AN ANALYSIS OF VARIATION AMONG PARTICIPANTS IN CROWING-COCK PHEASANTS CENSUSES

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Samuel Morgan Carney

1954

This is to certify that the

thesis entitled

An Analysis of Variation Among Participants in Crowing-Cock Pheasant Censuses

presented by

Samuel Morgan Carney

has been accepted towards fulfillment of the requirements for

M. S. **degree in** Fisheries & Wildlife

Victor D. Tault

Major professor

Date May 21, 1954

AN ANALYSIS OF VARIATION AMONG PARTICIPANTS IN CROWING-COCK PHEASANT CENSUSES

By

SAMUEL MORGAN CARNEY

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

1954

THESIS

ACKNOWLEDGMENTS

The writer is indebted to Dr. G. W. Petrides, who originally conceived the project, and whose summer camp classes of 1952 and 1953 collected much of the data.

Special thanks are due to Dr. D. W. Hayne, who always found time to discuss statistical ramifications pertinent to the problem.

Five graduate students generously gave their time during the spring term of 1953. They are L. H. Blankenship, R. C. Housedorf, D. B. Reid, C. R. Terman, and A. D. Geis, who was also helpful in a number of other ways.

Mr. R. I. Blouch of the Michigan Department of Conservation supplied maps and furnished information on Game Division census methods.

Drs. R. C. Ball and P. I. Tack read and criticized the manuscript. Dr. Tack also acted as advisor in the absence of Dr. Petrides.

Dr. Max Nelson of the Speech and Hearing Clinic gave hearing tests to many of the participants in this study.

Mrs. Henderson, secretary of the Department of Zoology, expedited certain administrative matters pertaining to enrollment that enabled the writer to re-enter school under the G.I. Bill.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

State-wide censusing of the ring-necked pheasant, Phasianus colchicus torquatus, by means of the fall road-side count, was first demonstrated in Iowa by Bennett and Hendrickson (1938). The following year Randall and Bennett (1939) stated they believed the method was also applicable to Pennsylvania conditions. Stiles and Hendrickson (1946) found the method to be satisfactory as an index of population levels over a ten-year period in Iowa. Working in Montana, Fisher et al. (1947) found the road-side count to be statistically weak on a monthly basis and questioned the validity of the method in Pennsylvania. However, Kozicky et al. (1952) presented statistical evidence that the method was valid on a state-wide basis in Iowa. Meanwhile, other workers were working with audio-census methods on spring populations (McClure, 1945). Kimball (1949) perfected the crowing-count census as a reliable technique for determining population trends, distribution, movement, and even spring storm mortality of pheasants. Some of the factors he listed as affecting the accuracy of this type of census are: (1) variation in the ability of individuals to hear cock-calls, (2) daily trend and

duration of maximum cock-crowing, (3) seasonal trend and duration of maximum cock-crowing, (4) uniformity of results, (5) effect of variable factors such as weather and cover upon the count. Kozicky (1952) investigated some effects of weather and also discussed uniformity of results. Thompson and Lemke (1953) dealt with non-randomness of pheasant calls.

This paper is limited entirely to a consideration of the first of Kimball's (op. cit.) factors, variation in the ability of individuals to hear cock-calls. The paper is a brief attempt to explore this variation and some of its causative agents, and to suggest possible methods for decreasing this variation.

The term "cock-crowing count" will be used throughout this paper instead of either "crowing count" or "crowing-cock count" because the writer believes it is the most completely accurate of the three terms.

METHODOLOGY

Field Procedures

All cock-crowing counts used in this study were made on pheasant census routes that had been laid out by the Game Division of the Michigan Department of Conservation, and which were in use annually by members of that agency.

As much as was possible, all of the counts were made following the method of procedure used by the Michigan Game Division. With the exception of the fifth feature listed below, this method closely approximates that recommended by Kimball (op. cit.). It has the following important features:

1. On each route, the counting is started exactly one-half hour before sunrise, and the route is covered as quickly as is possible allowing exactly two minutes for each count.

2. All pheasant cock-crows (two-syllable calls) are counted, but no effort is made to identify individual birds.

3. The count is made from a point 15 to 20 feet distant from the car to avoid any noises from the cooling motor that might alter listening conditions.

4. When the count has been completed at one station, the person counting returns to thecar and drives as rapidly as is possible to the next station and makes his next two-minute count.

5. All individual quail heard whistling and all individual grouse heard drumming are recorded.

6. Any noises which interfere with the count are recorded for those stations where they occur.

7. Counts are not made when the wind velocity is greater than eight miles per hour as determined by the Beaufort wind scale.

All participants in the counting rode together in the same vehicle and made their two-minute counts simultaneously. Each participant very carefully kept his count a secret from his fellow counters. Bovard (1953) demonstrated the importance of secrecy by showing that various social groups making estimates (of a different kind) greatly reduced the dispersion of their estimates after having been informed of their previous estimates and of the group norm on those previous estimates.

Four or five two-minute trial counts were made at the first station on the first day of both the spring-counts and the summer-counts of 1953. These counts were not kept secret because they were intended to demonstrate the method to participants who had no previous counting experience. None of these counts were recorded.

A large number of counts were rejected as not being suitable for analysis chiefly because of poor weather conditions or because the counts obtained were so low that an analysis would have been

meaningless. A number of counting runs over the routes were abortive because weather conditions changed abruptly and adversely during the actual counting run.

Statistical Procedures

All data utilized in this study were subjected to analysis of variance. Independence of the mean was tested by use of Bartlett's Test for Homogeniety of Variance (Snedecor, 1946). A significant Chi-square value was obtained using the original data. Bartlett's Test was repeated using the transformation $\sqrt{x + \frac{1}{2}}$ for each individual observation. This time the Chi-square value was not significant, indicating the mean and the variance were now independent of each other. All analyses of variance were then conducted using this transformation.

ANALYSIS OF 1952 SUMMER CAMP DATA

Differences Among Counts of Observers

As a part of the regular summer camp course given for students majoring in wildlife management at Michigan State College, cock-crowing counts were made during the summer of 1952. Usable data were obtained on four days. The counts were made on three routes by six students and their instructor, Dr. George W. Petrides. The writer was not present. In addition to the cock-crowing counts, all individual bobwhite quail heard whistling and all individual mourning doves heard "cooing" were recorded for those stations where they occurred. There is no record of the amount of previous counting experience that these students had, though it is thought to have varied to a considerable degree. The fact that these counts were not made during the peak of the seasonal pheasant-crowing period is not believed to be of any importance with respect to the variation among individual counts, though it undoubtedly reduced the size of these counts. Whether or not starting the counts approximately one-half hour later in the day than is recommended had any effect is problematical. Later in the day, interference increases

markedly, but interference and its effects on the counts will be taken up later in this paper.

The results of the summer camp counts are summarized in Table 1. There was very little agreement among the counts obtained by the participants. The one day on which no statistical differences appeared was a day on which the average total count was very low with an average of only 34.4 cock-calls being recorded for the entire route.

TABLE 1

RESULTS OF SUMMER CAMP 1952 PHEASANT COUNTS

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
25/June/52	Total	139	47.669		
Route 1	People	6	1.334	0.223	2.3375*
Ingham Co.	Stations	19	35.498	1.8683	19.645**
	People x stations	114	10.837	0.0951	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
26/June/52	Total	139	42.564		
Route 1	People	6	2.158	0.3596	5.49**
Ingham Co.	Stations	19	32.944	1.7339	26.47**
	People x stations	114	7.462	0.0655	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
10/July/52	Total	139	48.000		
Route 2	People	6	3.106	0.5177	7.681**
Lenawee Co.	Stations	19	37.212	1.9585	29.058**
	People x stations	114	7.682	0.0674	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
14/July/52	Total	139	45.800		
Route 3	People	6	0.651	0.109	1.57
Tuscola Co.	Stations	19	37.310	1.963	28.449**
	People x stations	114	7.839	0.069	

ANALYSIS OF DATA, SPRING 1953

Effect of Previous Experience

During the spring term of 1953, six graduate students, including the writer, made counts of pheasant cock-crows over three routes, each of which was run twice. On three of the six days thus represented, only five of the students were present. These counts were started at the recommended daily starting time and were also started during the period of maximum seasonal crowing intensity. However, due to weather conditions and the lack of available personnel, the counts were not concluded until well after the peak of the seasonal crowing intensity. Two of the students counting had considerable previous experience, whereas the other four had none. All record sheets were collected by the writer at the end of each day's count and sealed unread in envelopes. The results of the spring term counts are summarized in Table 2. It can be seen that:

1. Experienced observers obtained higher counts than did inexperienced observers on four of six days.
2. The counts made by experienced observers agreed on five of six days.

TABLE 2

RESULTS OF SPRING TERM 1953 PHEASANT COUNTS

16/April/53
Route 1
Clinton Co.

Source of Variation	DF	Sum of Sq.	Mean Sq.	F
Total	94	114.2995		
People	4	16.2845	4.0711	25.40**
experienced	1	0.4232	0.4232	3.13
inexperienced	2	3.0333	1.5166	7.05**
exp. vs. inexp.	1	12.8280	12.8280	151.63**
Stations	18	86.3128	4.7952	29.91**
Error	72	11.7022	0.1603	
error (exp.)	18	2.4331	0.1352	
error (inexp.)	36	7.7472	0.2152	
error (exp. vs. inexp.)	18	1.5219	0.0846	

21/April/53
Route 1
Clinton Co.

Source of Variation	DF	Sum of Sq.	Mean Sq.	F
Total	113	122.1880		
People	5	20.4959	4.0992	19.05**
experienced	1	2.6368	2.6368	27.10**
inexperienced	3	15.8185	5.2728	23.61**
exp. vs. inexp.	1	2.0406	2.0406	6.61**
Stations	18	82.3264	4.5737	21.25**
Error	90	19.3657	0.2152	
error (exp.)	18	1.7513	0.0973	
error (inexp.)	54	12.0574	0.2233	
error (exp. vs. inexp.)	18	5.5570	0.3087	

TABLE 2 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	113	243.1998		
	People	5	9.7641	1.9528	14.22**
	experienced	1	0.0104	0.0104	n.s.
	inexperienced	3	6.5752	2.1917	15.78**
23/April/53	exp. vs. inexp.	1	3.1785	3.1785	22.32**
Route 2	Stations	18	221.0792	12.2823	89.46**
Ingham Co.	Error	90	12.3565	0.1373	
	error (exp.)	18	2.2947	0.1275	
	error (inexp.)	54	7.4993	0.1389	
	error (exp. vs. inexp.)	18	2.5625	0.1424	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	113	231.9156		
	People	5	12.1457	2.4291	19.49**
	experienced	1	0.1820	0.1820	2.33
	inexperienced	3	8.3711	2.7904	21.80**
24/April/53	exp. vs. inexp.	1	3.5926	3.5926	22.30**
Route 2	Stations	18	208.5526	11.5863	92.99**
Ingham Co.	Error	90	11.2173	0.4082	
	error (exp.)	18	1.4071	0.0782	
	error (inexp.)	54	6.9098	0.1280	
	error (exp. vs. inexp.)	18	2.9004	0.1611	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	89	69.8093		
19/May/53	People	4	0.7546	0.1886	0.83
Route 3	Stations	17	53.9006	3.1706	13.88**
Eaton Co.	Error	68	15.1541	0.2285	

TABLE 2 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	94	176.5214		
	People	4	10.6486	2.6622	17.30**
	experienced	1	0.0561	0.0561	n.s.
	inexperienced	2	10.5708	5.2854	28.60**
15/June/53	exp. vs. inexp.	1	0.0218	0.0218	n.s.
Route 3	Stations	18	154.8007	8.6004	55.92**
Eaton Co.	Error	72	11.0721	0.1538	
	error (exp.)	18	2.4069	0.1337	
	error (inexp.)	36	6.6052	0.1835	
	error (exp. vs. inexp.)	18	2.0600	0.1144	

Note: Where degrees of freedom for stations are less than 19, one or more stations were thrown out because excessive interference prevented a count from being taken.

3. The counts made by inexperienced observers failed to agree on five of six days.

4. The counts made by all of the observers only agreed on one of six days.

Effect of Screening Counters

During the trial counts made just prior to the first day's counting, it was noted that one of the inexperienced students consistently obtained lower counts than did any of the other participants. Therefore, making the assumption that this person would probably not be selected by anyone screening observers for the purpose of making cock-crowing counts, the analyses were made again with his counts excluded. The results of this second series of analyses are summarized in Table 3. From these data it may be seen that:

1. Experienced observers still obtained higher counts than did inexperienced observers, but on only two of six days.

2. The counts made by experienced observers agreed on five of six days.

3. The counts made by inexperienced observers still failed to agree among themselves on three of six days.

4. The counts made by all observers agreed on two of six days.

The hearing of these six students was tested by Dr. Max Nelson of the Michigan State College Speech and Hearing Clinic, and all of them were found to have "normal" hearing. Thus it appears

TABLE 3

RESULTS OF SPRING TERM 1953 PHEASANT COUNTS (EXCLUDING ONE STUDENT)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	75	88.4712		
	People	3	7.2878	2.4293	16.11**
	experienced	1	0.4231	0.4231	3.13
	inexperienced	1	0.1975	0.1975	n.s.
16/April/53	exp. vs. inexp.	1	6.6672	6.6672	62.12**
Route 1	Stations	18	73.0408	4.0578	26.91**
Clinton Co.	Error	54	8.1426	0.1508	
	error (exp.)	18	2.4332	0.1352	
	error (inexp.)	18	3.7755	0.2098	
	error (exp. vs. inexp.)	18	1.9339	0.1074	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	94	88.1361		
	People	4	4.4888	1.1222	5.40**
	experienced	1	2.6368	2.6368	27.10**
	inexperienced	2	1.8223	0.9112	9.36**
21/April/53	exp. vs. inexp.	1	0.0297	0.0297	n.s.
Route 1	Stations	18	68.6690	3.8149	18.34**
Clinton Co.	Error	72	14.9783	0.2080	
	error (exp.)	18	1.7513	0.0973	
	error (inexp.)	36	8.6074	0.2391	
	error (exp. vs. inexp.)	18	4.6196	0.2566	

TABLE 3 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	94	198.6065		
	People	4	3.8603	0.9651	6.66**
	experienced	1	0.0105	0.0105	n.s.
	inexperienced	2	2.7064	1.3532	9.81**
23/April/53	exp. vs. inexp.	1	1.1434	1.1434	6.47*
Route 2	Stations	18	184.3084	10.2394	70.62**
Ingham Co.	Error	72	10.4378	0.1450	
	error (exp.)	18	2.2945	0.1275	
	error (inexp.)	36	4.9681	0.1380	
	error (exp. vs. inexp.)	18	3.1752	0.1764	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	94	183.7696		
24/April/53	People	4	1.2492	0.3123	1.87
Route 2	Stations	18	170.4650	9.4703	56.57**
Ingham Co.	Error	72	12.0554	0.1674	

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	89	69.8093		
19/May/53	People	4	0.7546	0.1886	0.83
Route 3	Stations	17	53.9006	3.1706	13.88**
Eaton Co.	Error	68	15.1541	0.2285	

TABLE 3 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	94	176.5214		
	People	4	10.6486	2.6622	17.30**
	experienced	1	0.0561	0.0561	n.s.
15/June/53	inexperienced	2	10.5708	5.2854	28.80**
Route 3	exp. vs. inexp.	1	0.0218	0.0218	n.s.
Eaton Co.	Stations	18	154.8007	8.6004	55.92**
	Error	72	11.0721	0.1538	
	error (exp.)	18	2.4069	0.1337	
	error (inexp.)	36	6.6052	0.1835	
	error (exp. vs. inexp.)	18	2.0600	0.1144	

Note: Where degrees of freedom for stations are less than 19, one or more stations were thrown out because excessive interference prevented a count from being taken.

that hearing ability apparently was not the reason for the one student's consistently low count.

It should be pointed out that the student whose count was consistently low was absent on the last two days so that these days are the same in both analyses.

On two days the counts made by inexperienced observers differed statistically among themselves, but did not differ significantly from the counts made by experienced observers. On the first of these days, April 21, 1953, the agreement is due to the failure of the experienced people to obtain counts that agreed among themselves; thus, their counts had a larger standard deviation. On the second day, June 15, 1953, one of the inexperienced students made an exceedingly high count such that the mean count was actually higher than that of the experienced people. This was the only time that the position of these two means was reversed, and the difference was not significant. Kimball (op. cit.) recognized this phenomenon and he stated, "An inexperienced worker will usually have low counts at first, and this is often followed by excessive counts due to misinterpretation of other sounds or to imagination."

While removal of the student who consistently made low counts considerably improved the agreement among the counts of inexperienced observers, and also improved their agreement with those of the

experienced observers, it is still evident that counts made by the latter tended to be higher and to agree better among themselves.

Effect of Interference

A series of analyses was made on the data from the five days on which stations having interference were prevalent enough to make it feasible to compare them with stations not having interference. Interference may be defined as any extraneous noises such as songbirds, frogs, heavy traffic, farm noises, or barking dogs which might mask out a portion of the pheasant calls or which might distract the observers from the counting.

The results of these analyses are shown in Table 4. As would be expected, there are highly significant differences among all stations whether or not interference was present. This is simply an indication that crowing pheasants were unequally distributed across the countryside. Thompson and Lemke (op. cit.) noted that pheasants either were not randomly distributed, or did not call at random, or both.

A seemingly more important fact is that on four of five days highly significant differences were found between stations with interference and stations without interference. The remaining day was

TABLE 4

EFFECT OF INTERFERENCE SPRING OF 1953

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F	
	Total	94	114.2995			
	Stations	18	86.3128	4.7952	29.91**	
16/April/53	int. vs. no int.	1	6.1131	6.1131	124.76**	
Route 1	interference	8	56.9838	7.1230	3.70**	2.76
Clinton Co.	no interference	9	23.2158	2.5795	17.37**	
	People	4	16.2845	4.0711	25.40**	
	Stations x people	73	11.7022	0.1603		
	int. x people	32	6.1596	0.1925		1.30
	no int. x people	36	5.3467	0.1485		
	int. x people vs.	4	0.1959	0.0490		

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F	
	Total	113	122.1880			
	Stations	18	82.3264	4.5737	21.25**	
21/April/53	int. vs. no int.	1	2.0993	2.0993	8.81*	
Route 1	interference	8	16.4724	2.0591	7.32**	3.44* (10%)
Clinton Co.	no interference	9	63.7547	7.0839	46.09**	
	People	5	20.4959	4.0992	19.05**	
	Stations x people	90	19.3657	0.2152		
	int. x people	40	11.2552	0.2814		1.83* (10%)
	no int. x people	45	6.9185	0.1537		
	int. x people vs. no int. x people	5	1.1920	0.2384		

TABLE 4 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F	
	Total	113	243.1998			
	Stations	18	221.0792	12.2823	89.46**	
	int. vs. no int.	1	27.9288	27.9288	343.95**	
23/April/53	interference	8	104.4280	13.0535	94.04**	1.32
Route 2	no interference	7	88.7224	9.8580	69.32**	
Ingham Co.	People	5	9.7641	1.9528	14.22**	
	Stations x people	90	12.3565	0.1373		
	int. x people	40	5.5516	0.1388		1.03
	no int. x people	45	6.3990	0.1422		
	int. x people vs. no int. x people	5	0.4059	0.0812		

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F	
	Total	113	231.9156			
	Stations	18	208.3526	11.5863	92.99**	
	int. vs. no int.	1	54.8085	54.8085	207.29**	
24/April/53	interference	5	78.4403	15.6881	108.19**	2.50
Route 2	no interference	12	75.3039	6.2753	60.05**	
Ingham Co.	People	5	12.1457	2.4291	19.50**	
	Stations x people	90	11.2173	0.1246		
	int. x people	25	3.6249	0.1450		1.39
	no int. x people	60	6.2703	0.1045		
	int. x people vs. no int. x people	5	1.3221	0.2644		

TABLE 4 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F	
	Total	89	69.8093			
	Stations	17	53.9006	3.1706	13.88**	
	int. vs. no int.	1	1.8676	1.8676	74.11**	
19/May/53	interference	9	28.4442	3.1605	16.75**	1.07
Route 3	no interference	7	23.5888	3.3698	11.42**	
Eaton Co.	People	4	0.7546	0.1886	0.83	
	Stations x people	68	15.1541	0.2285		
	int. x people	36	6.7917	0.1887		1.56
	no int. x people	28	8.2618	0.2951		
	int. x people vs. no int. x people	4	0.1006	0.0252		

Note: Where degrees of freedom for stations are less than 19, one or more stations were thrown out because excessive interference prevented a count from being taken.

significant at the 5 per cent level. Closer examination by the writer leaves him with the impression that this is not a valid test but is, rather, a reflection of the position of the stations on the route and hence a reflection of the time in relation to sunrise. Kozicky (op. cit.) found a significant decrease in the mean crowing counts observed at two stations at 45-minute intervals.

Tests comparing the variability of the stations without interference and the variability of the stations with interference showed significance at the 10 per cent level on only one of five days.

The variability of the counts by people at the stations with interference compared to the variability of people's counts at stations without interference also showed significance at the 10 per cent level only one time out of five.

ANALYSIS OF 1953 SUMMER CAMP DATA

Effect of Multiple Species Counts

The Michigan State College summer camp for wildlife management students made cock-crowing counts in the summer of 1953. Nine students, Dr. Petrides, and the writer participated. These people were divided into two groups, one of which counted pheasant cock-calls only, and another which counted not only pheasant cock-calls, but also individual quail whistling and individual mourning doves "cooing." Each of these two groups was subdivided into people with experience and people without experience. Thus, there were three experienced observers and two inexperienced observers counting cock-calls only, while there were three experienced and three inexperienced observers counting pheasant cock-calls, individual doves and quail. These counts were, of course, made after the peak of the seasonal pheasant crowing intensity. They were also started about one-half hour later than is recommended.

Three or four trial counts were attempted at the start of the first day's count. Unfortunately, the first station on the route had

an apparent maximum of two cock-crows so that these counts were virtually useless as a training device.

The general procedure used in making the counts was not such that good results could reasonably be expected. The writer can recall occasions when cars passed within a few feet while a count was being taken. Once the class was considerably distracted by the presence of a fox, and once sandhill cranes greatly interfered with the counting. Interference factors were so numerous that it was impossible to omit those stations at which they occurred and have any appreciable amount of data remaining. The results of these counts are summarized in Table 5.

These data are considered to be of questionable value by the writer and are submitted simply because they are all that he was able to obtain. They do seem to indicate that people counting single-species make higher counts than do people making multiple-species counts. There is also some support for the conclusion that experienced observers make higher counts than do inexperienced observers. The second day's data do not uphold either of these conclusions. However, on either day, the experienced people made a higher mean count than the inexperienced, and observers making single-species counts made a higher mean count than those making

TABLE 5

RESULTS OF SUMMER CAMP 1953 PHEASANT COUNTS

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	219	78.1586		
	People	10	23.0476	2.3048	20.95**
	pheasants only	4	12.8050	3.2013	25.88**
	exp. people	2	2.2084	1.1042	8.72**
	inexp. people	1	2.2657	2.2657	25.89**
	exp. vs. inexp.	1	8.3309	8.3309	54.10**
	pheas., doves, quail	5	8.6863	1.7373	17.29**
	exp. people	2	6.4797	3.2399	27.32**
	inexp. people	2	1.1254	0.5627	9.41**
	exp. vs. inexp.	1	1.0811	1.0811	0.74
23/June/53	pheas. vs. ph., do.. qu.	1	1.5563	1.5563	15.23**
Route 1	Stations	19	34.2195	1.8010	16.37**
Clinton Co.	Error (people)	190	20.8915	0.1100	
	error (pheas. only)	76	9.3983	0.1237	
	error (exp. people)	38	4.8095	0.1266	
	error (inexp. people)	19	1.6627	0.0875	
	error (exp. vs. inexp.)	19	2.9261	0.1540	
	error (ph., do., qu.)	95	9.5513	0.1005	
	error (exp. people)	38	4.5051	0.1186	
	error (inexp. people)	38	2.2760	0.0598	
	error (exp. vs. inexp.)	19	2.7702	0.1458	
	error (ph. vs. ph., do., qu.)	19	1.9419	0.1022	

TABLE 5 (Continued)

	Source of Variation	DF	Sum of Sq.	Mean Sq.	F
	Total	164	77.7310		
	People	10	4.8824	0.48824	3.54**
	pheasants only	4	2.2920	0.57300	3.25*
	exp. people	2	1.6064	0.80320	4.08*
	inexp. people	1	0.0403	0.04030	n.s.
	exp. vs. inexp.	1	0.6453	0.64530	3.39
	pheas., doves, quail	5	2.5291	0.50582	4.36**
	exp. people	2	1.4157	0.70785	5.92**
	inexp. people	2	1.0984	0.54920	4.44*
	exp. vs. inexp.	1	0.0149	0.01490	n.s.
27/June/53	pheas. vs. ph., do., qu.	1	0.0613	0.6130	n.s.
Route 2	Stations	14	33.5245	2.39461	17.35**
Lenawee Co.	Error (people)	140	19.3241	0.13803	
	error (pheas. only)	56	9.8633	0.17613	
	error (exp. people)	28	5.5154	0.19698	
	error (inexp. people)	14	2.0724	0.14803	
	error (exp. vs. inexp.)	14	2.6675	0.19054	
	error (ph., do., qu.)	70	8.1291	0.11613	
	error (exp. people)	28	3.3487	0.11960	
	error (inexp. people)	28	3.4665	0.12380	
	error (exp. vs. inexp.)	14	1.3139	0.09385	
	error (ph. vs. ph., do., qu.)	14	1.3317	0.09512	

multiple-species counts. Perhaps the fact that the second day was recorded over a shorter route (fifteen stations), and consequently was a less sharp test, may partly account for the lack of significance obtained.

DISCUSSION OF RESULTS

It would seem that, if as Stiles and Hendrickson (op. cit.), and Kozicky et al. (op. cit.) have demonstrated, the fall roadside census is a valid method of depicting pheasant population trends on a state-wide level, the cock-crowing pheasant census which Kimball (op. cit.) and Kozicky (op. cit.) have shown to be more accurate, must certainly be as good a method for determining spring breeding-cock population trends. Large scale counts made by a number of workers would presumably tend to balance out the inequalities among those workers' counts. However, unless there were agreement among those counts, the method would surely become progressively less accurate as the size of the area censused and the number of individuals censusing it decreased. This would make comparison of counties or other regions within a state increasingly risky. If the findings in this thesis generally are valid, then comparison of smaller areas within a state should be possible when all of the observers used have been trained until they count in a manner similar to experienced personnel. Multiple-species counts, in spite of their greater economy, should probably be avoided for most accurate results.

There is a real need for a study on the minimum training requirements necessary to produce "experienced" workers capable of making counts that agree with counts obtained by other experienced workers.

SUMMARY

Pheasant cock-crowing counts made by groups of people selected with no regard as to their previous counting experience or training showed almost no statistical agreement.

Pheasant cock-crowing counts made by a group of experienced observers were usually higher than counts made by a group of inexperienced observers.

Experienced workers obtained counts that agreed among themselves in the majority of cases, while inexperienced workers obtained counts that failed to agree among themselves at least as often as they agreed.

The presence of interference apparently had little or no effect on either the variability of the total counts at those stations where it was present or the variability among the counts of observers at those stations.

Data collected seemed to indicate a possibility that the counts of people making multiple-species censuses will generally be lower than counts made by people censusing only one species.

LITERATURE CITED

Bennett, Logan J., and George O. Hendrickson.
1938 Censuring [sic] the ringneck pheasant in Iowa. Trans. N. Am. Wildl. Conf. 3: 719-723.

Bovard, Everett W., Jr.
1953 Conformity to social norms in stable and temporary groups. Science 117(3040): 361-363.

Fisher, Harvey I., Robert W. Hiatt, and William Bergeson.
1947 The validity of the roadside census as applied to pheasants. Jour. Wildl. Mgt. 11(3): 205-226.

Kimball, James W.
1949 The crowing count pheasant census. Jour. Wildl. Mgt. 10(3): 101-120.

Kozicky, Edward L.
1952 Variations in two spring indices of male ring-necked pheasant populations. Jour. Wildl. Mgt. 16(4): 429-437.

Kozicky, Edward L., George O. Hendrickson, and Paul G. Homeyer.
1952 The adequacy of the fall roadside pheasant census in Iowa. Trans. N. Am. Wildl. Conf. 17: 293-304.

McClure, H. Elliot.
1945 Comparison of census methods for pheasants in Nebraska. Jour. Wildl. Mgt. 9(1): 38-45.

Randall, Pierce E., and Logan J. Bennett.
1939 Censusing ringneck pheasants in Pennsylvania. Trans. N. Am. Wildl. Conf. 4: 431-436.

Stiles, Bruce F., and George O. Hendrickson.
1946 Ten years of roadside censuses in Iowa. Jour. Wildl. Mgt. 10(3): 227-280.

Snedecor, George W.
1946 Statistical Methods. 4th Edition, Iowa State College Press, Ames, Iowa. 249-252.

Thompson, Donald R., and Charles W. Lemke.
1953 Audio census of some Wisconsin game birds. 14th Midwest Wildl. Conf. paper no. 40.

APPENDIX

ORIGINAL DATA SUMMER CAMP, 1952

Stations	25/June/52, Ingham Co. Students A	B	C	D	E	F	G	Stations	26/June/52, Ingham Co. Students A	B	C	D	E	F	G
1.	4	3	6	4	4	6	3	1.	6	5	7	5	4	5	5
2.	5	3	4	4	2	4	5	2.	2	4	4	4	3	2	5
3.	4	2	5	2	3	3	2	3.	2	1	1	1	2	1	1
4.	8	5	8	5	7	9	3	4.	9	6	6	3	6	6	5
5.	4	4	4	4	3	3	4	5.	6	3	3	1	4	4	5
6.	6	4	6	5	4	5	5	6.	2	3	2	1	4	3	2
7.	1	1	1	2	3	1	1	7.	2	1	2	1	2	1	1
8.	2	2	0	2	1	1	1	8.	2	3	2	2	2	3	0
9.	3	3	3	1	4	2	0	9.	3	1	3	3	3	2	3
10.	2	1	2	2	2	2	1	10.	4	5	5	5	5	3	3
11.	2	3	1	2	1	2	1	11.	5	2	4	2	3	2	3
12.	0	0	0	0	1	0	1	12.	4	2	1	1	2	2	2
13.	5	2	3	2	2	1	3	13.	6	5	7	4	5	6	4
14.	3	3	3	2	3	2	1	14.	3	2	4	1	2	3	1
15.	1	1	0	1	0	0	0	15.	2	2	3	1	1	0	1
16.	3	1	1	0	1	0	0	16.	1	1	0	0	0	1	0
17.	1	1	0	0	2	0	1	17.	0	0	0	0	0	0	0
18.	1	0	0	0	1	0	2	18.	3	1	1	1	2	1	1
19.	2	1	0	2	0	0	2	19.	2	2	2	2	2	2	2
20.	1	1	0	1	1	0	0	20.	2	0	0	0	1	0	0
	58	41	47	41	45	41	36		124	90	104	79	98	88	80
	$\bar{X}$ = 44.1								$\bar{X}$ = 94.7						

ORIGINAL DATA SUMMER CAMP, 1952 (Continued)

Stations	10/July/52, Lenawee Co. Students							Stations	14/July/52, Tuscola Co. Students						
	A	B	C	D	E	F	G		A	B	C	D	E	F	G
1.	10	10	5	10	10	13	7	1.	6	5	6	3	3	4	5
2.	17	17	17	14	15	16	12	2.	6	5	6	5	5	5	4
3.	11	5	8	8	9	5	7	3.	2	3	3	4	4	3	3
4.	5	5	8	7	9	6	7	4.	4	3	2	5	5	2	3
5.	6	5	6	5	6	6	6	5.	0	1	1	1	1	1	0
6.	7	6	7	12	7	8	2	6.	2	1	3	0	3	2	3
7.	7	5	8	7	6	5	4	7.	1	1	2	1	1	2	1
8.	14	12	10	10	10	15	15	8.	0	0	0	0	0	0	0
9.	9	8	6	7	9	11	6	9.	1	1	3	2	3	3	1
10.	11	8	9	6	8	7	7	10.	2	1	2	1	2	1	2
11.	11	9	8	9	13	7	5	11.	1	1	2	1	1	0	1
12.	15	11	13	14	11	11	13	12.	1	1	1	1	1	1	0
13.	12	12	13	11	12	10	8	13.	3	4	4	2	2	1	3
14.	13	7	9	9	11	11	7	14.	3	4	4	3	4	3	2
15.	8	7	6	8	8	9	3	15.	0	0	0	0	0	4	0
16.	9	9	6	8	11	9	9	16.	0	0	0	1	0	0	0
17.	6	5	7	6	8	7	3	17.	0	0	0	0	1	0	0
18.	12	6	7	8	6	5	6	18.	0	0	0	0	0	0	0
19.	5	4	5	3	4	3	0	19.	1	0	3	1	2	2	2
20.	3	3	4	2	1	2	5	20.	0	0	0	0	0	0	0
	191	154	168	164	174	166	134		34	31	42	31	38	35	30
	$\bar{X}$ = 164.4								$\bar{X}$ = 34.4						

ORIGINAL DATA SPRING TERM, 1953

Stations	16/April/53, Clinton Co. Students						Stations	21/April/53, Clinton Co. Students					
	A*	B*	C	D	E	F		A*	B*	C	D	E	F
1.	13	9	6	7	-	6	1.	27	28	32	18	21	12
2.	10	19	9	11	-	7	2.	36	35	32	26	31	31
3.	12	15	13	7	-	6	3.	27	15	26	9	12	5
4.	23	20	14	13	-	9	4.	26	23	16	19	16	4
5.	18	15	9	13	-	4	5.	34	31	28	22	28	15
6.	40	31	17	29	-	19	6.	25	19	26	23	23	14
7.	19	16	15	13	-	12	7.	21	18	19	25	16	11
8.	23	22	17	26	-	15	8.	17	19	15	22	23	14
9.	14	15	6	11	-	12	9.	19	18	21	17	16	13
10.	14	12	12	9	-	7	10.	16	13	15	13	18	11
11.	14	15	8	11	-	6	11.	23	15	20	17	20	12
12.	14	8	11	7	-	1	12.	21	16	12	25	24	12
13.	31	20	20	20	-	17	13.	27	19	28	21	21	17
14.	15	10	19	11	-	8	14.	13	7	18	10	11	8
15.	-	-	-	-	-	-	15.	-	-	-	-	-	-
16.	3	2	0	1	-	2	16.	11	5	20	11	15	4
17.	7	6	5	3	-	1	17.	8	3	6	6	11	4
18.	3	4	1	2	-	1	18.	7	3	7	4	6	1
19.	9	7	3	5	-	3	19.	12	12	11	5	11	6
20.	11	12	5	9	-	7	20.	14	9	15	8	11	5
	293	258	190	208	-	143		384	308	367	301	334	199

$\bar{X}$ = 218.4 all students
$\bar{X}$ = 275.5 experienced
$\bar{X}$ = 180.33 inexperienced
$\bar{X}$ = 199.0 inexperienced (without F)

$\bar{X}$ = 315.5 all students
$\bar{X}$ = 346.0 experienced
$\bar{X}$ = 300.25 inexperienced
$\bar{X}$ = 334.0 inexperienced (without F)

* Experienced students.

ORIGINAL DATA SPRING TERM, 1953 (Continued)

23/April/53, Ingham Co.							24/April/53, Ingham Co.						
Stations	Students						Stations	Students					
	A*	B*	C	D	E	F		A*	B*	C	D	E	F
1.	39	33	33	32	29	27	1.	36	44	35	27	40	27
2.	46	36	32	30	35	35	2.	39	42	33	35	37	36
3.	45	36	44	31	31	23	3.	28	33	30	26	31	23
4.	15	25	29	18	18	14	4.	25	32	19	21	21	15
5.	17	14	14	9	14	7	5.	21	20	24	15	21	10
6.	27	24	26	14	20	15	6.	26	30	27	27	25	24
7.	24	19	15	13	19	15	7.	13	11	11	6	8	5
8.	-	-	-	-	-	-	8.	-	-	-	-	-	-
9.	22	22	22	13	16	13	9.	19	22	18	15	15	10
10.	28	35	33	32	26	28	10.	24	27	21	27	17	14
11.	26	24	23	26	22	17	11.	12	13	15	14	12	8
12.	12	13	5	9	8	8	12.	9	12	5	12	10	4
13.	8	11	9	9	12	7	13.	7	7	11	5	6	4
14.	6	5	9	4	10	3	14.	17	17	14	14	12	8
15.	7	6	7	2	7	6	15.	20	14	16	17	12	8
16.	7	11	11	6	10	6	16.	4	5	4	1	7	2
17.	9	11	9	6	10	4	17.	6	6	6	5	5	2
18.	1	2	4	2	5	0	18.	6	3	6	10	5	1
19.	5	4	4	4	6	2	19.	3	3	5	4	2	[illegible]
20.	3	2	3	1	3	1	20.	1	3	4	1	2	0
	347	333	332	261	301	231		316	344	304	287	288	203

$\bar{X}$ = 300.83 all students
$\bar{X}$ = 340.0 experienced
$\bar{X}$ = 281.25 inexperienced
$\bar{X}$ = 298.0 inexperienced (without F)

$\bar{X}$ = 290.33 all students
$\bar{X}$ = 323.3 experienced
$\bar{X}$ = 270.5 inexperienced
$\bar{X}$ = 293.0 inexperienced (without F)

* Experienced students.

ORIGINAL DATA SPRING TERM, 1953 (Continued)

19/May/53, Eaton Co.							15/June/53, Eaton Co.						
Stations	Students						Stations	Students					
	A*	B*	C	D	E	F		A*	B*	C	D	E	F
1.	5	3	3	4	5	-	1.	6	8	6	6	8	-
2.	9	8	6	11	4	-	2.	9	15	14	7	8	-
3.	16	14	16	7	12	-	3.	13	10	13	9	6	-
4.	10	13	13	20	17	-	4.	22	22	33	17	21	-
5.	13	12	10	13	13	-	5.	23	20	30	17	20	-
6.	21	20	16	21	15	-	6.	15	19	27	20	19	-
7.	17	10	10	12	13	-	7.	9	14	19	8	10	-
8.	13	14	10	5	16	-	8.	5	6	9	2	5	-
9.	10	5	9	16	6	-	9.	1	2	7	0	4	-
10.	5	2	7	3	3	-	10.	4	5	13	3	5	-
11.	13	8	8	4	6	-	11.	3	1	5	1	0	-
12.	4	7	3	6	3	-	12.	1	0	4	0	0	-
13.	2	1	4	1	2	-	13.	2	1	3	1	0	-
14.	6	4	4	5	1	-	14.	3	0	3	0	0	-
15.	-	-	-	-	-	-	15.	-	-	-	-	-	-
16.	2	2	5	3	6	-	16.	2	1	3	1	1	-
17.	-	-	-	-	-	-	17.	0	0	0	2	0	-
18.	3	6	7	5	5	-	18.	0	0	4	0	0	-
19.	7	4	8	6	7	-	19.	3	1	1	1	2	-
20.	2	1	8	5	4	-	20.	4	3	3	1	1	-
	158	134	147	147	138	-		125	128	197	96	110	-

$\bar{X}$ = 144.8 all students
$\bar{X}$ = 146.0 experienced
$\bar{X}$ = 144.0 inexperienced

$\bar{X}$ = 131.2 all students
$\bar{X}$ = 126.5 experienced
$\bar{X}$ = 134.3 inexperienced

* Experienced students.

ORIGINAL DATA SUMMER CAMP, 1953

23/June/53, Clinton Co.

Stations	Students										
	Pheasants Only					Pheasants, Doves, & Quail					
	A*	B*	C*	D	E	F*	G*	H*	I	J	K
1.	3	3	2	2	1	4	3	2	2	2	3
2.	7	7	5	7	4	6	9	4	5	7	6
3.	7	4	6	3	1	4	7	4	3	4	4
4.	10	3	5	6	4	4	12	6	4	5	3
5.	10	9	5	6	3	4	8	4	5	4	5
6.	8	7	7	7	4	4	8	5	6	8	5
7.	5	3	2	3	2	4	7	2	3	3	3
8.	14	5	5	4	2	6	9	3	4	5	3
9.	3	5	4	0	1	0	4	0	3	3	2
10.	5	6	6	3	2	2	5	4	2	3	1
11.	5	3	8	5	3	4	7	4	1	6	3
12.	12	7	8	6	5	4	12	5	4	4	4
13.	11	7	6	3	3	4	7	3	3	6	1
14.	5	6	9	5	0	3	4	3	4	3	3
15.	4	2	2	1	0	1	2	1	1	2	1
16.	7	5	3	4	4	3	4	3	2	2	2
17.	6	7	3	4	2	3	4	4	2	2	1
18.	6	2	2	2	0	1	6	0	2	3	1
19.	3	2	2	1	0	1	1	0	1	2	1
20.	7	5	5	8	4	9	7	2	5	6	3
	138	98	95	80	45	71	126	59	62	80	55

$\bar{X}$=82.64 all students

$\bar{X}$=91.20 pheasants only

$\bar{X}$=110.33 pheasants only (experienced)

$\bar{X}$=62.50 pheasants only (inexperienced)

$\bar{X}$=75.50 pheasants, doves. & quail

$\bar{X}$=85.33 (experienced)

$\bar{X}$=65.67 (inexperienced)

* Experienced students.

ORIGINAL DATA SUMMER CAMP, 1953 (Continued)

27/June/53, Lenawee Co.

Stations	Students										
	Pheasants Only					Pheasants, Doves, & Quail					
	A*	B*	C*	D	E	F*	G*	H*	I	J	K
1.	19	3	7	10	8	6	12	12	6	7	8
2.	7	8	11	7	5	6	9	7	4	10	5
3.	3	1	4	3	1	3	3	3	3	4	2
4.	3	5	3	1	1	1	3	1	2	3	1
5.	3	4	2	2	2	3	2	2	2	4	1
6.	9	6	7	3	3	7	6	8	5	6	1
7.	9	3	4	2	5	4	6	4	6	5	0
8.	9	7	6	5	8	3	10	5	7	7	6
9.	4	2	3	2	1	4	4	3	3	3	2
10.	3	4	2	2	2	2	4	2	3	2	2
11.	3	1	3	2	4	3	2	2	3	3	2
12.	3	3	2	2	5	3	4	2	4	3	3
13.	6	1	5	7	4	1	5	4	4	4	6
14.	2	2	2	2	1	1	3	0	2	4	1
15.	4	3	3	8	3	1	3	5	2	4	3
	87	53	64	58	53	48	76	60	56	69	49

$\bar{X}$=61.18 all students

$\bar{X}$=63.00 pheasants only

$\bar{X}$=68.00 pheasants only (experienced)

$\bar{X}$=55.50 pheasants only (inexperienced)

$\bar{X}$=59.67 pheasants, doves, and quail

$\bar{X}$=61.33 (experienced)

$\bar{X}$=58.00 (inexperienced)

* Experienced students.