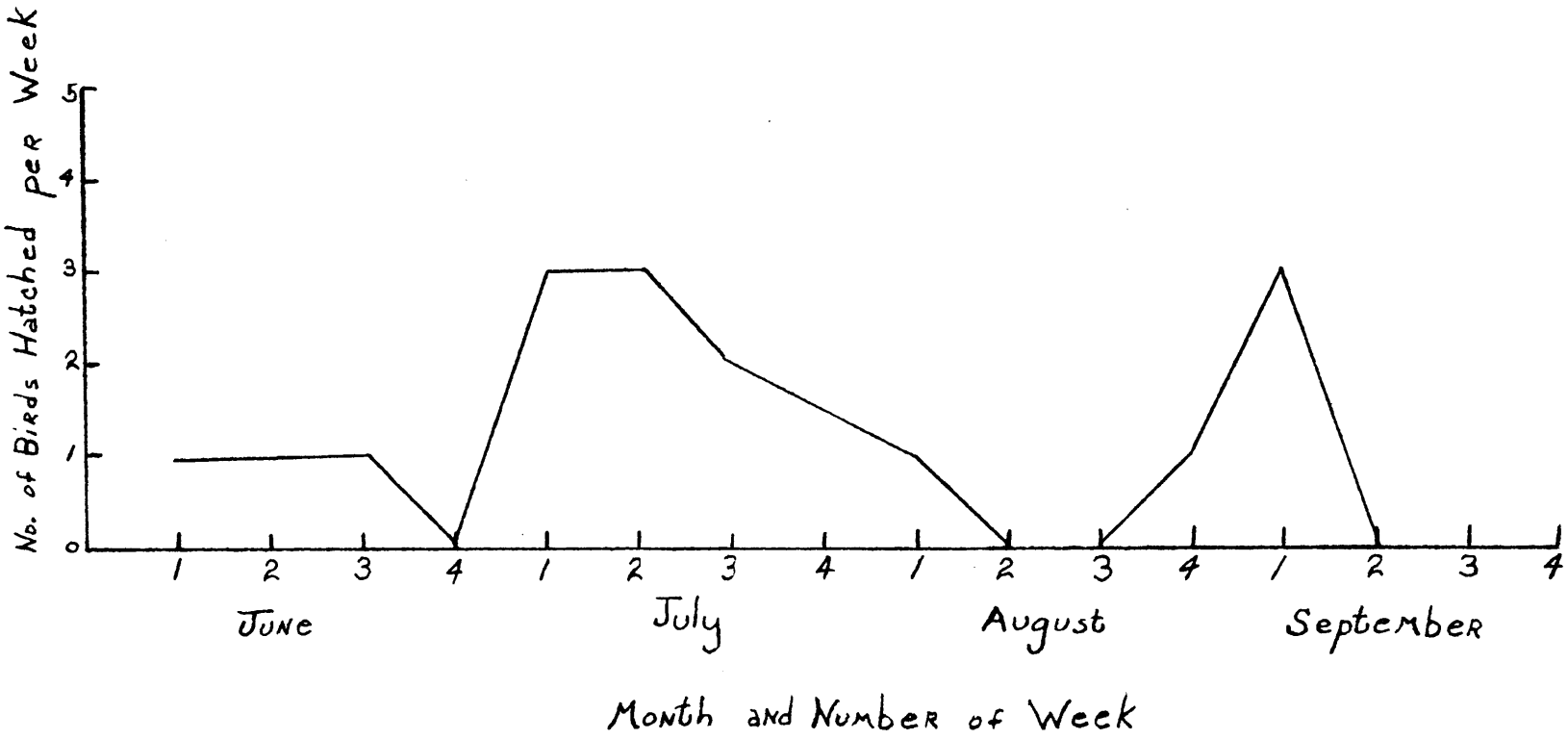
* Bird over 150 days old but is a young of the year.

Carrying capacity of the area. The carrying capacity, or "basic threshold" as used by some workers, for the V.P.I. Farms is approximately one quail per nine acres, or 245 birds on the 2200 acres. The carrying capacity on this area, as on any area, has shown a ten-

dency to fluctuate slightly in various years. However, the spring population, even during years when it approached a depression phase, has always shown the ability to approach the early fall carrying capacity. It is believed that the limiting factor operating against the V.P.I. quail is not weather or productivity, but rather is the limited suitable quail habitat available.

The spring to fall percentage of increase has been quite varied on the V.P.I. Farms. Variation in the spring to fall increase has been brought about by the degree of fluctuation in the size of the spring population. When the spring population becomes low or at the depression phase, breeding is stimulated while the reverse is true when over-winter survival reaches a high percentage and the resulting spring population is large. Data for spring to fall percentage of increase can be found in Table 7.

Figure 4. Graph Showing hatching dates of Quail on the V.P.I. College Farms for 1951



CONTROLLED HARVEST

The controlled harvest experiment was initiated on the V.P.I. Farms in December, 1947 and was run each year until the present study. The primary purpose of the experimental harvest of quail has been to determine if conservative shooting merely utilizes a portion of the quail population which would normally be lost to other decimating factors. Errington and Hammerstrom (1935) found in the northern bob-white range that conservative shooting only utilized that portion of the population which would normally be lost to other causes.

The controlled harvest on the V.P.I. Farms was run 1947-49 on two separate equal divisions of the farms, designated as "A" and "B", with approximately the same number of quail on either area. This division, (see Figure 1) was delineated by Stroubles Creek;the area to the east (designated by Area "A") was used as the area from which the quail were removed under a conservative harvest plan. However, the rapid development of this section of the V.P.I. Farms during the spring and summer of 1950 for dairy cattle production caused the population to shift on the area. This has resulted in a preponderance of quail on the west side of Stroubles Creek (previously designated as Area "B"). As a result of this population shift, it became necessary to revamp the coveys chosen for the harvest experiment. Coveys were selected at random, with a control covey in the immediate vicinity, from which quail could be harvested by shooting without danger to farm workers or to farm buildings and which could be hunted without unfavorable public reaction.

Methods

The controlled harvest, as explained by Gehrken (1948), was accomplished by use of a three-man team and from one to three quail dogs. One man served as observer and the other two shot those quail that were to be removed. The observer was responsible for making an accurate count of the covey and marking down cripples and singles. This team was always composed of project personnel.

In the years 1947-49, the objective of the conservative harvest was to remove all quail in excess of eight per covey from Area A. In the years 1950-51, the objective of the harvest was to remove 50 per cent of the harvest coveys as long as this removal of birds did not cut the covey below six birds. Data can be found in Table 10.

Results

In 1947-48, 29 quail were collected and four were shot and lost during the shooting period that lasted from December 8 to December 22. Thus, 33 quail were removed from the population. (Gehrken 1948)

In 1948-49, six quail were removed from Area A between December 1 and December 22. The poor success of this harvest was contributed to changes in the agricultural practices on the area that were made during the preceding years. (Overton 1950)

In 1949-50, 22 quail were collected from Area A and two were shot and lost. These 24 quail were removed between November 1 and November 8. This date was set earlier in order that the factors which handicapped the harvest of 1948-49 would be eliminated. (Overton 1950)

In 1950-51, 24 quail from six coveys were collected from those

coveys chosen for harvest and were removed between November 1 and November 22. These 24 quail represent 31 per cent of the total population chosen for harvest. Examination of these data shows that the harvest coveys had an over-winter survival of 37 per cent, while the control group had an over-winter survival of 31 per cent.

In 1951-52, 43 quail were collected from eight coveys. The harvest was begun October 30 and completed on November 21. Figure 3 and Table 11 show that the over-winter survival of the eight harvested coveys (117 quails) had an over-winter survival of 51 per cent (not including the 43 quail taken by shooting) while the 11 unharvested coveys (162) had an over-winter survival of only 30 per cent. And 18 per cent loss in the November population prior to the harvest reduced the coveys to such an extent that only 43, or 36 per cent, of the total harvest group quail could be taken safely.

Conclusions

Analysis of Figures 5-10 reveal that the conservative harvest does not ultimately affect the trend of the over-winter population curve. Although the rate of decrease during the controlled harvest takes the form of an abrupt drop, it does not affect the population curve for after a period of two months the curve recovers completely and follows the typical curve. These data indicate that the segment of the population which is removed during the harvest is simply that portion of the population which would normally be lost to other decimating factors. Analysis of these data also reveal that at least 40 per cent of the fall

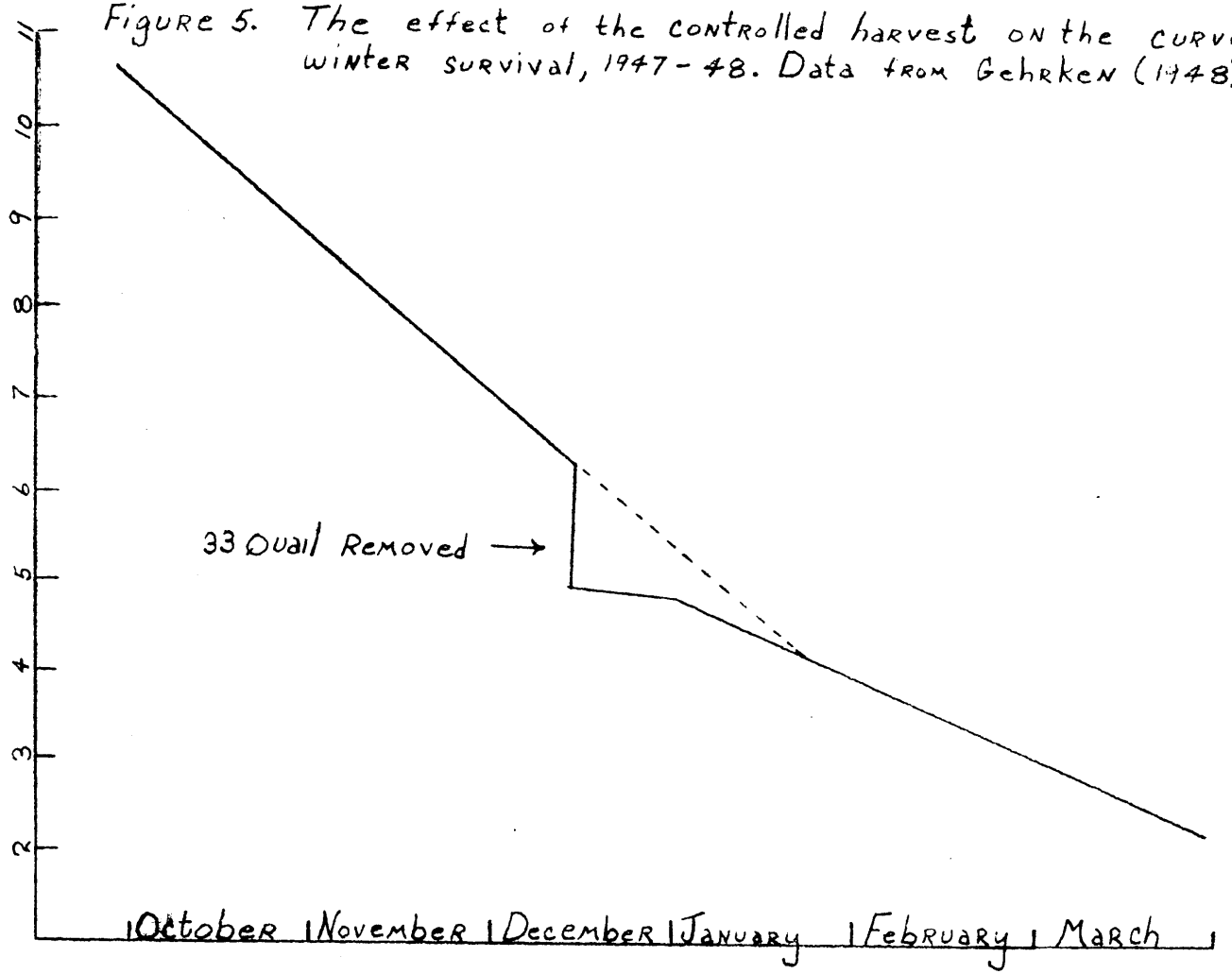
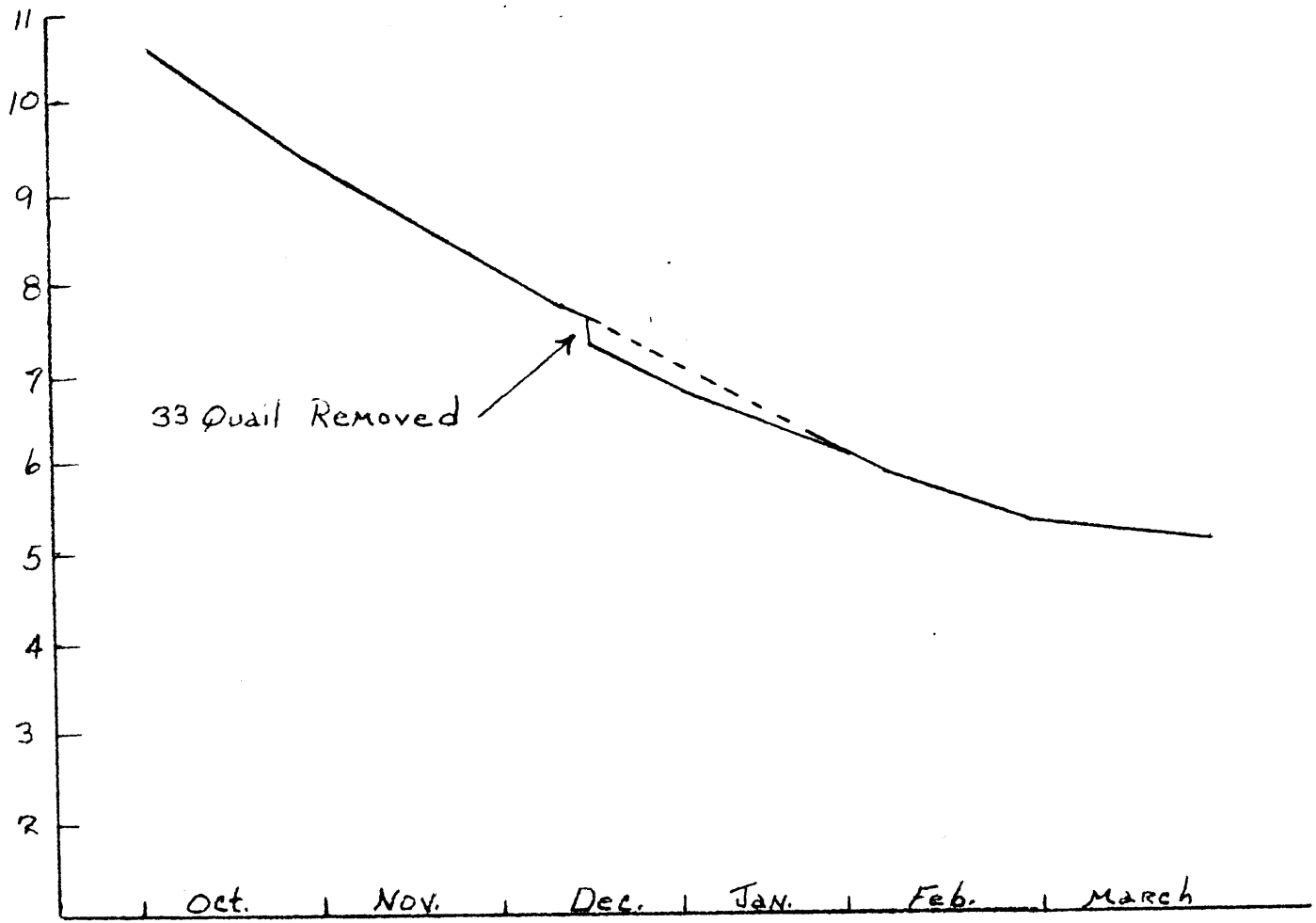


Figure 5. The effect of the controlled harvest on the curve of over-winter survival, 1947-48. Data from Gehrken (1948)

Figure 6. The effect of the controlled harvest on the curve of overwinter survival, 1948-49. Data from Overton (1950).



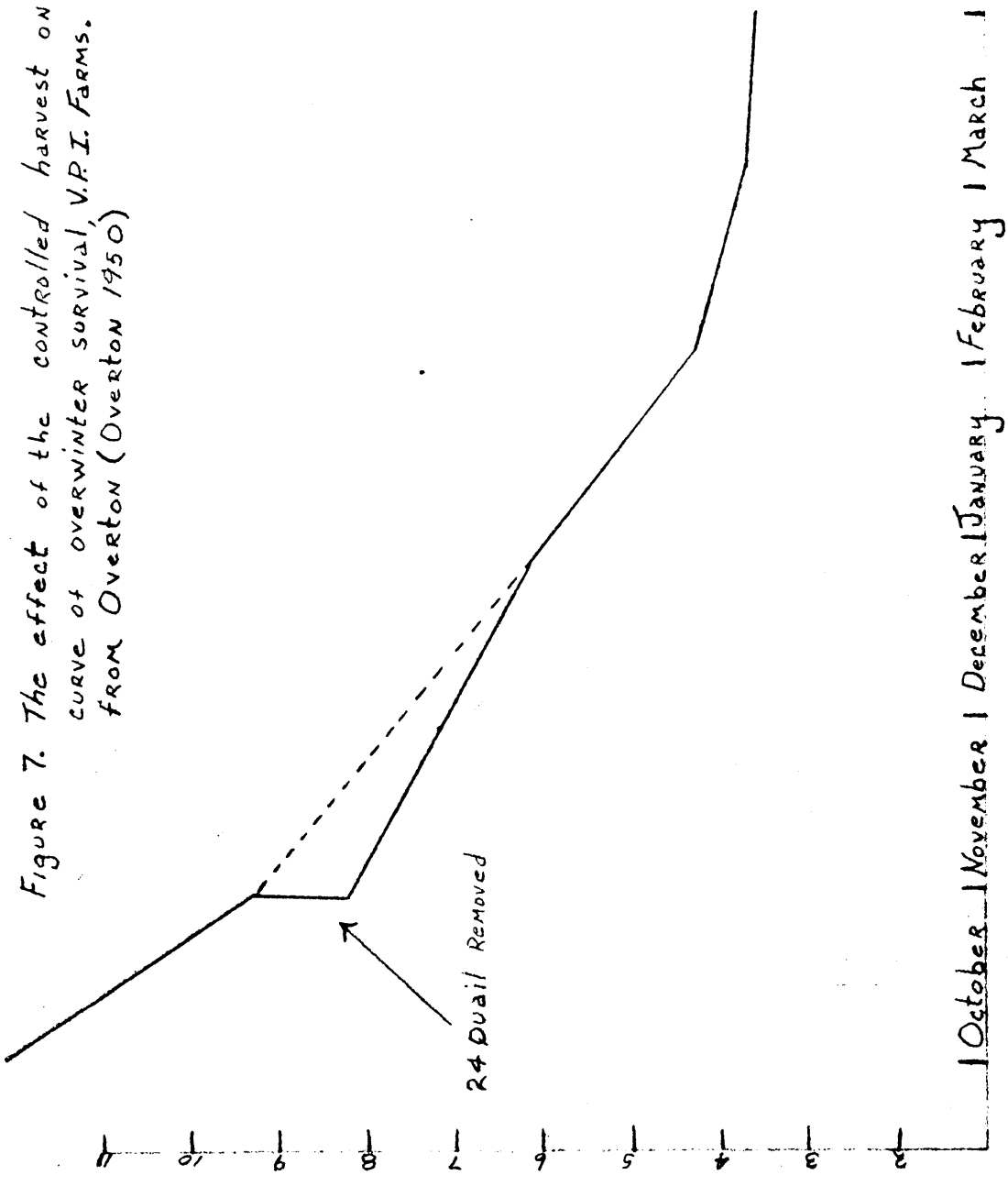


Figure 7. The effect of the controlled harvest on the curve of overwinter survival, V.P.I. Farms. Data from Overton (Overton 1950)

Figure 8. The influence on overwinter survival of the removal of 36 percent of the quail from eight coveys as compared with the overwinter survival of quail in 11 coveys used as controlls, V.P.I. College Farms, November 1951 through March 1952.

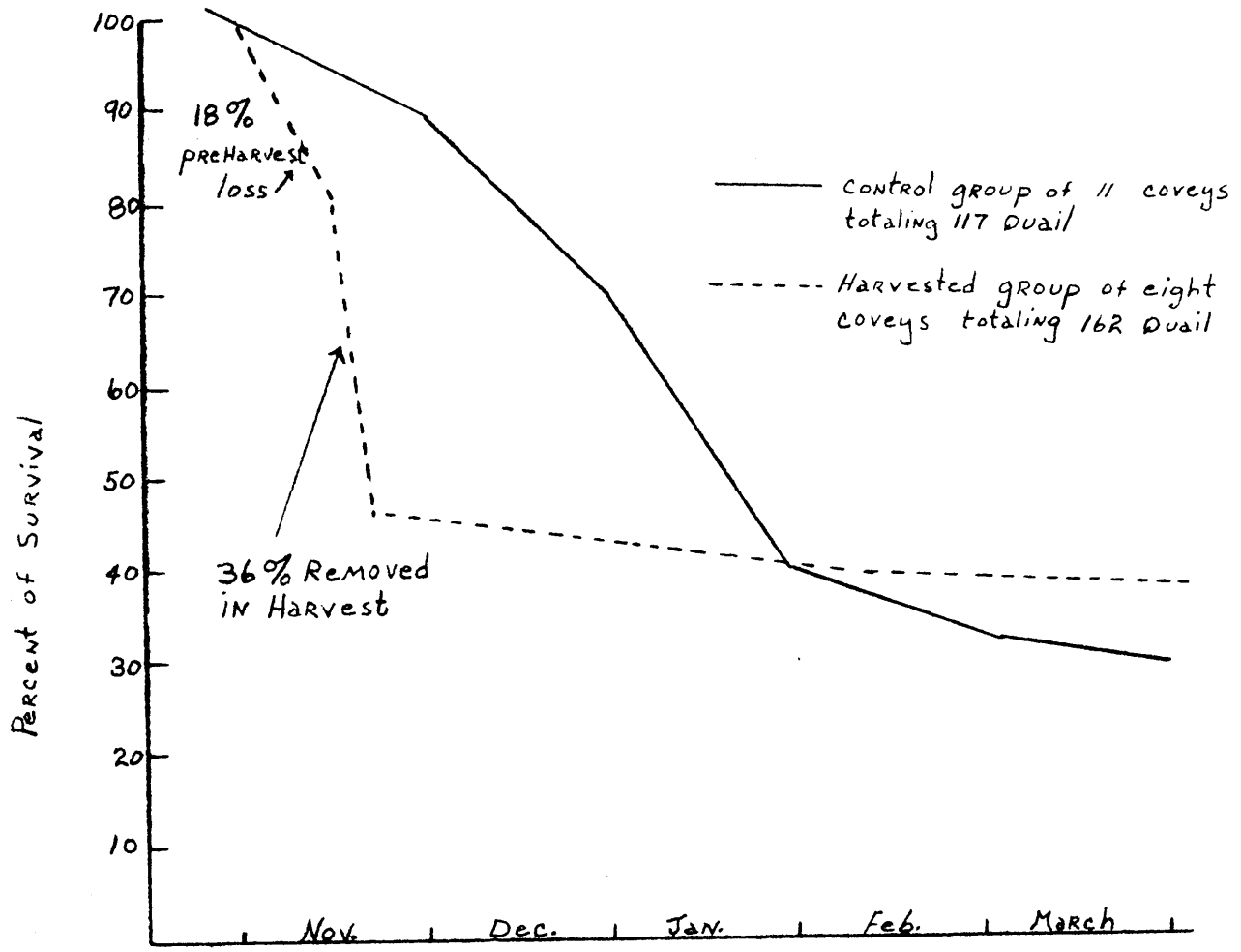
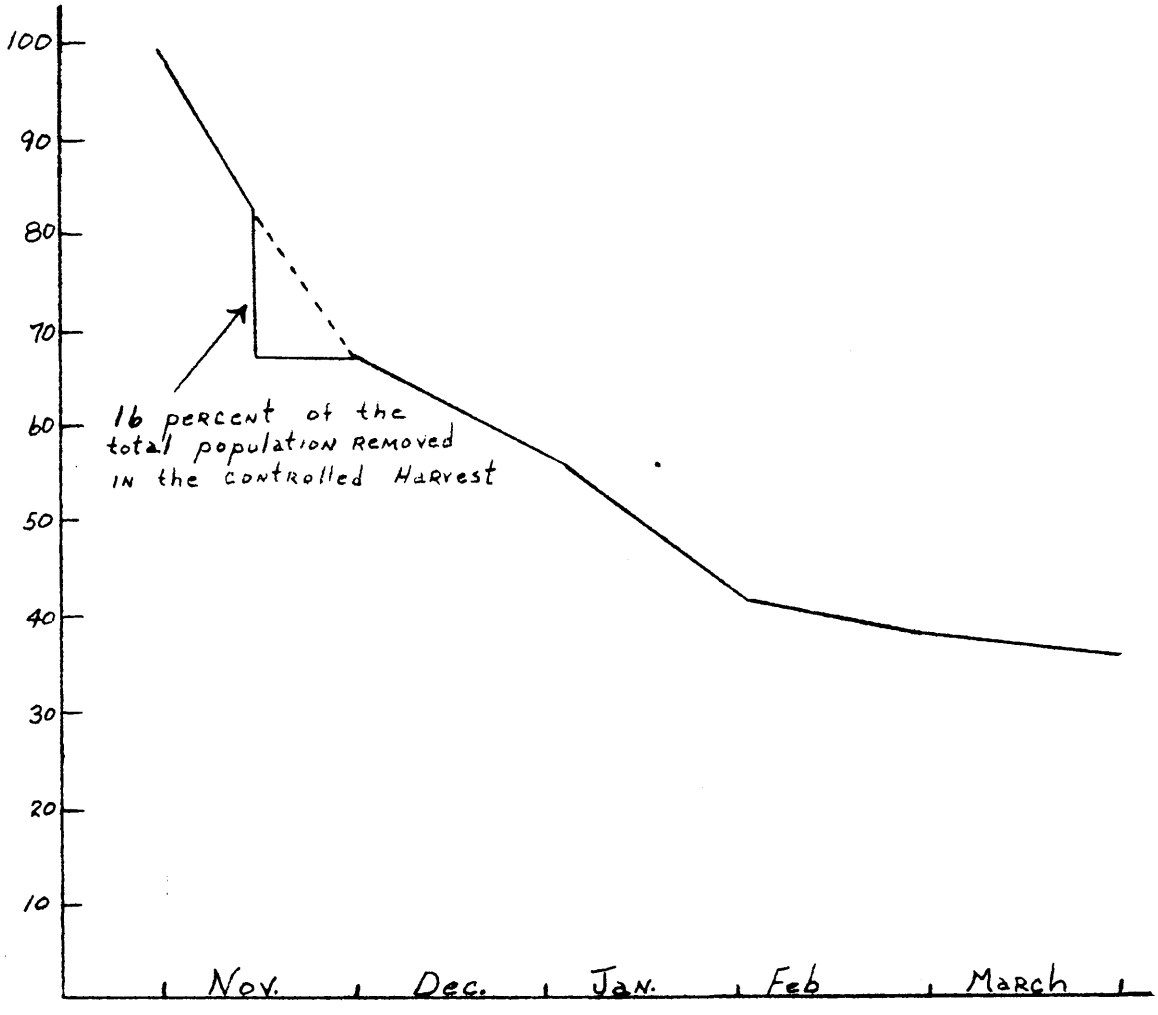


Figure 9. Overwinter survival of 19 coveys (279 total) of quail on the V.P.I. College Farms, November, 1951 through March, 1952.



population can be removed without ultimately affecting the general trend of the population curve.

The trend of the population curve also indicates that as the season progresses, the segment of the population which can be safely removed becomes progressively smaller. This fact supports the theory of early November quail seasons.

Comparison of the over-winter survival of the coveys which were chosen for harvest and the control group from which none of the birds were removed indicates that in each instance, over-winter survival of the coveys from which birds were removed by shooting had the highest percentage of survival. If these data are valid, they would then indicate that the over-winter survival of the population is benefited by shooting. However, it would be desirable to apply a statistical analysis to these small samples to determine the significance of the percentage of change.

Table 10. The influence of harvesting 31 per cent of the quail population on over-winter survival, V.P.I. Farms, 1950-51. (Mosby, 1950).

Harvested Segment Nov. 1, 1950 Population	No. Quail Removed Nov. 1, 1950	April 1, 1951 Population	Per Cent Over-Winter Survival
79 (6 coveys)	24 (31 %)	29	37 %
Control Segment			
172 (13 coveys)	0	54	31 %

Table 11. Results of the 1951 fall quail harvest, V. P. I. Farms

Covey	Size	No. Birds Harvested	No. Remaining in Covey after Harvest	No. Remaining in Covey Jan. 1, 1952
II	12	6	6	6
III	15	6	7	7
V & VI	21	5	6	6
X	19	5	7	6
XIII	17	5	12	9
XV	17	8	9	8
XVII	16	8	7	7
Total	117	43	54	49

TRAPPING AND BANDING

Trapping on the V.P.I. College Farms during previous years has been winter trapping carried out through fall and winter months with use of the standard Stoddard Covey Trap as described by Stoddard (1931). The Florida Collaspible Trap was used on the area for the first time during the fall and winter of 1951-52 in conjunction with the standard Stoddard Covey Trap. During the summer months of 1951, a summer trapping program was undertaken with standard Stoddard Coveys modified for "hen and cock" trapping.

Summer Trapping

In an attempt to determine the apparent loss of quail during the fall shuffle and also to obtain data on covey movements, mobility and intercovey shuffling, movements of cocks on breeding grounds and the eventual movement of cock birds to coveys, a summer trapping program was undertaken.

Methods

Quail are always difficult to trap and practically impossible to take during the summer from baited positions. In order to have sufficient marked quail for the fall and winter study, it was desirable to trap as many quail as feasible during the spring and summer. The Stoddard Hen and Cock Trap had been successfully used on a number of areas, so it was decided that hen-cock traps be tried on this study area. The trapping device was used primarily for three reasons: (1) to test the success of the hen-cock trap on an area supporting a moderate quail population-one quail per nine acres, (2) to attempt to modify the standard Stoddard Covey Trap to this trapping method, thereby creating

a dual purpose trap that could be used inter-changebly with little conversion trouble, and (3) to mark birds just prior to the fall shuffle.

The standard covey trap was modified by placing a one foot square compartment inside the trap and then lacing this compartment to the top of the trap with light steel trolling wire, which could be easily removed. This provided an isolated compartment in which pen-reared unmated hen birds could be placed for "bait". The compartment also created a passageway through which one or more trapped cock birds could move around after entering the trap.

Twenty unmated, pen-reared hen quail were secured from a commerical quail farm to be used as whitling hens to "bait" unmated cock birds. It was found that most of the bait hens called best after the first day in the traps and over 70 per cent of the trapped cocks were taken on the third day. For this reason, bait birds were left in the traps for a period of five days before being removed for a five day rest. Food and water were available to the bait hen at all times.

The traps were checked twice daily, morning and at dusk in the evening. It was found that a late check about 10-12 A.M. on the morning trips produced better results, as early checks scared away hesitant cocks that had not entered the trap.

These traps were usually placed on the fringe of underbrush and dried grass was placed on the trap to shade the bait bird and also to make it less conspicious to avian predators that may prey on cock birds that come to the trap, but had not entered.

Loss of Bait Birds

A normal loss of bait birds is expected in any trapping program which requires that birds be closely confined, with little room for normal movements. The bait birds were placed in compartments 10 inches in height and remained in this compartment from five to six days, varying with success of the trap. Losses of bait birds was due to four causes (1) predation (2) weather (3) handling (4) miscellaneous.

Seven bait hens were lost through predation, four losses were caused by foxes and three by weasels. The biat hens killed by weasels were left in the compartments in all three instances. Little trap disturbance could be found. The weasels apparently entered the trap through the confusion or funnel entrance and dug a very small hole under the wire of the hen's compartment. Examination of all three of these birds revealed small punctures in the head and neck region, several of which punctured the brain case causing a cerebral hemorrage.

The fox kills revealed noticeable trap disturbance and fresh fox scats with quail remains were found near the vicinity of the trap. The fox squeezed into the trap entrance and by battering the compartment, managed to release the bait hen into the main part of the trap. Much pawing and the abundance of torn out feathers indicated that it usually took some time for the fox to make the kill. Fox hair was found in all four of these traps. It is interesting to note that after steel traps were placed at the traps, that two dogs and one skunk were taken.

Weather accounted for two hens. These birds died as the result of a heavy rain and hail storm that occurred one evening. The birds were

found dead the following morning. Examination showed no external marks, no internal disturbances could be found, however, the feathers and down were still wet. It is believed that the inability of movement caused death by exposure.

Two birds were lost through handling. These birds escaped while being removed from the trap release door.

Three birds were lost through miscellaneous means. One bird apparently died a natural death, as autopsy revealed nothing. Two were released by persons trespassing on the area. In one instance the trap was stolen.

Use of the "Wint" Bow Tie for Marking

Some method was needed to mark the birds in such a manner that the birds could be distinguished when put to wing. No paint or "dope" applied to the feathers during the mating season could be used since any such marking would be lost when the old set of feathers was replaced in early fall.

The "bow tie" marking system as described by Wint (1951) had been used successfully on Ring-neck pheasants and quail on several areas. This method was adopted with several modifications.

The "bow tie" was constructed of a heavy plastic material secured from the Montgomery Ward Company, 1949-50 catalogue No. 71B7830L, listed as artifical leather plastic upholstery, at $1.40 per yard , 54 inches wise, weight listed one pound and two ounces per yard. This material was available in ivory, red, blue, green, yellow, white, and brown. Only red, white and yellow materials were used for "bow ties", these

three being the most easily recognized at long distances. The bow tie was cut to the following dimensions; three-quarters inch wide and three inches long. Two small holes were punched in the center of the tie with a leather punch.

A surgical skin clamp (no. 16 Michell Wound Clip), secured from any surgical supply house, was inserted through the two holes punched in the "bow tie" and used to attach the "bow tie" to the bird. attachment of the "bow tie" to quail is most easily accomplished by two men, While one man held the bird, the other grasped the loose skin at the nape of the neck, and holding the "bow tie", grasp the wound clip between his thumb and index finger, pinched the would clip together through the loose neck skin. It is very important that the points on the wound clip be against opposite sides when pinched to prevent loss of the marker.

The piercing of the skin did not seem to affect the bird adversely in any way. On most of the birds, the head of the wound clip pierced the skin making a hole which allowed the clip to swing on a pivot. This injury healed and formed a flap of loose skin like the handle of a cup. Birds tagged with the "bow tie" were observed to preen the "bow tie" as if part of their feathers. All "bow ties" were attached in the field at the trap site, thereby eliminating any undue handling of the birds which might have had an adverse effect.

In addition, all birds were tagged with a metal leg band bearing a recorded number which asked that the band be returned to the Virginia Game Department, Richmond, Virginia.

Results

The summer trapping program was a decided success. Nineteen unmated cock birds were taken. In every area that a whistling bird was heard, he was trapped. It is believed that all of the unmated cock birds in the summer were trapped and tagged. Much information pertaining to breeding grounds, summer sex ratios, and movements were the result of summer trapping and have been discussed under other sections.

Conclusions

The hen and cock trapping technique should operate successfully on any area where a moderate quail population exists. Experience gained in operation of this trapping program indicates that it is possible to take a larger segment of the unmated male population. The program can be operated with a minimum of expense and proved not too demanding of the workers time once it was in operation. In view of the fact that two cock birds mated after trapping, it seems advisable to begin trapping operations early in the nesting season.

Winter Trapping

Trapping through the winter months on the V.P.I. Farms did not prove too successful due to the lack of favorable winter trapping weather. Both the standard Stoddard Covey Trap and the Florida Collapsible Trap were used.

Methods

A detailed description of the operation and baiting of the standard Stoddard Covey Trap is presented by Gehrken (1948), therefore, it seems unnecessary to undertake a discussion of this trapping technique.

Ten Florida Collapsible Traps were constructed and used for both quail and dove projects. This trap was used in conjunction with the Stoddard Covey Trap on the study area. Traps were rotated in an effort to determine which was best suited to the area. In some cases, these two traps were alternated at bait positions in an effort to take birds. All bait positions were treated alike and the same type of bait, shelled corn, was used for both traps.

Results

The fall and winter trapping program was begun on September 24, 1951. The birds were reluctant to use bait spots to any degree, at least not regularly enough to permit placing of traps at the bait spots, due to the unusually mild winter experienced during the trapping period. Only seven days of snow presented the ideal conditions needed for winter trapping.

Past experience has borne out that winter trapping from bait positions gives very poor if any results except during those periods when inclement weather severely limits the available food.

During the study 13 quail were trapped and handled by use of standard Stoddard Covey Traps. Birds were banded with numbered, metal leg bands, the numbers of these bands being recorded for future reference.

The Florida Collapsible Quail Trap was used extensively until it was discovered that the birds were entering the trap, but were then escaping back through the trap entrance. The trap entrances were slightly modified by several methods in an attempt to prevent loss of the trapped

birds. None of the trap entrane modifications were successful and the birds continued to escape. It is highly probable that the techniques employed by this worker were not ideal for this type of trap. It is interesting to note that 11 birds were taken in the Stoddard traps shortly after the failure of the Florida traps to take quail at the same bait positions.

ANALYSIS OF SEX AND AGE RATIO DATA

The analysis of open season sex and age ratio data provides the game manager an opportunity to make estimates of a number of population conditions occurring from season to season. These conditions include such population characteristics as, rearing success, juvenile mortality, adult breeding season mortality, peaks of breeding and nesting and general population mortality rates.

It may not prove practical or desirable to attempt to estimate the value of all the above mentioned factors, for a large degree of success in estimating these factors will depend on the size of the population sample and the period of the season during which it is taken.

Petrides (1949) states that, "in collecting sex and age ratio information, it must be recognized that observed ratios are not always necessarily true ratios. Bag ratios of hunted or trapped specimens, in particular, may or may not reflect the conditions prevalent in the population".

A complete analysis of sex and age ratio data in relation to the population was not undertaken in this study. The apparent tendency of the V. P. I. Farms quail population to react differently from other quail populations, coupled with the small population samples makes analysis of these data rather difficult.

Methods

A detailed discussion of the methods used in determining sex and age ratio was presented by Overton (1950) and the writer does not deem it necessary to repeat the discussion of the techniques employed.

However, these techniques will be briefly mentioned so the reader will be familiar with the method used in each phase.

Age determination was based on the molt characteristics of the species as worked out by Petrides and Nestler (1943). The difference between the adult primaries and coverts and the juvenile primaries and coverts furnish the index for age determination.

Age in weeks was determined by the progress of the wing molt. The molt is complete at approximately 21 weeks, beyond which no age determination can be made.

Determination of sex in adult quail is rather exact as they are dimorphic. The juvenile birds did prove confusing if collected before the post-juvenile molt was complete.

Results

Sex and age ratio data are available for a total of 345 trapped and shot quail on the V. P. I. Farms over a period of five years. Of necessity, most of these yearly samples were small, and even though the sample of 345 birds appears to be a sufficiently large one, it represents only a 27 per cent sample of the early fall population for these five years.

The sex ratios of the V. P. I. Farms quail samples are compared in Table 12 with the ratios found by Leopold (1945) in Missouri and a sample taken from the Piedmont, Virginia in 1951.

Table 12. Sex ratios of the quail from the 1951 fall quail harvest and the Piedmont of Virginia are compared with data taken from the spring-fall census of the V.P.I. Farms (1937-1950) and with ratios found in Missouri by Leopold (1945).

Location	Method of Collection	Size of Sample	Sex Ratios (M:100 Females) Adult	Juvenile	Total
V.P.I. Farms (1951 harvest)	Shot	43	136	222	186
Piedmont Area (Va.)	Shot	34	172	118	126
Missouri	Shot	1,633	161	102	106
Missouri	Shot	23,819	-	-	106
VPI Farms (1937-50)	Shot & Trapped	302	205	136	147

Table 13. Age ratios found on the V.P.I. Farms as compared to ratios found by Leopold (1945) in Missouri

Location	Method of Collection	Size of Sample	Percentage of Total Juvenile	Adult
V.P.I. Farms	shot	100	74	26
V.P.I. Farms	trapped	257	80	20
V.P.I. Farms	total	357	77	23
Missouri	shot	1,633	77	23
Missouri	shot	6,067	83	17

As previously stated, all of the V.P.I. Farms quail samples are small, as well as the sample taken from Piedmont, Virginia, and for this reason, they were compared with a larger sample taken from Missouri.

Examination of the V.P.I. quail sex ratio data reveals that there is an unaccountable preponderance of males present in each annual population. The preponderance of males was most pronounced in the juvenile segment of the population which is unexplainable; however,

Overton (1950) found the preponderance of males most prominent in the shot sample where the ratio was 550 males to 100 females. A possible explanation of sex ratios showing such a great difference is that the samples were too small and were not representative of the true sex ratio of the population. As most of the trapping occurred during the late winter and early spring, there is a possibility that the differential mortality acting against the females (Latham, 1947) may have caused the preponderance of males in this segment of the population. Or, perhaps, the preponderance may be due in some way to the high post-nesting mortality as determined by Overton (1950) and sustanated by the data found during the present study.

The age ratios of the V.P.I. Farms quail (Table 13) more nearly resembled those found in Missouri and in other areas having large representative samples.

These data seem to indicate that juvenile quail comprise approximately 80 per cent of the total fall population in both Virginia and Missouri and that this segment of the population comprises the normal increase each year.

The age in weeks of the 29 juvenile quail collected on the V.P.I. Farms during the harvest of 1951 was estimated by the method described by Petrides and Nestler (1943). From this information and the known date of kill, the approximate date of hatching was determined and graphed in Figure 4. Overton (1950) found that only 33 per cent of the quail were hatched prior to July 31 which was considered the mid-point of the nesting season. Analysis of the 29 juvenile quail collected

during the harvest of 1952 indicated that 69 per cent of the quail were hatched prior to July 31 and that a sample of 34 juvenile quail taken from Piedmont, Virginia in 1952 had hatched 100 per cent prior to this date. It is interesting to note that during the season in which Overton found only 33 per cent of the birds hatching prior to July 31, he also found that of 313 juvenile birds examined from 12 Southeastern Virginia counties, only 67 per cent of these birds hatched prior to the established mid-point of the nesting season. These data would seem to indicate that intensive farming practices on the V.P.I. Farms may result in a high percentage of first nesting failures or that weather may also cause variations in the hatching dates.

Average brood size during the annual harvest was determined through use of the available hatching dates. Records were kept of each quail collected, the covey it was removed from and the date taken during the harvest. Discussion of average brood size may be found under the section "Post-Nesting Mortality".

Conclusions

It is apparent that the small samples on the V.P.I. Farms quail population are a handicap in the analysis of the sex and age ratio data. These data would certainly be more valid if statistical treatments could be applied to determine the degree of possible error. The use of statistical treatments might also possibly reveal that V.P.I. sex and age ratio would more closely resemble those of the large Missouri samples.

While it is believed that the intensive farming practices on the V.P.I. Farms account for the preponderance of males in the population,

they are still partly unexplained, for the juvenile segment of the population approaches a figure beyond conception.

The wide variation in the hatching dates of quail on the study area indicates that intensive farming practices and close grazing cause a high percentage of re-nesting.

Analysis of the sex ratio data and the brood size estimated by the juvenile: adult female ratio warrant the conclusion that a high post-nesting mortality does occur on the study area.

Analysis of available sex and age ratio data seem to strongly indicate that the intensive farming practices and the high degree of pasture manipulation for grazing are the limiting factors of the quail population on the V.P.I. Study Area. It is also believed that the tendency toward a high degree of land management, coupled with small population samples, are responsible for the great difference of the V.P.I. quail sex and age ratio data as compared with more adequate samples.

HABITAT STUDY

Quantitative studies of quail habitat have fallen far behind the rapidly advancing qualitative techniques. Field evaluation of quail habitat through the use of quadrat plots and cover density measurements are at best difficult and the information gained is often scant in comparison to the amount of time which these techniques consume in the field. The attempt of numerous workers to evolve a system of numerical evaluation has been largely unsuccessful.

Classroom activity and the numerous other aspects of the quail population study heavily taxed all available field time; therefore, little time was consumed in the use and study of quadrat plots and cover density measurements. The small amount of time spent with the use of these techniques and the scant information which was gained does not seem worthy of discussion under this section.

Cover Mapping

The V.P.I. Farms were cover mapped during the summer and again in the fall of 1952. The various land uses and crops were plotted on a map which had been reduced from an aerial photograph. Since the scale of the map was only one inch to 1750 feet, both accuracy and detail were limited.

The field map was broken into the same classifications as used by Overton (1950) and plotted on separate maps. Detailed discussions of land classification and use of the land classification maps are presented by Overton (1950).

Cover maps proved quite helpful during the period of the fall and

winter census and their use can save one much time while doing routine censusing. The cover maps also proved quite helpful in predicting and following the individual covey shuffling.

Food Habits

Food taken from 32 quail crops in November, 1951 were analyzed to determine the major foods of the quail on the study area. The tabular results of this crop analysis may be found in Table 14. Of a total of 43 quail harvested in the fall, 11 or 25 per cent of them were found to be empty.

Two methods were used to analyze the quail crops and were as follows:

1. Each item was measured by volume for each individual crop and the data were tabulated on an individual file card.
2. Each crop was examined separately, but without a volumetric measurement for each crop. The various food items in each were separated and listed, following which identical items of food for the entire group of crops was combined as a unit. A volumetric measurement of the aggregate of each food item for the entire group of crops was then made.

The techniques employed are rather slow and at times difficult because of the number of small measurements involved; however, it does have the advantage of supplying detailed information for each crop.

The food habits of the quail taken during the 1951 harvest reveal that there were five major foods: Zea mays (39.5 per cent), Glycine max (16.2 per cent), Ambrosia artimisiifolia (15.9 per cent), Triticum aestivum (5.6 per cent) and Persicaria (3.7 per cent).

Table 14. Food taken by 32 quail collected on the V.P.I. College Farms in November, 1951

Food Item	Volume		Occurrence	
	No.cc	%	No.	%
Plant:				
Zea mays, corn	38.1	39.5	8	25
Glycine max, soybean	15.7	16.2	5	15
Ambrosia artisimifolia,ragweed	15.7	15.9	14	44
Triticum aestivum, wheat	5.4	5.6	4	12
Persicaria, smartweed	3.6	3.7	4	12
Solanum nigrum, deadly nightshade	3.1	3.2	8	25
Cornus florida, dogwood	3.0	3.1	2	6
Lespedeza bicolor,bicolor lespedeza	2.2	2.3	3	9
Vigna sinensis, cowpeas	1.8	1.9	5	15
Stellaria media, chickweed	1.6	1.6	3	9
Panicum spp. panic, grass	1.1	1.1	5	15
Ambrosia trifida, great ragweed	0.7	0.7	3	9
Solanum carolininse,horse nettle	0.6	0.6	3	12
Chenopodum album, lambsquarters	0.5	0.5	2	6
Quercus alba, white oak	0.1	0.1	1	3
Pinus virginiana, Virginia pine	trace)		1	3
Medicago sativa, alfalfa leaves	trace)		5	15
Desmodium spp, beggar's lice	trace)	0.4	2	6
Bidens spp, bur marigold	trace)		2	6
Digitaria sp, crab grass	trace)		2	6
Animal :				
grasshopper	2.1	2.2	3	9
cricket	1.4	1.4	3	9
leaf hopper	trace		1	3
Total	96.4	1100.0	90	100

The results of these data indicate that the most important foods for this season were cultivated crops and typical cropland weeds. Of second importance are the weed crops of ungrazed woodlots. It is interesting to note that various workers on this study area have found the reverse to be true; namely, that ungrazed woodlots were of major importance in producing quail foods. This factor can probably be explained by the great increase of intensive cropping of the area, also the increased number of woodlots that are at present being grazed.

Predation

Only 12 cases of predation were found during the course of the study. Of these 12 cases, four were attributed to fox and eight to avian predators.

Avian kills on the study area have been consistently higher than fox throughout the course of study, even though the area carried an extremely high fox population.

Swink (1951) working on the V.P.I. Farms examined 405 red fox fecal passages and found only one case of quail predation. It should be stated; however, that three bait hen quail were lost in traps which did not show up in the analysis of the collected fox fecal passages. A total of 42 fox stomachs from other areas, were examined by Swink and no quail remains were found.

These data would seem to indicate that while the study area did support a high red fox population, estimate of about 50 foxes during the early summer of 1952, the fox is not a serious quail predator on this area.

METHODS OF ESTIMATING POPULATIONS

An integral part of game management is an accurate determination of the size of game populations during different seasons of the year. The ability to determine accurately the size of the population in advance to the different life cycles that a population must pass through annually would be of great value to the game manager, for with this information he would be able to apply the proper game management technique well in advance of any crisis. As long as game managers are forced to set open seasons and bag limits well in advance to the hunting season, they must be able to estimate accurately population sizes in order to set these seasons and bag limits wisely.

Two methods of estimating quail populations were attempted during this study. Before drawing any conclusions from these two population estimate attempts, it would be wise to consider that these two techniques have been tested for a period of only one year. It is believed that the minimum testing on any such technique would be a period of at least five years. If these two techniques are to become accurate methods of quail population estimates, then surely, through the process of testing, they will undergo a number of changes. These methods and the figures derived from them are presented in hope that someone will, through additional testing and changes, find them accurate methods of estimating quail populations.

Estimate of the Spring Population By Use of the Roadside Whistle Count

Methods. Stoddard (1931) noted that: ".... most of the bob-white calls of any definite area are issued largely from certain well defined points, and that the notes of many individual cocks could be recognized by some slight differences in quality, facts indicating that the volume of bob-white calls came from the comparatively few individuals that whistled at intervals throughout the day. The number of whistlers also just about fitted the known surplus of cocks; not the cock population as a whole."

In hope that an index to quail abundance could be found, the roadside whistle count was begun on July 27 and continued through August of 1951.

Bennitt (1951) found that most calling was done the first half hour before sunrise and from that period until nine A.M. the calls began to fall off. Any period after nine A.M. in the morning is not suitable for roadside whistle counts as quail calling has dropped off to the point that accurate call figures can not be obtained. Bennitt also found that during the operation of roadside whistle counts the quail calls were audible for a radius of one half mile. Thus in order that overlapping of quail calls be prevented, the call stations must be slightly over one half mile radius apart.

Quail whistle counts were taken from county secondary roads surrounding the study area and from well traveled farm roads. In

order to get complete coverage of the study area, 13 listening stations were set up. The counts were run on Tuesday and Thursday of each week and were begun each morning at six A.M., for a period of six weeks. Five minutes were spent listening at each station, then the observer drove to the next listening station. The same route must be run each trip and the stations visited in the same sequence. At the end of the whistle count route, the pertinent weather data were recorded. It was found that more whistles were recorded during clear weather than in cloudy or overcast weather.

Results

The total number of whistling birds on the area was averaged at the end of this study. This figure revealed that there was an average of 14 unmated cock birds on the area during this period. This apparently was not too far off for a total of 19 cocks assumed unmated which were trapped prior to the study; two were observed to become mated, thus the assumed unmated cock population from trapping was 17 birds.

Estimate of the probable quail population present on the V. P. I. Farms was made with the following formula and under these assumptions: (1) an approximate spring population of 88 birds as determined by field censuses as of April 15,1951, (2) a whistle count of 14 unmated cock quail, and (3) that the population of an area may be determined by the following formula :

$$\frac{\text{No. of Whistling Males} \times 100}{\text{Difference in sex ratio based on population of 100}} = \text{Estimated spring population of quail}$$

Applying the date collected from the whistle count survey, one would get the following estimate if average (normal) sex ratio of 55 males : 45 females were used :

Example 1. $\frac{14 \times 100}{55 - 45} = 140$ quail

Applying the data collected of 14 unmated cocks to the same formula and using the sex ratio, calculated from existing data, found on the College Farms, 147 males : 100 females or 59.5 males:40.5 females, one would get the following estimate:

Example 2. $\frac{14 \times 100}{59.5 - 40.5} = 74$ quail

Results

If the spring population of the area is assumed to be approximately 88 quail, the estimated population calculation of Example 1 is 59 per cent greater than the actual population and the estimated population as calculated by Example 2 is 16 per cent lower than the actual population.

From these two examples, it would appear that it is possible to calculate the breeding population of quail on an area with reasonable accuracy if the sex ratio of the area is known, but the average data for the normal sex ratio may give unreasonable estimates.

Estimate of the Spring Population by Use of the Figures for Spring to Fall Population Increases

Methods. Estimate of the 1951 fall quail population was made from past data on the spring-fall rate of increase of the quail population,

V. P. I. Farms. Data are available (Mosby 1950) for spring to fall increase in the quail population on the area for the three years, 1947, 1948 and 1949. Less accurate data are available for the spring-fall increase for the two years 1936 and 1937. An estimate of 81 quail was made for the spring population in 1950. A graph of the spring population and rate of spring to fall increase was drawn up, (the fall population figures were then placed on a graph) as shown in Figure 10. When the spring population of 1951 (88 birds) was placed on this graph, the prediction for the fall of 1951 was 235 birds.

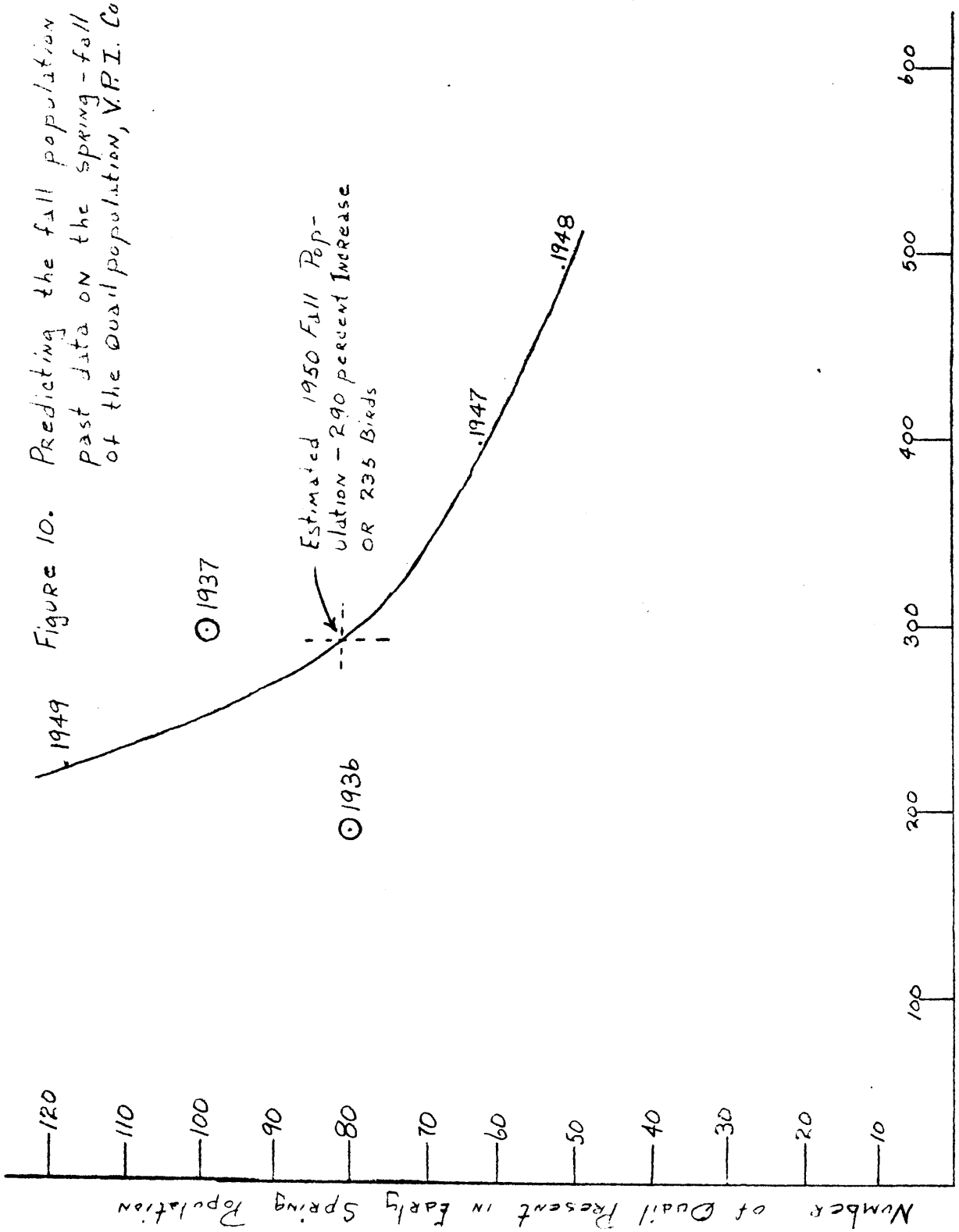
Results

The estimate of the 1951 fall quail population taken from the plotted graph in Figure 10 was 235 birds. Since the actual fall population known to be on the area was 279 quail, the estimate of 236 birds was 15.4 per cent lower than the actual population.

After attempting to estimate the fall quail population by use of a graph showing spring populations and rate of spring-fall increase, another method of estimating the fall quail population was tried to determine if there was any correlation between the two population estimate methods using rate of spring-fall population increase figures.

The second prediction was determined by the average spring fall population increase per bird. The average population increase per bird would be 3.8 per cent. When this figure was multiplied by the known spring population of 1951, the population prediction was

Figure 10. Predicting the fall population from past data on the spring - fall increase of the Quail population, V.P.I. College Farms.



the following fall was 334 birds. Since the known fall population was 279 birds, the estimate of 334 birds was 19.7 per cent greater than the actual population, thereby showing that there is definitely no correlation between the two population estimates using spring to fall population increase figures.

Conclusions

Actually , no concrete conclusions may be drawn from the methods of estimating spring and fall populations on the grounds that estimates of population by use of these methods were made for only one year. It is believed that a minimum of five years of testing these methods of estimating fall and spring population would be required before valid conclusions could be made.

The methods of population estimates employed and the figures derived from them appear only to be indicators of the future success of these techniques after they have been put through testing. However, for use of this study, certain conclusions in the form of indicators will be made.

In attempting to estimate the spring population on an area through use of the roadside whistle count, it would appear that it is possible to calculate the breeding population of quail with reasonable accuracy if the sex ratio of the area is known, but average data for the sex ratio may give unreasonable estimates. The roadside whistle count estimate would be much more useful if accurate sex ratios taken from other areas could be used. As pointed out in the results of the road-

side whistle count estimate, the use of average sex ratio figures gave an unreasonable estimate when applied to the V.P.I. College Farms.

Since quail population fluctuations on the V.P.I. Farms show numerous tendencies to react differently from other normal population studies completed on other areas, it was believed that the varied population reactions may have distorted the results of the spring population estimate. However, the fact that the V.P.I. Farms does show a preponderance of males should be considered for it is reasonable to believe a preponderance of males would place the estimate above the actual population, but this was not the case. The average quail cock:hen ratio having fewer cocks in the spring population gave an estimate 38 per cent greater than the actual population, while the cock: hen ratio on the study area having a preponderance of males gave an estimate slightly lower than the actual spring population. It is evident from these data that the roadside whistle count technique for estimating spring quail population possibly needs certain modifications and more thorough testing.

The technique of estimating fall quail population by use of spring population figures and the rate of spring to fall population increase from a plotted graph gave an estimate 15.4 per cent lower than the actual population present on the study area. An error of 15 per cent does not represent a figure which will approach the accuracy needed to determine population present on either small or large areas. However, several factors in the method of population estimate should be considered.

The data for the 1936-37 rate of spring to fall increase is generally considered to be inaccurate, but had to be used in order to get a sufficient population curve on the plotted graph. The spring population of 1940 was not thoroughly censussed, but an estimate of the spring population was made in order that a spring-to-fall population increase figure would be available for the 1950 population. Surely the inaccuracy of a large part of the population data affected the population estimate derived from the data and could have caused the estimate to vary considerably in accuracy.

Needless to say, the technique employed in estimating the fall population needed more accurate figures and thorough testing. It is believed that this technique does possess certain potentials for estimating fall population which could come to light with more intensive work.

LOSSES IN THE EARLY FALL POPULATION

Most concern in quail population losses in previous years has been with losses believed to occur during the critical winter months. Analysis of data taken from the V.P.I. quail population indicates that a sizeable portion of the population losses occurs during the early fall, principally prior to the Virginia hunting season beginning about November 20.

The early fall or November quail losses on the V. P. I. Farms have been compared with carrying capacity of the area and the early spring population in an attempt to find some correlation among these factors. It is regretable that the heavy-fall losses were not discovered in time to attempt some detailed measure of the available early fall foods.

Percentage of Loss for 1951-1952

During the month of November, 1951, a total of 44 quail or 15.8 per cent of the 276 birds present on the study area was lost during the earlier part of the month. This loss in early November prior to the beginning of the controlled harvest reduced the coveys to such an extent that only 43 quail or 36 per cent of the fall population could be safely removed and still not reduce a covey to less than six or eight quail.

During the fall of 1951, the fall shuffle had begun in the month of October and birds had become rather difficult to locate on certain areas during the latter two weeks of October. Covey movements seemed to cease about November fifteenth and the coveys maintained their usual range. During this period, the sharp decrease in number of birds in the coveys became evident. In two coveys the loss amounted to 40 per cent of the covey number while in three other coveys, the loss amounted to 30 per

cent. Losses occurred in a one to two day period. No increase in signs of predation were noted and areas from which the birds were lost were thoroughly covered by trained bird dogs and observers. All coveys on the farm had been repeatedly counted; no increase in any of these coveys was found. It is highly improbable that these birds moved off the area for several reasons. First, the adjoining land is heavily grazed and food cover is at a premium. Secondly, some of the areas which might possibly contain a minimum of food and cover to attract quail were covered with dogs and none of the quail were found.

Percentage of Loss for Preceding Years

Available data on the losses which have been observed during November for the five years, 1947 through 1952, indicate that a rather sizeable portion of the quail population is lost during the month of November. Table 15.presents the available data on these losses.

It will be noted that the quail harvests removed some 89 quail in November during three of these five years of the controlled harvest. A total of 381 quail, including the 89 removed by shooting, were lost during the month of November; this number represents some 30 per cent of the total 1,269 quail known to be present in early November during this five year period. The quail taken during the controlled harvest amounted to only seven per cent of the total population, whereas some 23 per cent of the total November quail were lost to what has to be attributed to natural causes.

Relationship to Carrying Capacity of the Area

Analysis of the data found in Table 15 reveal that approximately 30 per cent of the total population is lost regardless of whether the population reaches a figure beyond the theoretical carrying capacity or falls slightly below. During the years of 1947 and 1948 there was no controlled harvest, yet the November loss was 25 per cent and 32 per cent of the total population, respectively.

From these figures it would seem obvious that a large portion of the early fall quail population on the V.P.I. Farms will be lost annually and that the birds removed each year during the controlled harvest would have been lost to other natural causes. Apparently there is some mechanism operating against the V.P.I. quail population if the theoretical carrying capacity of the area is valid; this mechanism could well be the scarce food and cover which seem to be well defined even during the early fall.

Table 15. November losses in the V.P.I. College Farm quail population, including quail removed during the controlled harvest experiments, for the five-year period 1947 through 1951.

Year	November Harvest	November Losses	Total Loss	Total Quail
1951	43	44	87	279
1950	22	30	52	248
1949	24	79	103	263
1948	0*	81	81	247
1947	0*	58	58	232
5-year total	89	292	381	1,269
% Total Nov. 1 Quail	7	23	30	100

* Quail harvest made in December

Relation to Spring Population

Data taken from Table 15 on the total early fall quail population and from Figure 3 on the percentage of summer increase indicate that there is no correlation between the early fall losses and the spring population. It is conceivable that during the years of a high summer increase resulting in a maximum fall population, would overload the range and result in heavy early fall losses due to over-population; however, such is not the case with the V.P.I. quail population.

Conclusion

The data presented indicate that a rather sizeable portion of the early fall population on the V.P.I. Farms is lost each year, principally prior to the Virginia hunting season November 20th. Theoretically, November should be one of the months in the year when food and cover are at a maximum and should be in ample supply to support a very high quail population. Notwithstanding the fact, it is apparent that the quail population suffers a rather considerable loss during this month. It is entirely possible, if the data presented here are valid , that the opening of the hunting season earlier than the latter part of November would permit the removal of a segment of the quail population by sportsmen that would otherwise be lost to normal causes.

It is apparent that the losses of early November are as serious as over-winter loss and certainly should receive as much consideration from research projects and workers.

SUMMARY AND CONCLUSIONS

1. The controlled harvest experiment which was begun in December,1947 and continued through November,1951, showed that conservative shooting merely utilizes a portion of the quail population which would normally be lost to other decimating factors. Apparently , a controlled harvest does not ultimately affect the general trend of the population curve. These studies also indicate that the later the harvest is carried out in the fall, the smaller will be the removable surplus.
2. Data collected from 1947-52 on over-winter survival indicate that a rather sizable proportion of the quail population is lost during the month of November, principally prior to the beginning of the Virginia hunting season November 20th. This November loss of birds averages, for these years, about 30 per cent of the total early fall populations. The controlled harvest accounted for only 7 per cent while over 23 per cent was lost to natural causes. These data also suggest that the carrying capacity of any area is rather well defined even during those periods of the year when both food and cover are apparently in maximum abundance. It is entirely possible, if these data are valid, that the opening of the hunting season earlier than the latter part of November would permit the removal of a segment of the quail population by sportsmen which would otherwise be lost to normal causes.
3. Covey trapping by use of the standard Stoddard Quail Trap in this section of Virginia is feasible only during those periods of the winter when food is least available due to inclement weather.

4. Summer trapping using the Stoddard Quail Trap converted to a hen-and-cock trap produced excellent results. In every area in which a whistling cock was located, he was trapped.

5. Data collected during the summer trapping period seem to indicate that whistling cocks do maintain a definite whistling territory. As far as could be determined from marked birds, 82 per cent of the whistling males remained in their whistling territory. Some random movements were recorded during the latter part of the nesting season.

6. Juvenile quail comprise approximately 80 per cent of the total fall population on the V.P.I. Farms.

7. The fall sex ratio on the V.P.I. Farms shows a high preponderance of males over females. This would indicate that a large number of mature females are lost during or following the nesting season. This theory is also supported by the wide dispersion of hatching dates. In 1951, a very favorable hatching season, only 33 per cent of the quail were hatched prior to July 31, which is considered the mid-point of the hatching season for Virginia. It should be pointed out that the V.P.I. Farms are intensively grazed and cultivated.

8. Two methods of estimating quail populations were developed during this study. The first estimate was obtained from a plotted graph of the spring population and rate of spring-to-fall increase as determined for seven years' previous work on the V.P.I. Farms. This method of population estimation gave a figure lower than the actual population.

   The second population estimate was determined by a roadside whistle count which was begun in July and carried out through August. By determining the average number of whistling cocks on the area and with

the use of the following formula, a population estimate of the early spring population was made:

$$\frac{\text{No. of whistling cocks X 100}}{\text{Difference in sex ratio based on population of 100}} = \text{estimated spring population of quail}$$

This method of population estimate when calculated gave a figure 16 per cent lower than the actual population.

From these data, it would appear that it is possible to calculate the breeding population of quail on an area with reasonable accuracy if the sex ratio of the area is known, but average data for the sex ratio may give unreasonable estimates.

9. The analysis of quail crops from the V.P.I. Farms indicated that the most important quail foods on these farms are produced in cultivated crops and typical cropland weeds. Of second importance were weed crops produced in ungrazed woodlots. It is interesting to note that other workers on this area have found that ungrazed woodlots were of major importance in producing quail foods.

10. Data indicate that there is a high collrelation between spring-to-fall increase and the over-winter survival of quail. A high spring-to-fall increase (generally resulting from a low spring population) usually results in a higher over-winter survival than does a low spring-to-fall increase (which is the case when a high spring population exists on the area).

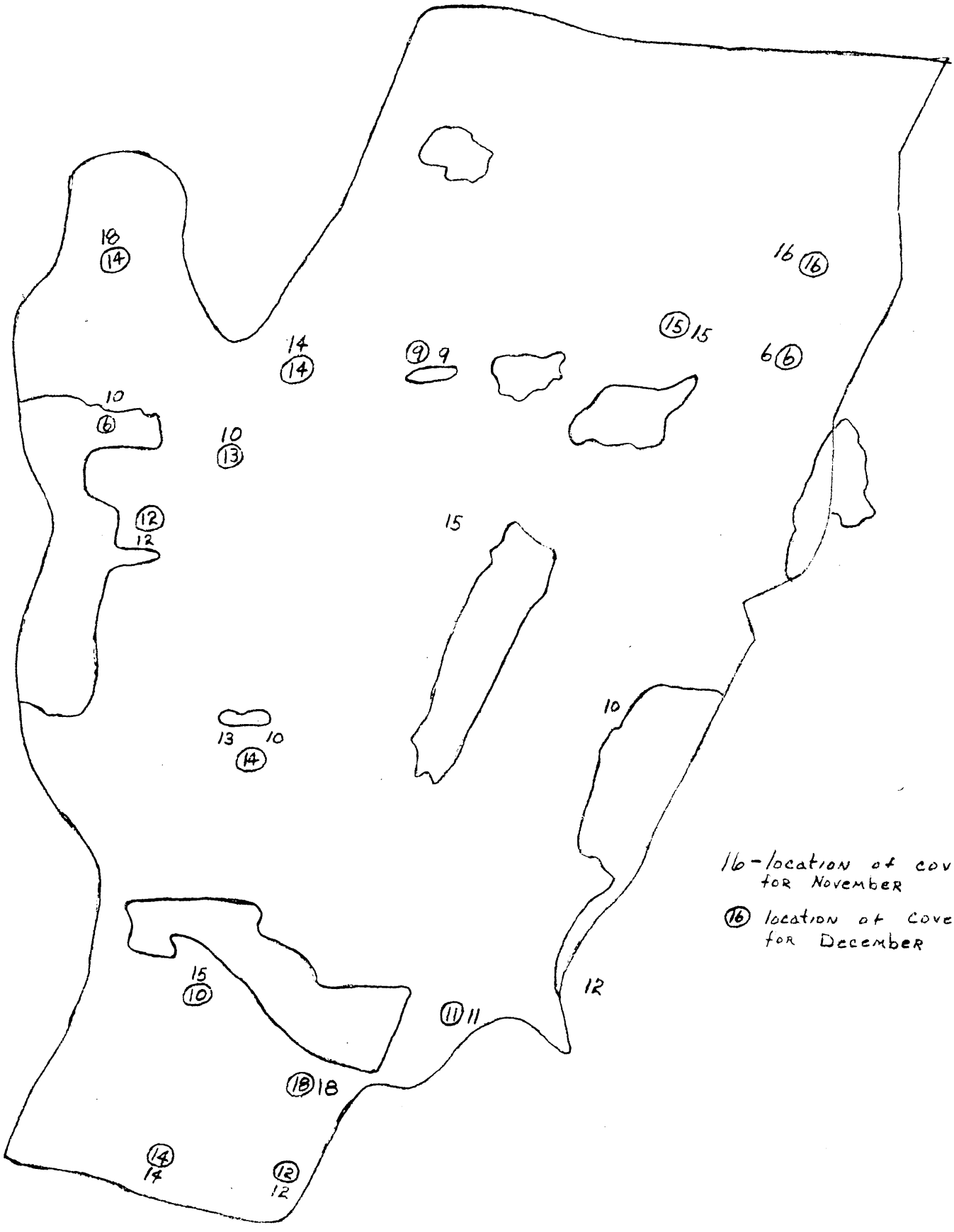
MANAGEMENT RECOMMENDATIONS

The first recommendation that may be made from this investigation is that the Virginia hunting season of November 20 be set back to November first in order to allow the hunters an opportunity to harvest those quail which are normally being lost to other causes during the early fall.

Further research should be made to determine the effect of supplemental quail foods, such as Game Bird Mixture, sericia and bicolor lespedezas upon the early fall quail population. It appears that food plantings which have been designed to produce a habitat supplement during the critical winter months should be modified to also produce a maximum of habitat supplement to the early fall population.

APPENDIX

Figure 11. Locations of coveys for month of November and December 1951, V.P.I. College Farms.

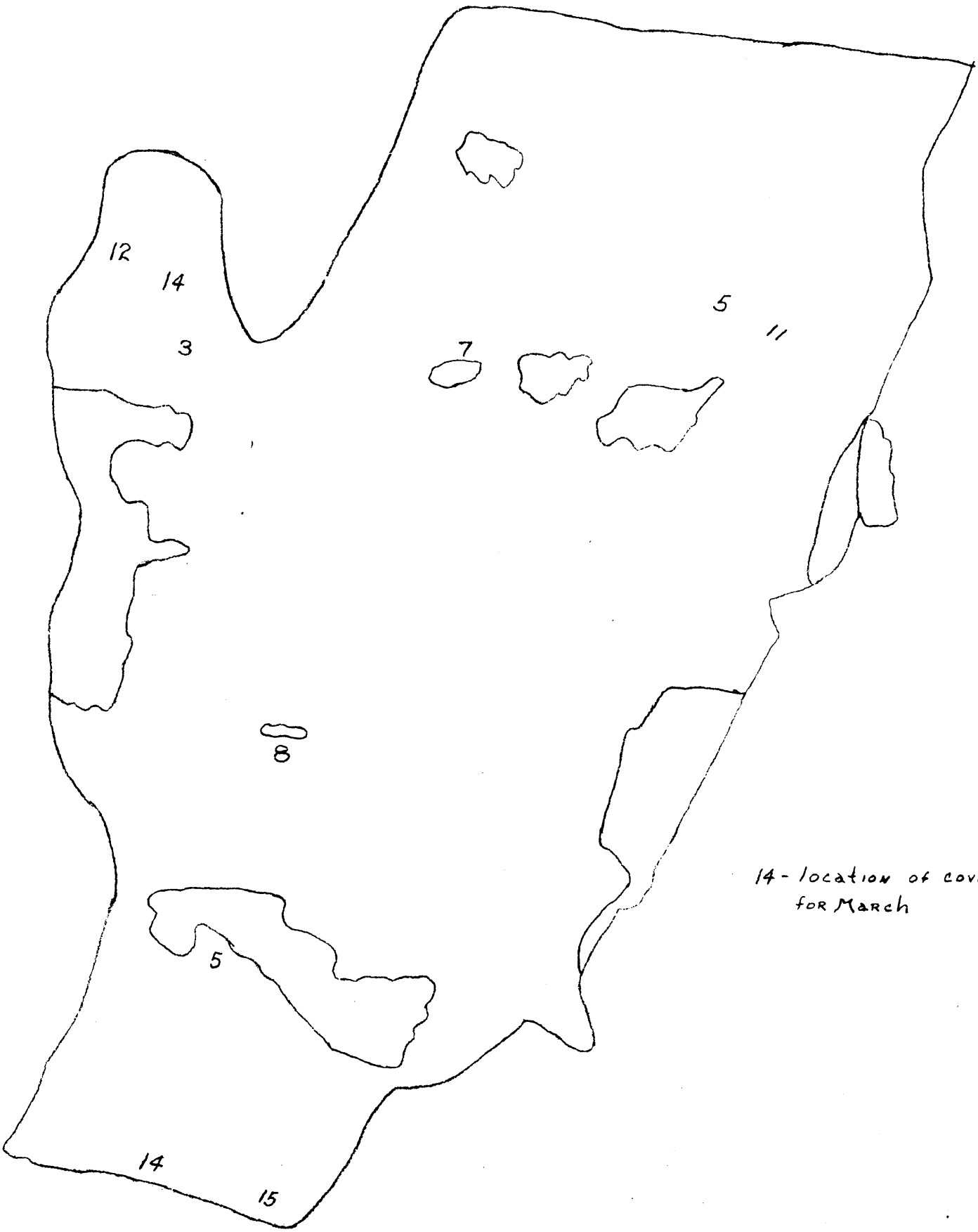


16 - location of coveys for November

(16) location of coveys for December

Figure 12. Locations of coveys for months of January and February 1952, V.P.I. College Farms

Figure 13. Locations of coveys for Months of March, V.P.I. College Farms, 1952.



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