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INVESTIGATIONS OF SOME FACTORS INFLUENCING WHISTLING OF BOBWHITE QUAIL IN NORTHEASTERN KANSAS

by

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INTRODUCTION

For many years biologists have recognized the significance of bird song. Bicknell (1884) stated "The voices of birds apart from their intrinsic interests and associations, are closely related to the times and seasons of the birds themselves and to other phenomena of their lives."

Many estimates of bird populations are based on vocalization counts. For the results of these counts to be reliable and comparable, numerous variables must be eliminated or recognized.

The variables which influence the results of vocalization counts can be separated into two broad catagories: (1) those which affect rate and intensity of sound emitted and (2) those which affect audibility or detection of sound.

The objectives of this study were to determine the effects of time and meteorological factors on the rate and intensity of bobwhite quail (*Colinus virginianus*) whistles emitted. During the study several of the variables affecting the audibility of whistles were also considered.

The study was initiated in the spring of 1963, continued throughout the summer and the spring and summer of 1964 and 1965.

REVIEW OF LITERATURE

The subject of measurement of bird populations has been extensively treated by Kendeigh (1944). Bird sounds have long been incorporated as indices to bird populations. Coo counts of mourning dove (*Zenaidura macroura*) have been utilized for estimating populations in many areas (McClure 1939, McGowan 1953, Odum 1959, Lowe 1956, Southeastern Association of Game and Fish Commissioners 1956). Peenting counts of American woodcock (Philohela minor) were developed by Kozicky, Bancroft and Homeyer (1954). Ruffed grouse (Bonasa umbellus) drumming counts applicable to population density were described by Petraborg, Wellein and Gunvalson (1953) and Amman and Ryel (1963). Rodgers (1963) employed hooting counts for estimating blue grouse (Dendragapus obscurus) populations; while Smith and Gallizoli (1964) utilized whistle counts of gambel quail (Lophortyx gambelii) as population indices.

Throughout the range of the ring-necked pheasant (Phasianus colchicus) crowing counts are utilized to predict population trends (McClure 1946, Kimball 1949, Kozicky 1952, Nomsen 1953, Carney and Petrides 1957, Robertson 1958, Nelson, Buss and Baines 1962). Population estimates of the bobwhite quail utilizing whistle counts are in wide use (Stoddard 1931, Bennitt 1951, Reeves 1954, Rosene 1957, Speake 1960, Hanson and Miller 1961, Stempel 1961, Kabat and Thompson 1963).

Although many estimates of bird populations are now utilizing vocalization counts, several investigators have questioned the reliability of the results. Tippensee (1948) stated counts of whistling birds provide a rough measure of population density but may be less accurate than other methods. Norton et al. (1961) statistically analysed the data of Bennitt (1951), Reeves (1954) and Rosene (1957) and concluded the whistle count method of bobwhite quail census was unreliable.

When using indices to populations weather, season, time of day, and other variables which affect the validity of comparisons must be standardized (Leopold 1933).

Meteorological Factors

Possibly the earliest example of meteorological factors influencing vocal behavior of animals were the positive correlations found between temperature and chirping rate of crickets (Oeconthus niveus) Brooks 1881, Edes 1899, Allard 1930b). A positive correlation between temperature and calling rate was reported by Frings and Frings (1957) for the cone-headed grasshopper (Neoconocephalus ensiger) and Zweifel (1959) for the frog Bombina varigata.

Accounts of meteorological factors influencing calling of birds are numerous. Alexander (1931) stated cold temperature and wind reduced song in passerine birds. Leopold and Eynon (1961) found wind and heavy rain inhibited bird song. Armstrong (1961) mentioned light intensity, cloudy weather, mist, rainfall and dew as influencing singing of different birds in various ways. Hansen (1952) found wind to be an important factor in reducing calls in the tawny owl (Syrnium aluco); cold weather also checked the activity of calls and cold weather and wind together had a very depressing effect. He recorded no correlation between calls and light intensity.

Kozicky, Bancroft and Homeyer (1954) listed strong wind velocity, temperature and rain as important variables to consider when conducting peent counts of American woodcock; however, Pitelka (1943) reported normal day-to-day variations of temperature did not appear to influence the rate of calling but length of crepuscular calling periods were longer at higher temperatures.

Rain, thunderstorms and cloudy, misty weather all tended to stop or sharply curb drumming of ruffed grouse. Wind velocity did not affect drumming rate but did reduce the radius of audibility (Petraborg, Wellein and Gunvalson 1953).

Investigations of the Southeastern Association of Game and Fish Commissioners (1956) revealed mourning dove calling was depressed by rain, but no significant differences were detected between counts taken on clear and cloudy days. Wind velocity had a pronounced effect on the audibility of calls and high velocities on the rate of calling itself. No relationships were found between temperature, dew or cloud cover and results of pheasant crow counts conducted by Kozicky (1952). Kimball (1949) found wind influenced pheasant crowing counts.

According to Elder (1956), wind velocity, temperature and vapor pressure deficit accounted for only 20 percent of whistling variation of bobwhite quail. Temperature was the most important variable. Whistling activity diminished and frequently ceased entirely during periods of gusty winds. Bennitt (1951) reported a negative correlation of quail whistles with temperature but found cloudiness, wind and relative humidity of little importance. Stoddard (1931) noted warmth stimulated quail whistles.

Time of Day

Armstrong (1963) found light intensity the most important factor which determined the beginning of a bird's day, and therefore had a profound influence on the beginning of diurnal song. Most passerine birds start singing about the time of civil twilight. Cloudiness at dawn delays the time of first song (Leopold and Eynon 1961, Allard 1930a).

The daily peak of calling of the ring-necked pheasant varies from 15 minutes to 40 minutes before sunrise (Kimball 1949, Tabor 1949, Kozicky 1952, Nelson, Buss and Baines 1962). According to the report of the Southeastern Association of Game and Fish Commissioners (1956) the number of mourning doves calling reached a peak at sunrise and diminished gradually for the next 1½ hours. The peak of whistling of bobwhite quail was in the hour following sunrise (Bennitt 1951, Elder 1956). Kabat and Thompson (1963) reported the peak of calling of the bobwhite occurred soon after sunrise with a high rate of whistling for 1 hour to 1½ hours.

Time of Year

Bird song is usually a seasonal phenomena reaching a peak at the maximum dispersive activity just before the breeding season (Wynne-Edwards 1962). Studies by Leopold and Eynon (1961) showed the ring-necked pheasant crowing curve was correlated with gonadotrophic activity of the pituitary. Davis (1958) found singing of the rufus sided towhee (Pipilo maculatus) was directly correlated to number of Leydig cells. Kozicky, Bancroft and Homeyer (1954) listed stage of breeding cycle as an important variable in woodcock singing counts. The peak of mourning dove calling in the southeastern United States occurred in late April (Southeastern Association of Game and Fish Commissioners 1956).

The rate of pheasant crowing was high and fairly constant in South Dakota from mid-April to late May (Kimball 1949). In Iowa the peak was in late April (Nomsen 1953) and in Washington between April 5 and April 17 (Nelson, Buss and Baines 1962).

The whistling of male bobwhite quail has a phenological basis resulting in a strongly developed seasonal pattern of whistling activity (Kabat and Thompson 1963). Calls in Florida become general in early April dwindling by mid-August (Stoddard 1931). The peak of calling in Missouri and Wisconsin was either in late June or early July (Bennitt 1951, Kabat and Thompson 1963).

Psychological Effects

According to Wynne-Edwards (1962), the song of birds can often be stimulated by the sound of rival voices.

Genelly (1955) reported calling of California quail (Lophortyx californicus) was increased by presence of females and calling of competitors. Competition among neighboring male woodcock accelerated rate of calling (Pitelka 1943). Stokes (1961) mentioned the rally call of the chuker partridge (Alectoris graeca) may serve to repel intruding males and attract females. Ring-necked pheasants can be stimulated to crow by crowing of others of their kind (Nelson, Buss and Baines 1962) and individual mourning doves call more frequently when other doves are calling (Southeastern Association of Game and Fish Commissioners 1956). Whistling of other bobwhite quail may stimulate whistling of unmated bobwhite cocks (Stoddard 1931, Bennitt 1951).

Sex Ratio of Population

Davis (1958) found unmated male towhees sing more persistently than mated male towhees. Unmated male mourning doves coo at a higher rate for a longer period of time each day than mated mourning doves (Jackson and Baskett 1964). Mating calls of California quail were given primarily by unmated males (Genelly 1955). The chuker partridge continues to call after being paired but lone males were the most persistent singers (Stokes 1961).

Stoddard (1931) revealed the bobwhite note was given largely by the unmated male. Studies by Bennitt (1955) substantiated this but he noted that occasionally mated cocks give the bobwhite call. According to Kabat and Thompson (1963), most or all male quail whistled during the peak of sexual activity.

Factors Affecting Audibility or Detection of Calls

Vocalization counts conducted by groups of inexperienced people show very poor agreement (Carney and Petrides 1957, Nelson, Buss and Baines 1962, Kozicky, Bancroft and Homeyer 1954, Amman and Ryel 1963).

Differences in vegetation and topography among areas may cause variation in audibility of calls (Robertson 1958, Nelson, Buss and Baines 1962).

According to Stoddard (1931), the audibility of quail whistles is more than $\frac{1}{4}$ mile; in some instances over intervening water and prairie land, audibility can exceed 1 mile. In hilly terrain, Bennitt (1951), often failed to hear a bobwhite whistle much less than ½ mile away and has heard cocks at more than 1 mile under favorable conditions. The effect of wind velocity on audibility has been discussed in the review of meteorological factors.

MATERIALS AND METHODS

Study Area

This study was conducted in Riley County in the northwestern region of the Flint Hills of Kansas.

Topography consists of rolling prairie land broken by the valleys of Mill, Baldwin and Wildcat creek drainages. Several minor drainages also intersect the area.

The soils of the area belong to the Prairie Great Soil Group and are characterized in the uplands by shallow soils with frequent outcrops of shale and cherty limestone (Lovell 1964).

The average annual precipitation is 32.0 inches and the average annual temperature is 55.7° F. (Decennial Census of U. S. Climate - Kansas, 1962).

The study area is principally true prairie with some timber along the water courses (Fish 1953, Herbel and Anderson 1959).

The prairie consisted of herbaceous plant associations dominated by grasses including: bluestem (Andropogon),[1] grama (Bouteloua) switchgrass (Panicum) and indiangrass (Sorghastrum) mixed with many forbs (Fish 1953). Several shrubs are invading the pasture land:

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[1] Common and Scientific names after Anderson, 1961.

two of the most characteristic are snowberry (Symphoricarpos occidentalis) and smooth sumac (Rhus glabra). Thickets of American plum (Prunus americana) extend into the grassland in many areas (Weaver and Fitzpatric 1934). Aromatic sumac (Rhus aromatica) and redcedar (Juniperus virginiana) are common in some pastures.

Both lowland and upland woods are represented; the lowland type found only along the water courses was typified principally by cottonwoods (Populus) and willows (Salix). Bankwoods of oak-hickory (Quercus and Carya) and blackjack oak (Q. marilandica) were present. Hedges of osage orange (Maclura pomifera) were common in some areas.

Between the upland prairie and lowland deciduous forest are various croplands primarily: corn (Zea), grain sorghum (Sorghum), wheat (Triticum) and alfalfa (Medicago).

Routes

On 18 March 1963, two 10-mile listening routes were established (Figure 1). A listening station was established every ½ mile along these transects for a total of 40 stations, 20 for each route. From 25 March to 31 July 1963; 27 March to 31 August 1964; and 1 April to 31 June 1965 each route was traversed by two investigators once each week beginning ½ hour before official sunrise. The direction of travel on each route was reversed each week.

At each station one observer listened for a total of 5 minutes and tallied the total number of quail whistles heard for each minute and when possible the rate of whistling of individual birds. The other investigator collected meteorological data with appropriate

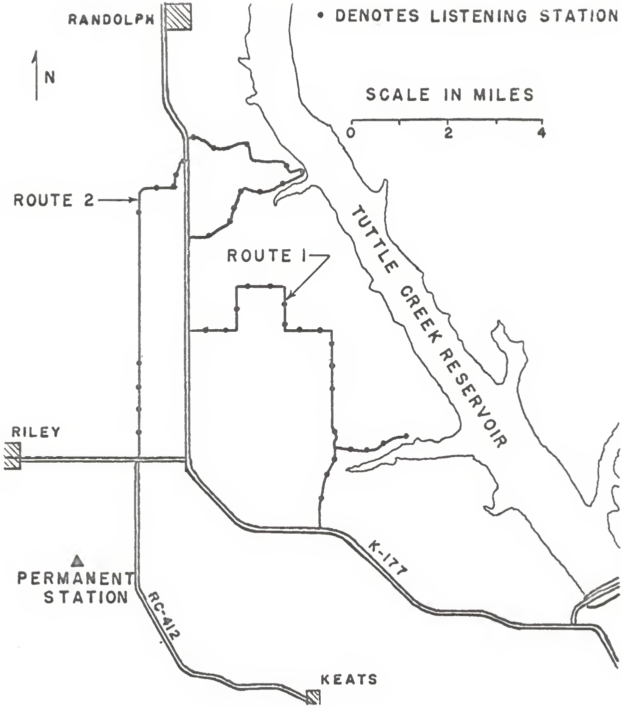

Fig. 1. Map of study area showing listening routes and location of permanent station.

instruments: temperature and relative humidity using a Bendix Frieze Psycron, wind velocity with a Deuta-Werke hand-held anemometer, light intensity with a Gossen Tri-Lux footcandle meter and barometric pressure with a Taylor meteorological barometer. Time of day was recorded at the beginning of each listening period.

After each 5-minute period, the investigators drove to the next station and repeated the above procedure. The total time for completion of each route was approximately 3 hours. Unusual weather conditions or other phenomena that could affect calling or audibility were entered in the daily field notebook. Records were kept of all quail observed along the routes.

Permanent Station

On 15 April 1963, a permanent weather and listening station was established (Figure 1). A Short and Mason recording hygrotherograph and standard raingage were placed at this area. Whistle data were collected once each week at the permanent station during 1963, 1964 and 1965. Beginning ½ hour before official sunrise, two investigators listened for 5-minute periods at 15-minute intervals until 2½ hours after sunrise. During each listening period, one investigator tallied the total number of whistles for each minute of the period while the other investigator tallied the number of quail whistling during each minute and their location on an outline map of the area. Appropriate meteorological data were recorded for each corresponding period plus total rainfall for the preceding week. A spotting scope and binoculars were used to observe whistling behavior and movements whenever possible.

Intensity of Quail Whistles

A portable sound level meter (General Radio Co., Type 1551B) was employed to determine if a significant difference in intensity of quail whistles existed. When a quail was whistling close enough to register on the sound level meter, the intensity of ten consecutive whistles was measured. The quail was then flushed and the distance from the quail to the meter measured. A correction factor was calculated to compensate for differences in distance and vegetative cover. A Matsushita SK-128 high-fidelity speaker attached to a Wollensak model L 1700 tape recorder was used to broadcast a single quail whistle at a standard intensity at each whistling site. By taking readings with the sound level meter located where the original reading was made, the actual intensity of the quail whistles could be determined.

Effect of Vegetation on Sound Transmittance

On 20 April 1965, a plant growth study was initiated in a deciduous forest and a brushy pasture along route 1. In the deciduous forest, leaves of five oak, three snowberry, three western buckeye (*Aesculus glabra*), three American elm (*Ulmus Americana*), two red bud (*Cercis canadensis*) and two gooseberry (*Ribes missouriense*) plants were measured. In the brushy pasture, leaves of five smooth sumac, three American elm and two snowberry plants were measured. Approximately 10 leaves of each plant were measured at weekly intervals between 29 April and 25 June 1965.

Light meter readings were taken in conjunction with the measurements at predetermined points at the ground surface, 3 ft. and 6 ft. above the ground surface to determine changes in light penetration (Sather 1950).

To determine the effect of vegetative growth on transmittance of sound, a study was initiated in conjunction with the plant growth study. In the areas of the study sites, two 200-ft. lines were established. A speaker attached to a tape recorder broadcasting a single quail whistle at a standard intensity was placed at one end of the line. Decibel readings were taken with the sound level meter at 25, 50, 75, 100, 150 and 200 ft. distances along the line. Readings were taken on 20 April, 11 May, 19 May, 18 June and 25 June 1965.and interpreted in view of plant growth data. Sound level readings were also taken in a similar manner over various vegetation present in the area including: corn, grain sorghum, wheat, alfalfa, pastureland and native meadow. The differences in sound transmission were then compared.

Analysis of Data

The data were transferred to IBM punch cards and analysed by the multiple linear regression method (Snedecor 1956) on an IBM 1620 digital computer. All statistical symbols used are after Snedecor (1956).

The variables tested against number of quail whistles heard (Y) were: time of day (x_1), day of year (x_2), wind velocity (x_3), light intensity (x_4), barometric pressure (x_5), temperature (x_6) and relative humidity (x_7).

Data were stratified and analysed in three parts: (1) time factors (x_1 and x_2) using the equation $Y=a+b_1x_1+b_2x_2$, (2) meteorological factors (x_3 through x_7) using the equation $Y=a+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7$ and (3) all variables using the formula $Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7$.

For the route analyses only total calls per 5 minute period were tested against the variables. For the permanent station analyses both total calls per 5 minute period and rate of calling of individual birds per minute were tested against the variables. The route data were analysed by separate stations for each year, by pooling the stations on each route for each year and by pooling years and routes. The permanent station data were analysed for each year and by pooling years. To determine which individual variables were most important, partial regression coefficients (b) were determined and tested for significance by Student's t test.

Only complete bobwhite whistles were used in the analyses.

Two levels of significance were used: .05 was considered significant and .01 highly significant.

RESULTS

A total of 51,091 quail whistles were analysed: 12,287 in 1963; 23,672 in 1964 and 15,132 in 1965.

In 1963 the first bobwhite whistles were heard on 29 March, in 1964 on 3 April and in 1965 on 1 April. In 1963 the peaks of whistling activity were on 17 June, 19 June and 28 June for route 1, route 2 and the permanent station, respectively (Fig. 2 and 5). The peaks of whistling during 1964 were on 29 June, 24 June and

17 July for route 1, route 2 and the permanent station, respectively (Fig. 3 and 5). For 1965 the peak for route 1 was 15 June, route 2, 17 June and the permanent station 19 June.

In most cases after the peak, a rapid drop in the number of calls heard was followed by a gradual leveling off. A smaller secondary peak was recorded during late July and early August in both 1963 and 1964.

Variation in Calls Attributable to Variables Tested

The R^2 or fraction of variance of quail whistles (Y) attributable to the variables are shown in Tables 11 through 16 in the Appendix. Using time factors along (x_1 and x_2) the R^2 values were significant for 27 and highly significant for 66 of 120 separate station analyses. Using meteorological factors alone (x_3 through x_7) the R^2 values were significant for 46 and highly significant for 38 of 120 separate station analyses. Using total variables analysed (x_1 through x_7) the R^2 values were significant for 36 and highly significant for 76 of 120 separate station analyses.

The highest and lowest R^2 values were 0.87 and 0.03, 0.90 and 0.10 and 0.99 and 0.24 for time, meteorological and total factors, respectively.

To account for the effect of the peak of calling on linear regression analyses by day of year, the pooled route and the permanent station call and meteorological data were separated into two parts: (1) pre-peak period and (2) post-peak period.

All R^2 values for pre-peak analyses proved to be highly significant for all treatments of the data (Table 1). For post-peak analy-

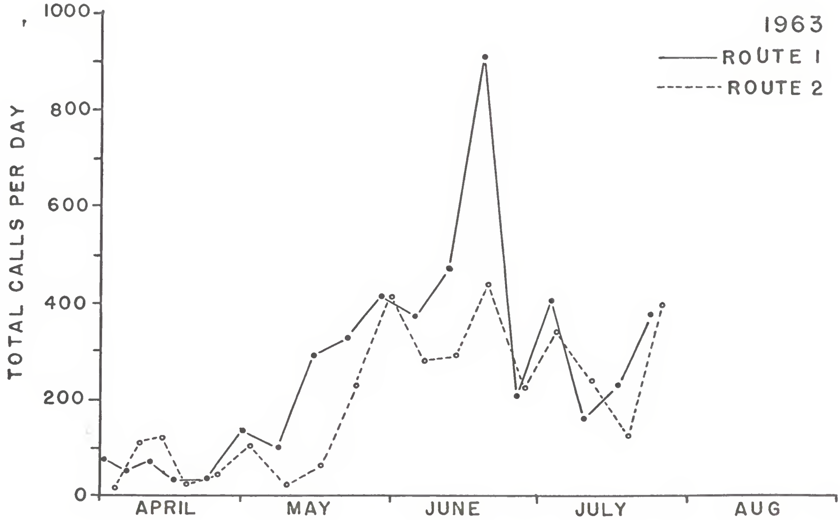

Fig. 2. Seasonal distribution of bobwhite quail whistles. Total calls for each day based on 100 minutes of listening time.

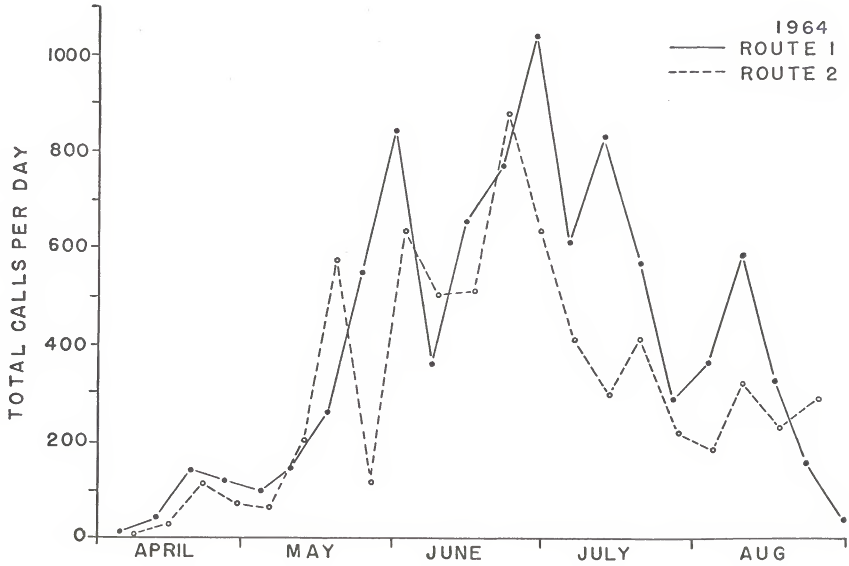

Fig. 3. Seasonal distribution of bobwhite quail whistles. Total calls for each day based on 100 minutes of listening time.

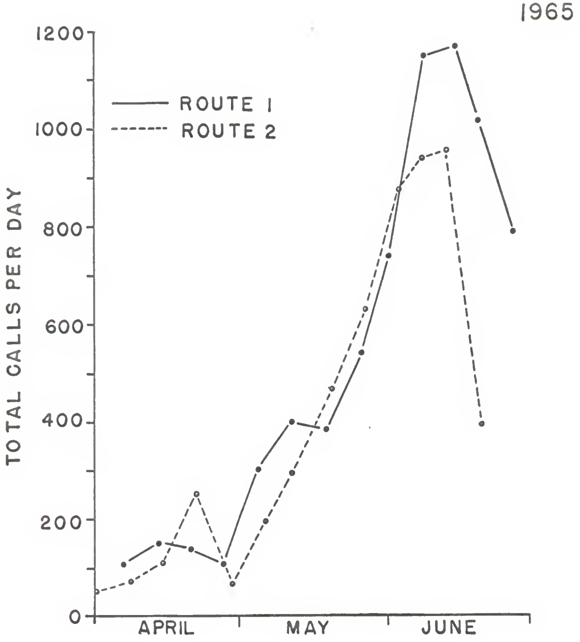

Fig. 4. Seasonal distribution of bobwhite quail whistles. Total calls for each day based on 100 minutes of listening time.

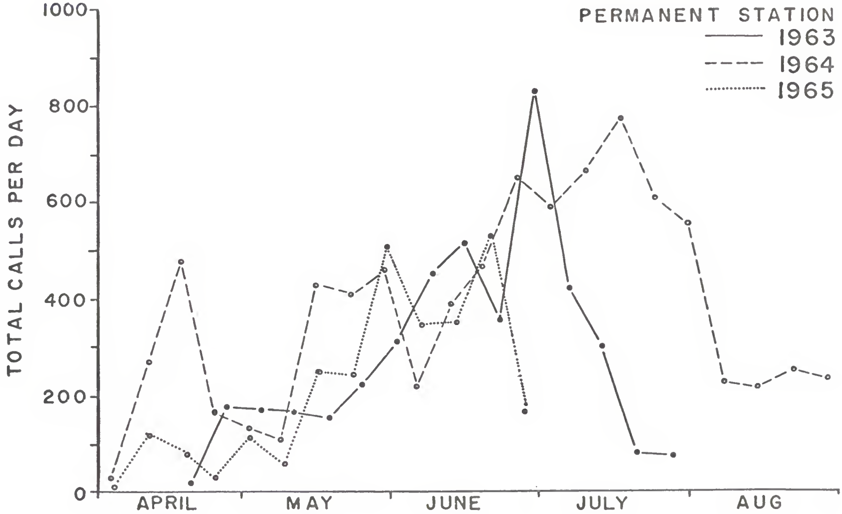

Fig. 5. Seasonal distribution of bobwhite quail whistles. Total calls for each day based on 50 minutes of listening time.

ses, all R^2 values were highly significant except for time factors of the route data in 1963.

Importance of Individual Factors

Day of the year (x_1). The most important factor influencing number of quail whistles heard was day of the year. Total calls were significantly correlated with day of year for 20 and highly significantly correlated for 13 of 120 separate station analyses. The significance of day of the year was exemplified by pooling stations on the routes, pooling routes and years and by the permanent station analyses. Only one analysis proved nonsignificant for pre-peak data when pooled data and permanent station data were analysed. Three analyses were nonsignificant for post-peak data. Calls were positively correlated with day of year before the peak and negatively correlated after the peak (Table 2).

Time of Day (x_2). Calls were significantly correlated with time of day for only 7 of 120 station analyses when stations were treated separately. When pooled and at the permanent station, however; it proved to be a significant factor in several analyses, both before and after the peak. A negative correlation of calls with time of day was found (Table 3).

In 1963, the daily peak of whistling activity was at sunrise, 20 minutes after in 1964 and in 1965 the calls were about stable from sunrise to an hour after (Fig. 6). The average daily whistling activity increased from 20 minutes before sunrise to a peak 20 minutes after sunrise and steadily decreased thereafter (Fig. 7).

Table 1. Fraction of variation of quail whistles heard, attributable to variables tested.

Analysis	Pre-Peak Data: Time	Pre-Peak Data: Meteor.	Pre-Peak Data: Total	Pre-Peak Data: No. Obs.	Post-Peak Data: Time	Post-Peak Data: Meteor.	Post-Peak Data: Total	Post-Peak Data: No. Obs.
1963								
Route 1	0.34**	0.17**	0.35**	300	0.03	0.07**	0.08**	100
Route 2	0.17**	0.13**	0.21**	280	0.01	0.26**	0.27**	120
Perm. Sta.	0.55**	0.52**	0.60**	80	0.39**	0.40**	0.46**	40
1964								
Route 1	0.38**	0.20**	0.45**	279	0.22**	0.21**	0.39**	198
Route 2	0.30**	0.19**	0.35**	260	0.12**	0.16**	0.30**	180
Perm. Sta.	0.23**	0.48**	0.48**	128	0.43**	0.48**	0.56**	90
1965(1)								
Route 1	0.38**	0.17**	0.48**	217				
Route 2	0.34**	0.15**	0.37**	240				
Perm. Sta.	0.51**	0.33**	0.60**	120				
Pooled Data(2)								
Routes	0.31**	0.14**	0.31**	1537				
Perm. Sta.	0.31**	0.28**	0.38**	301	0.18**	0.36**	0.42**	130

(R^2 of Variables)

(1) No Post-Peak data collected in 1965.
(2) No pooled analysis conducted on post-peak route data. Permanent station post-peak data only for 1963 and 1964.
** Significant at .01 level.

Table 2. Effect of day of the year on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	0.484	0.055	8.74**	292	-0.022	0.267	0.08	92
Route 2	0.217	0.047	4.58**	272	-0.204	0.178	1.15	112
Perm. Sta.	0.601	0.185	3.24**	72	-1.739	1.490	1.17	38
1964								
Route 1	0.698	0.065	10.74**	271	-0.665	0.092	7.19**	190
Route 2	0.611	0.082	7.42**	252	-0.446	0.077	5.79**	172
Perm. Sta.	0.008	0.144	0.06	120	-0.708	0.187	3.78**	82
1965(1)								
Route 1	1.181	0.109	10.85**	209				
Route 2	0.862	0.099	8.62**	232				
Perm. Sta.	0.821	0.099	8.32**	112				
Pooled Data(2)								
Routes	0.518	0.028	18.52**	1529				
Perm. Sta.	0.374	0.075	4.95**	293	-0.532	0.163	3.26**	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.
** Significant at .01 level.

Table 3. Effect of time of day on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	-0.021	0.026	0.79	292	-0.021	0.055	0.39	92
Route 2	-0.068	0.021	3.24**	272	0.003	0.026	0.10	112
Perm. Sta.	-2.354	1.140	2.06**	72	-0.913	1.928	0.47	38
1964								
Route 1	-0.060	0.032	1.86	271	0.066	0.050	1.32	190
Route 2	-0.106	0.031	3.36**	252	0.004	0.033	0.13	172
Perm. Sta.	-0.616	0.953	0.65	120	-0.415	1.495	0.28	82
1965(1)								
Route 1	-0.008	0.042	0.19	209				
Route 2	-0.068	0.043	1.59	232				
Perm. Sta.	-0.342	0.885	0.39	112				
Pooled Data(2)								
Routes	-0.073	0.013	6.27**	1529				
Perm. Sta.	-2.248	0.525	4.28**	293	-2.676	1.168	2.29	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.
** Significant at .01 level.

Wind Velocity (x_3). Calls were significantly correlated to wind velocity for 10 of 120 separate station analyses. The pooled route data proved nonsignificant for all analyses except route 1, 1965 where a highly significant negative correlation of calls with wind was noted. Calls and wind velocity were significant for the permanent station analysis, for pre-peak data of 1963 and highly significant for 1964 and pooled data, both before and after the peak (Table 4).

Light Intensity (x_4). Calls were significantly correlated with light intensity for 5 of 120 separate station analyses and proved to be insignificant in all other analyses (Table 5).

Barometric Pressure (x_5). Calls were significantly correlated with barometric pressure for only 3 of 120 separate station analyses. The pooled station analysis was significantly correlated with calls in the route 2, 1964 pre-peak analysis and 1965 permanent station analysis. A highly significant correlation of calls with barometric pressure was noted for the route 2, 1964, pooled route data and 1964 permanent station for the pre-peak analyses. A highly significant negative correlation of calls with barometric pressure was noted for all post-peak route analyses except route 1, 1963. Pre-peak correlations of calls with barometric pressure were both positive and negative (Table 6).

Temperature (x_6). Calls were significantly correlated with temperature for 7 of 120 separate station analyses. A significant negative correlation of calls with temperature was noted for pooled

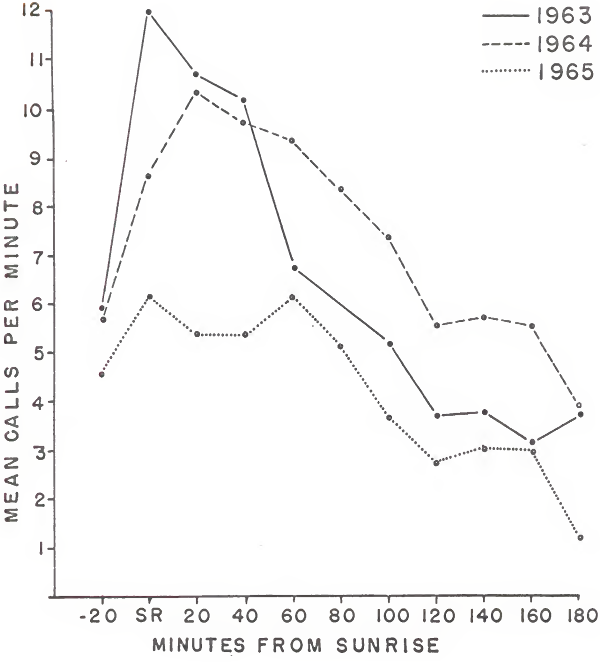

Fig. 6. Time-wise distribution of 4,146, 8,236 and 2,840 bob-white quail whistles recorded during 1963, 1964 and 1965, respectively.

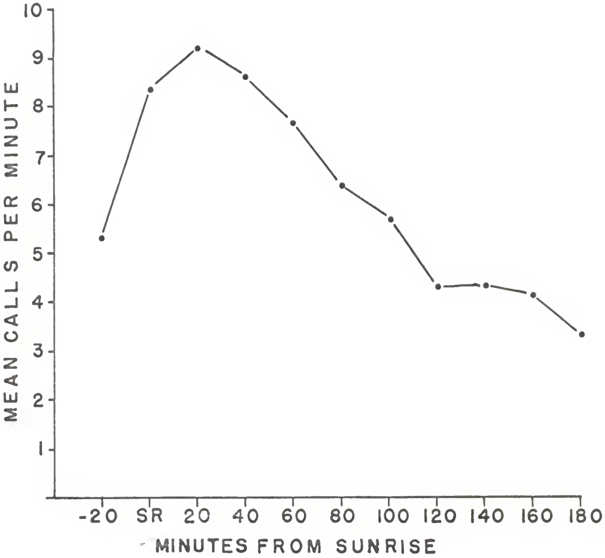

Fig. 7. Time-wise distribution of 15,222 bobwhite quail calls recorded during this study.

Table 4. Effect of wind velocity on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	-0.066	0.212	0.31	292	0.183	0.644	0.28	92
Route 2	-0.062	0.167	0.37	272	-0.809	0.670	1.21	112
Perm. Sta.	-1.606	0.791	2.03*	72	-1.373	1.542	0.89	38
1964								
Route 1	0.352	0.272	1.29	271	-0.754	0.479	1.57	190
Route 2	-0.077	0.244	0.32	252	0.619	0.395	1.57	172
Perm. Sta.	-1.553	0.447	3.47**	120	-3.860	0.963	4.01**	82
1965(1)								
Route 1	-0.564	0.110	5.11**	209				
Route 2	-0.072	0.387	0.19	232				
Perm. Sta.	-0.741	0.419	1.77	112				
Pooled Data(2)								
Routes	-0.018	0.107	0.17	1529				
Perm. Sta.	-1.248	0.285	4.38**	293	-4.791	0.799	6.00	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.
* Significant at .05 level.
** Significant at .01 level.

Table 5. Effect of light intensity on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	0.000	0.000	0.63	292	0.001	0.000	1.57	92
Route 2	0.000	0.000	1.56	272	0.000	0.000	0.60	112
Perm. Sta.	0.000	0.000	0.25	72	0.000	0.001	0.06	38
1964								
Route 1	0.000	0.000	1.67	271	0.000	0.000	0.67	190
Route 2	0.000	0.000	1.91	252	0.000	0.000	0.17	172
Perm. Sta.	0.001	0.000	1.70	120	0.001	0.000	0.71	82
1965(1)								
Route 1	0.000	0.000	1.02	209				
Route 2	0.000	0.000	0.01	232				
Perm. Sta.	0.000	0.000	1.03	112				
Pooled Data(2)								
Routes	0.000	0.000	1.48	1529				
Perm. Sta.	0.000	0.000	0.83	293	0.000	0.000	0.80	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.

Table 6. Effect of barometric pressure on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	0.005	0.006	0.81	292	0.035	0.034	1.02	92
Route 2	0.004	0.005	0.81	272	-1.068	0.176	6.06**	112
Perm. Sta.	-0.652	0.444	1.47	72	0.469	1.385	0.34	38
1964								
Route 1	0.033	0.039	0.84	271	-1.127	0.174	6.47**	190
Route 2	0.042	0.018	2.39*	252	-0.630	0.126	5.02**	172
Perm. Sta.	0.625	0.145	4.31**	120	0.057	0.355	0.16	82
1965(1)								
Route 1	-0.356	0.358	0.99					
Route 2	-0.325	0.113	2.88**	232				
Perm. Sta.	-0.284	0.123	2.31*	112				
Pooled Data(2)								
Routes	0.010	0.004	2.58**	1529				
Perm. Sta.	0.049	0.097	6.50	293	0.593	0.310	1.91	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.
* Significant at .05 level.
** Significant at .01 level.

pre-peak analyses for route 2, 1965 and years pooled for the routes (Table 7). A highly significant correlation of calls with temperature was noted for pre-peak analyses of route 1 and the permanent station for 1964 and 1965. The permanent station data of 1964 was positively correlated with calls and the others were negatively correlated with calls. A highly significant negative correlation of calls with temperature was noted for route 1, 1964 post-peak analyses.

Relative Humidity (x_7). Total number of quail calls and relative humidity were significantly correlated for 5 of 120 separate station analyses. A significant correlation of calls with relative humidity was noted for pooled station data of route 1, 1965, route 2, 1963 and 1964 permanent station pre-peak analyses and 1964 route 2 post-peak analyses (Table 8). A highly significant negative correlation of calls with relative humidity was noted for the pre-peak pooled permanent station analysis and the post-peak analysis of 1964 permanent station data.

Rate of Calling by Individual Birds

The rate of calling of individual birds at the permanent station was based on 2,035 minutes of calculating number of quail whistling and total number of calls for each minute. Periods between calling were included. The average rate of calling per minute was 2.82, 3.09 and 2.55 for 1963, 1964 and 1965, respectively. For the 3 years of the study, the average rate of calling was 2.87 calls per minute.

Table 7. Effect of temperature on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	0.223	0.122	1.83	292	0.611	1.008	0.61	92
Route 2	-0.033	0.082	0.40	272	0.292	0.437	0.67	112
Perm. Sta.	0.325	0.517	0.63	72	1.024	3.563	0.29	38
1964								
Route 1	-0.524	0.115	4.54**	271	-2.610	0.591	4.41**	190
Route 2	-0.140	0.159	0.88	252	-0.894	0.224	3.99**	172
Perm. Sta.	1.327	0.301	4.41**	120	-0.953	0.491	1.94	82
1965(1)								
Route 1	-1.414	0.266	5.27**	209				
Route 2	-0.515	0.240	2.14**	232				
Perm. Sta.	-1.014	0.251	4.03**	112				
Pooled Data(2)								
Routes	-0.122	0.055	2.23*	1529				
Perm. Sta.	0.219	0.175	1.25	293	-0.570	0.500	1.14	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.
* Significant at .05 level.
** Significant at .01 level.

Table 8. Effect of relative humidity on whistling of quail when all variables are considered: b=regression coefficient, Sb=standard deviation, t=student's t value without regard to sign and d.f.=degrees of freedom.

	Pre-Peak Data				Post-Peak Data			
Analysis	b	Sb	t	d.f.	b	Sb	t	d.f.
1963								
Route 1	-0.094	0.073	1.83	292	-0.536	0.406	1.32	92
Route 2	0.155	0.073	2.73*	272	0.099	0.099	0.79	112
Perm. Sta.	-0.043	0.387	0.11	72	0.682	2.097	0.32	38
1964								
Route 1	0.200	0.102	1.95	271	-0.455	0.234	1.94	190
Route 2	-0.220	0.130	1.70	252	0.264	0.120	2.20**	172
Perm. Sta.	-0.579	0.223	2.60*	120	-1.756	0.591	2.97**	82
1965(1)								
Route 1	-0.342	0.172	1.99*	209				
Route 2	-0.002	0.170	0.01	232				
Perm. Sta.	0.218	0.134	1.63	112				
Pooled Data(2)								
Routes	0.030	0.041	0.74	1529				
Perm. Sta.	-0.264	0.097	2.72**	293	-0.953	0.515	1.85	122

(1) No post-peak data collected in 1965.
(2) No post-peak analysis of route data conducted, post-peak data of permanent station only for 1963 and 1964.
* Significant at .05 level.
** Significant at .01 level.

The average rate of calling of 41 birds for 225 minutes of listening time along the routes was 4.3 per minute. Periods between calling were not included for this figure. The highest rate of whistling of the bobwhite call by an individual bird was 11 per minute.

The permanent station data for 1965 and the pooled data of 1963, 1964 and 1965 were analysed to determine the effects of the variables on rate of calling of individual birds. The R^2 values for 1965 permanent station analyses were 0.26, 0.33 and 0.41 for time factors, meteorological factors and total factors, respectively. The R^2 values of pooled permanent station data of 1963, 1964 and 1965 were 0.10, 0.17 and 0.20 for time factors, meteorological factors and total factors, respectively. All R^2 values were highly significant.

A highly significant correlation of rate of calling with day of year, wind velocity, barometric pressure and relative humidity was noted in 1965. A highly significant correlation of rate of calling with time of day, wind velocity, temperature and relative humidity was noted for the pooled data of 1963, 1964 and 1965 (Table 9).

A highly significant correlation existed between rate of calling of individual birds and total calls heard (r=0.52).

Table 9. Effect of variables tested on the rate of calling when all variables were considered: b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign. (1965, 112 degrees of freedom and pooled 293 degrees of freedom)

	Permanent Station 1965			Permanent Station Pooled		
Variable	b	Sb	t	b	Sb	t
T:D	-0.0031	0.0602	0.051	-0.1169	0.0372	3.144**
D:Y	0.0262	0.0067	3.902**	0.0087	0.0053	1.636
W	-0.1061	0.0285	3.719**	-0.0640	0.0202	3.172**
L	-0.0000	0.0000	0.192	0.0000	0.0000	1.163
BP	-0.0285	0.0084	3.405**	0.0079	0.0069	1.143
T	-0.0181	0.0171	1.056	0.0354	0.0124	2.854**
RH	0.0370	0.0091	4.062**	-0.0254	0.0069	3.688**

** =Significant at .01 level
T:D=Time of day
D:Y=Day of year
W =Wind velocity
L =Light intensity
BP =Barometric pressure
T =Temperature
RH =Relative humidity

Intensity of Whistling

The intensity or loudness of quail whistles was not significantly correlated with the variables tested (Table 10). The R^2 value=0.62 but was insignificant with 4 degrees of freedom.

Table 10. Effect of variables tested on intensity of quail whistles when all variables were considered: b= regression coefficient, Sb=standard deviation and t=student's t value without regard to sign. (4 degrees of freedom)

Variable	b	Sb	t
T:D	-0.1073	0.0943	1.138
D:Y	0.1021	0.3902	0.262
W	4.6695	2.7890	1.674
L	0.0008	0.0006	1.320
BP	11.1389	21.9150	0.508
T	0.7036	0.5156	1.365
RH	0.2208	0.6128	0.360

T:D=Time of day
D:Y=Day of year
W =Wind velocity
L =Light intensity
BP =Barometric pressure
T =Temperature
RH =Relative humidity

Effect of Vegetation on Sound Transmittance

As the density of vegetation increased, the radius of audibility of quail whistles decreased. This effect was most evident in the areas of deciduous forests; as both leaf growth and light obstruction increased, sound intensity of a quail whistle decreased (Fig. 8).

The radius of audibility of quail whistles were also influenced by type of vegetation. The greatest absorption of sound occurred in a corn field (61.8 percent difference between decibel readings at 0 and 100 ft. from source) and the least occurred over pastureland (35.7 percent difference between decibel readings at 0 and 100 ft. from source).

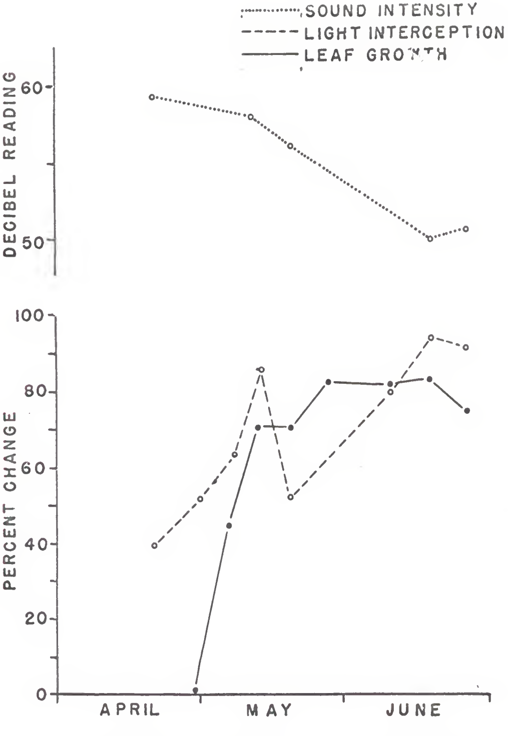

Fig. 8. Intensity of sound at 200 feet compared to percent of light interception and percent leaf growth in a deciduous forest.

Location of Whistling Perches

During the three years of the study, a total of 51 male bobwhite quail were observed on "whistling perches". The average perch was 5 ft. above the ground, the highest being 30 ft. and the lowest the ground itself. Of the 51 whistling quail observed, 25 were in trees, 13 on fences or fence posts, 12 were on the ground and 1 on a haystack.

DISCUSSION

Variables Affecting Calling

The results of the study indicated day of the year, time of day, wind velocity, temperature and relative humidity as the most important factors influencing whistling activity of bobwhite quail. Light intensity and barometric pressure had little influence on whistling behavior.

Whistling of quail began about the first of April; reaching a peak from mid-June to mid-July.

Bennitt (1951), Kabat and Thompson (1963), and Hartowicz (1964) reported peaks of whistling activity from mid-June to mid-July. Bennitt (1951) noted a regular subsidence of quail whistles at the level of the peak after the peak was reached. Data of Kabat and Thompson (1963) and that collected during this study showed a large decrease of whistling birds after the peak whistling period.

According to Speake (1960) bobwhite quail whistling activity fluctuated with nesting activity and a sharp decline in calling corresponded to peaks of hatching. Hartowicz (1964) reported the statewide peak of quail hatching in Kansas as mid and late June, during 1963 and 1964, respectively. These times correspond favorably to peaks of calling on the routes for both 1963 and 1964. The permanent station data for 1963 and 1964 do not correspond to these times but the peak in 1964 was about two weeks later than in 1963 (Fig. 5) as was the peak of hatching between 1963 and 1964. The small area sampled may have been the reason for this difference.

The whistling peaks in 1963 were narrow and sharply defined while in 1964 broader and less distinct. The hatching curve reported by Hartowicz (1964) in Kansas for 1963 was likewise narrower and more distinct than the 1964 hatching curve. This suggests a sharp peak in whistling activity may denote a sharp hatching peak and vice-versa.

The daily whistling activity increased from before sunrise to a peak about 20 minutes after sunrise and then declined. In 1963 twice as many calls were heard at sunrise than 1 hour after sunrise (Fig. 7). In 1964 a 25 percent decline in calling activity was noted from sunrise to 1 hour after. In 1965 the calling activity from sunrise to 1 hour after showed no substantial decrease, probably due to more cloudy, windy weather in 1965. Tabor (1949) noted pheasant crow counts taken before sunrise could be compared to counts taken after sunrise only on cloudy, windy days. The average activity of calling for the three years declined 50 percent from sunrise to 1 hour after sunrise (Fig. 6). Bennitt (1951) and Elder (1956) reported no substantial decrease in calling activity in the hour following sunrise.

With the exclusion of heavy rain during which quail ceased whistling entirely, wind was the most important of meteorological factors which influenced whistling behavior. As wind velocity increased, number of calls heard decreased. This could have been caused by a reduction of actual whistling or by a reduction in the radius of audibility of quail whistles due to noise caused by wind. A combination of both factors probably account for the reduction of whistles heard.

The route data generally showed poor correlation between wind velocity and quail whistles except for those stations exposed to the wind. Wind measurements taken at stations sheltered by vegetation and topography were not representative of actual wind velocities of the general area. The permanent station was exposed to the wind and representative velocity measurements were possible resulting in correlations between wind velocity and calls.

Each mile per hour increase in wind velocity affected whistling to a greater degree after the seasonal peak of whistling than before. Bennitt (1951) reported no correlation of quail calls with wind velocity. Elder (1956) found no correlation between quail whistles and wind velocity but noted that a correlation may have been found if wind velocities had been higher. (Elder recorded wind velocities greater than 8 m.p.h. for only 2 of 53 mornings).

After the seasonal peak of whistling activity, a negative correlation of calls with temperature was noted. Before the peak was reached; however, temperature correlations were sporadic being both negative and positive. The route data usually showed negative correlations and the permanent station positive. Generally, before the peak was reached as temperature increased, calls increased and after the peak as temperature increased, calls decreased.

Both Bennitt (1951) and Elder (1956) reported temperature as the meteorological factor most important in quail whistling behavior. Both studies were conducted in July after the peak of whistling activity and negative correlations with whistles were noted.

A negative correlation of calls with relative humidity was noted both before and after the seasonal peak of whistling was reached. As relative humidity increased, calls decreased. Bennitt (1951) and Elder (1956) reported no relationship between relative humidity and calling activity.

Both temperature and relative humidity cause a change in the actual whistles emitted and not the radius of audibility. The attenuation of sound at the temperatures and relative humidities experienced during the study was not great enough to be detected or cause any appreciable change in the radius of audibility of quail whistles (Harris 1957, Beranek 1960).

Barometric pressure was found to be significantly correlated with quail whistles during several route analyses; the correlation was believed spurious however. After the seasonal peak of whistling, a negative correlation of whistles with barometric pressure was noted, as barometric pressure increased, calls decreased. This was probably a function of topography rather than a true correlation between barometric pressure and whistling activity. More whistles were tallied at higher elevations than low elevations due to a larger radius of audibility because of sparser vegetation and a greater number of birds in the higher pastureland. The permanent station and separate station analyses where the altitude was held constant showed little correlation of calls with barometric pressure.

Light intensity showed the poorest correlation with quail whistles of any factors tested. A large variation in light intensity was noted, readings from less than .1 foot candle to 5000 foot candles during one morning were common. Measurements may have been mis-leading since quail were sometimes whistling in the open when readings were taken in the shade or vice-versa.

Rate of Calling by Individual Birds

When periods between active calling were included the average rate of whistling during the time of the study was 2.87 calls per minute. When only actively calling, birds were tallied and periods between active calling excluded, the rate averaged 4.3 calls per minute.

Stoddard (1931) reported one bird averaging about 2 calls per minute throughout one day, and another about 4 calls per minute for 28 minutes. Robeson (1963) noted two whistling quail, one being mated, whistled an average of 4 calls per minute and another unmated male whistled an average of 6 calls per minute.

The highly significant correlation between rate of calling and total calls heard (r=0.52) suggests a change in rate of calling per minute and not the number of birds calling causes the number of calls heard to vary. Periods between active calling were included in the analysis of rate of calling of individual birds so possibly higher rates of calling are caused by shorter periods between active calling periods. The high correlation between rate of calling and total calls heard may have caused the significance between rate and the variables tested in Table 9.

Intensity of Whistling

Intensity of whistling was found nonsignificant with the variables tested. The nonsignificance however, may have been caused by the small sample size or by inadequate sound measurement equipment for this type of study. It was noted that intensity of whistles could be controlled by quail from the ringing loud bobwhite down to the "whisper call" mentioned by Stoddard (1931).

Effect of Time Within the Listening Period on Number of Calls Heard

It was postulated that during the five minute listening period on each station along the routes, the number of calls heard during the first minute of listening differed significantly from calls heard during the last four minutes due to frightening of birds or some factor causing the investigator's hearing ability or attention to be at a lower level.

To determine if such a significant difference existed, the mean of calls during the first minute was tested against the mean of calls during the last four minutes by student's t test. The results of the tests for each route for each year proved to be nonsignificant. It was concluded that no differentiation between calls heard during different segments of the listening period existed.

Effect of Number of Calls on R^2 Value

The importance of a substantial number of calls was demonstrated by the effect of number of calls on the R^2 values determined at separate stations along the routes. As number of calls increased the R^2 values generally increased allowing a greater percent of variation in number of quail whistles to be explained (Fig. 9).

Relation of Data to Whistle Counts

Many variables may influence the results of whistle counts. For whistle counts to be reliable and comparable from year to year and from area to area, these variables must be recognized and where possible eliminated.

Both day of year and time of day are controllable variables for initiation of whistle counts. The day of the year should be standardized, preferably during the time of the year when most calls are heard and the least variability is present.

On most days the daily variation of whistling activity was quite substantial, especially the period around sunrise; therefore, whistle counts should start and end at approximately the same time in relation to sunrise.

Although growth of vegetation in the spring does affect radius of audibility of quail whistles, most growth has been completed by mid-May; therefore, any whistle counts conducted after mid-May need not take plant growth into account. If counts are to be compared from area to area; however, the type and density of vegetation should be known and the results adjusted if vegetative types are dissimilar.

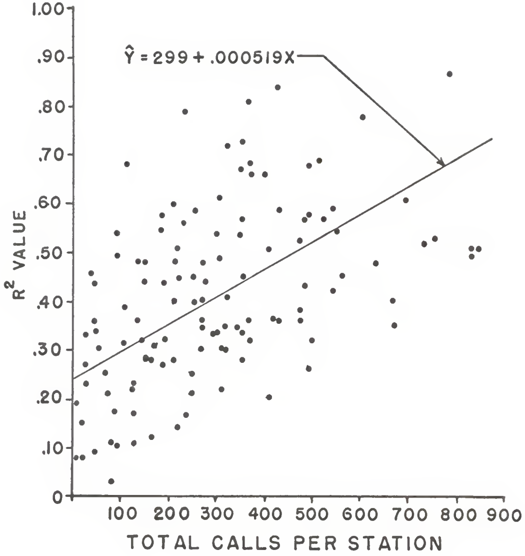

Fig. 9. Fraction of variation of calls attributable to day of year and time of day (R^2) as related to total calls heard at each station for each year.

Whistle counts must be adjusted for meteorological variables since such variables are constantly changing. If day of year and time of day are not standardized they must be adjusted accordingly.

Two correction factors were determined from the results of the pooled permanent station data. These data were considered more reliable than the route data because vegetation changes were not as great, time was more controllable and variability of meteorological factors were less.

A correction factor wad determined by adjusting the mean calls heard per 5 minute period by an amount determined from the regression coefficients of the variables considered and the amount of deviation of the variables from a predetermined standard as follows:

Yadj=Yobs. -[b D:Y(Std. D:Y - obs D:Y)] - [b T:D(Std. T:D - obs T:D)] - [b W(Std. W - obs W)] - [b T(Std. T - obs T)] - [b RH(Std. RH - obs RH)].

where: Yadj=Mean calls/5 minute period after correction
Yobs=Mean calls/5 minute period before correction
b =correlation coefficient
Std=standard
obs=observed
D:Y=Day of year
T:D=Time of day
W =Wind velocity
T =Temperature
RH=Relative humidity

The standard used for this study was the mean of the variables considered over the three year period of the study. For northeast Kansas, the following correction factor is recommended for days before peak whistling period if day of year and time of day are not standardized:

$$Yadj = Yobs - [0.037(129 - \bar{X}\ D{:}\ obs)] - [-0.112(69 - \bar{X}\ T{:}D\ obs)] - [-1.25(5 - \bar{X}\ W\ obs)] - [0.22(57 - \bar{X}\ T\ obs)] - [-0.26(77 - \bar{X}\ RH\ obs)].$$

If day of year and time of day are standardized, only the last three meteorological adjustments need be used.

$$Yadj = Yobs - [-1.25(5 - \bar{X}\ W\ obs)] - [0.22(57 - \bar{X}\ T\ obs)] - [-0.26(77 - \bar{X}\ RH\ obs)].$$

For days after the peak whistling period, the following correction factor is recommended:

$$Yadj = Yobs - [-0.58(203 - \bar{X}\ D{:}Y\ obs)] - [-0.142(78 - \bar{X}\ T{:}D\ obs)] - [-4.74(3.20 - \bar{X}\ W\ obs)] - [-0.57(72 - \bar{X}\ T\ obs)] - [-0.95(75 - \bar{X}\ RH\ obs)].$$

Again if time of day and day of year are standardized, no adjustment is necessary for them.

$$Yadj = Yobs - [-4.74(3.20 - \bar{X}\ W\ obs)] - [-0.57(72 - \bar{X}\ T\ obs)] - [-0.95(75 - \bar{X}\ RH\ obs)].$$

Then using the time of the year from mid-May to mid-June as a basis, a 19.60 percent increase of whistling was noted between 1963 and 1964 and a 36.93 percent increase between 1964 and 1965. When the correction factor was applied, these figures became 18.62 percent and 31.55 percent, respectively. An outline of changes of whistling activity is shown in Table 26 in the Appendix.

If number of quail whistles are an indication of bobwhite quail populations, the breeding population of quail on the study area increased 18.62 percent between 1963 and 1964 and 31.55 percent between 1964 and 1965. Mail carrier survey information showed an 11 percent increase in adult bobwhite quail population between 1963 and 1964 (Hartowicz 1964).

Recommendations

Recommendations for conduction of whistle counts in northeastern Kansas are as follows:

(1) day of the year - counts twice each week from mid-May to mid-June.

(2) time of day - from 15 minutes before sunrise to 1 hour after.

(3) use of correction factors as stated previously.

(4) for representative wind measurements and consequent adjustments, stations should be chosen that are exposed to the wind.

(5) listening periods should be 5 to 10 minutes long depending on area to be censused.

(6) experienced investigators should conduct the counts.

SUMMARY

To determine the effects of time of year, time of day, wind velocity, barometric pressure, light intensity and relative humidity on rate and intensity of bobwhite quail whistles, whistle counts were conducted from 25 March to 31 July 1963; 27 March to 31 August 1964;and 1 April to 31 June 1965.

Once each week two routes, consisting of 20 listening stations each, and a permanent station were visited. Five-minute counts of

whistles were taken at each station on the routes and at the permanent station for 10 periods at 15 minutes intervals starting ½ hour before sunrise. Meteorological data were taken for each listening period and compared to quail whistles by the multiple linear regression method. The data were analysed in three parts (1) time factors (day of year and time of day), (2) meteorological factors (wind velocity, temperature, relative humidity, barometric pressure and light intensity) and (3) total factors. Some data were separated into pre-peak and post-peak analyses. A total of 51,091 quail whistles were analysed: 12,287 in 1963; 23,672 in 1964 and 15,132 in 1965.

The first calls of the season were heard on 29 March, 3 April and 1 April for 1963, 1964 and 1965, respectively. The peak period of whistling varied from 15 June to 17 July for the three years.

The highest and lowest R^2 values (amount of variation of whistles attributable to variables tested) were 0.87 and 0.03, 0.90 and 0.10 and 0.99 and 0.24 for time, meteorological and total factors, respectively for separate station analyses.

When the data were pooled, from 20 percent to 60 percent of the variability of quail whistles could be explained by the factors examined.

The primary factors influencing whistles in their order of importance were: time of year, time of day, wind velocity, relative humidity and temperature. Light intensity and barometric pressure had little influence on whistling behavior.

The daily peak of whistling activity varied from sunrise to

20 minutes after sunrise, number of calls decreasing thereafter.

Wind velocity was important only when the listening stations were exposed to the wind and was negatively correlated with quail whistles as was relative humidity.

After the seasonal peak of whistling, temperature was negatively correlated with quail whistles but sporadic before the peak being both positive and negative.

After the seasonal peak of whistling, a negative correlation of whistles with barometric pressure was noted. The correlation was believed to be a function of topography rather than a true correlation with whistling activity.

Rate of calling of individual birds when periods between active calling were included, averaged 2.87 calls per minute, actively calling quail averaged 4.3 calls per minute. A highly significant correlation existed between rate of calling and total calls heard (r=0.52).

No correlations between intensity of quail whistles and any of the variables were noted.

Both growth of vegetation in the spring and type of vegetation affected the radius of audibility of quail whistles.

The relation of the variables to quail whistle counts was discussed. Correction factors for adjusting the results of whistle counts were determined from the regression coefficients of the variable considered and the amount of deviation of the variables from a standard determined by the means of the variables.

The results indicated an 18.62 percent increase of whistling activity between 1963 and 1964 and a 31.55 percent increase between

1964 and 1965.

Recommendations were made for conducting whistle counts in northeastern Kansas.

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APPENDIX

Table 11. Amount of variation of total calls attributable to variables tested for each individual station, Route 1, 1963. (R^2=fraction of variation attributable to regression of x's on Y).

Station	Total Calls	R^2 of Variables: Time Factors	Meteor. Factors	Total Factors
1	27	0.08	0.31*	0.38*
2	21	0.15	0.27*	0.40*
3	11	0.08	0.41*	0.44*
4	223	0.45**	0.51**	0.56**
5	175	0.31*	0.48**	0.58**
6	136	0.11	0.10	0.24
7	239	0.17	0.28*	0.39*
8	266	0.31**	0.26*	0.47**
9	139	0.48**	0.46**	0.66**
10	347	0.67**	0.34*	0.75**
11	275	0.48**	0.27*	0.69**
12	98	0.49**	0.35*	0.67**
13	340	0.35**	0.26*	0.53**
14	526	0.57**	0.39**	0.74**
15	348	0.57**	0.41**	0.65**
16	320	0.35**	0.42**	0.50**
17	358	0.45**	0.30*	0.59**
18	304	0.49**	0.33*	0.54**
19	148	0.32*	0.38*	0.55**
20	303	0.32*	0.21	0.37*

* Significant at .05 level.
** Significant at .01 level.

Table 12. Amount of variation of total calls attributable to variables tested for each individual station, Route 2, 1963. (R^2=fraction of variation attributable to regression of x's on Y).

Station	Total Calls	R^2 of Variables: Time Factors	Meteor. Factors	Total Factors
1	85	0.11	0.24	0.43*
2	129	0.23*	0.30*	0.37*
3	37	0.23*	0.32*	0.38*
4	84	0.03	0.43**	0.43*
5	31	0.27*	0.30*	0.54**
6	16	0.19	0.22	0.39*
7	49	0.09	0.19	0.24
8	104	0.31*	0.32*	0.47**
9	307	0.61**	0.51**	0.69**
10	256	0.40**	0.48**	0.57**
11	276	0.44**	0.33*	0.51**
12	147	0.48**	0.49**	0.63**
13	52	0.34*	0.33*	0.54**
14	162	0.28*	0.36*	0.49**
15	311	0.30*	0.38*	0.46*
16	362	0.36**	0.68**	0.70**
17	115	0.17	0.59**	0.66**
18	355	0.28*	0.46**	0.53**
19	247	0.21	0.27*	0.33*
20	409	0.20	0.50**	0.52**

* Significant at .05 level.
**Significant at .01 level.

Table 13. Amount of variation of total calls attributable to variables tested for each individual station, Route 1, 1964 (R^2=fraction of variation attributable to regression of x's on Y).

	R^2 of Variables			
Station	Total Calls	Time Factors	Meteor. Factors	Total Factors
1	209	0.28*	0.19	0.39**
2	42	0.37**	0.38**	0.53**
3	72	0.25*	0.11	0.30*
4	367	0.32**	0.17	0.53**
5	169	0.13	0.13	0.40**
6	270	0.36**	0.44**	0.75**
7	320	0.42**	0.24*	0.73**
8	477	0.36**	0.24*	0.46**
9	475	0.39**	0.39**	0.60**
10	839	0.51**	0.55**	0.67**
11	561	0.45**	0.45**	0.73**
12	342	0.54**	0.23*	0.68**
13	666	0.35**	0.55**	0.70**
14	827	0.50**	0.27*	0.81**
15	827	0.51**	0.20*	0.72**
16	663	0.40**	0.31*	0.62**
17	543	0.42**	0.36**	0.77**
18	482	0.43**	0.42**	0.57**
19	293	0.33**	0.12	0.53**
20	424	0.36**	0.15	0.43**

* Significant at .05 level.
**Significant at .01 level.

Table 14. Amount of variation of total calls attributable to variables tested for each individual station, Route 2, 1964. (R^2=fraction of variation attributable to regression of x's on Y).

Station	Total Calls	R^2 of Variables: Time Factors	Meteor. Factors	Total Factors
1	99	0.10	0.22*	0.29*
2	79	0.22*	0.22*	0.33*
3	85	0.17	0.07	0.32*
4	196	0.32**	0.22*	0.37*
5	226	0.46**	0.26*	0.53**
6	191	0.27*	0.10	0.47**
7	111	0.23*	0.26*	0.38*
8	420	0.36**	0.20*	0.53**
9	732	0.55**	0.30*	0.63**
10	452	0.55**	0.41**	0.58**
11	347	0.34**	0.45**	0.63**
12	489	0.26*	0.24*	0.41*
13	266	0.40**	0.39**	0.60**
14	206	0.40**	0.40**	0.72**
15	319	0.30**	0.41**	0.51**
16	753	0.53**	0.43**	0.60**
17	499	0.30**	0.49**	0.53**
18	627	0.48*	0.50**	0.71**
19	251	0.25*	0.31*	0.45**
20	220	0.14	0.29*	0.49**

* Significant at .05 level.
** Significant at .01 level.

Table 15. Amount of variation of total calls attributable to variables tested for each individual station, Route 1, 1965. (R^2=fraction of variation attributable to regression of x's on Y).

Station	Total Calls	R^2 of Variables: Time Factors	Meteor. Factors	Total Factors
1	115	0.39*	0.45	0.66
2	87	0.54*	0.24	0.72
3	32	0.33	0.35	0.55
4	369	0.66**	0.28	0.87*
5	216	0.60**	0.44	0.92**
6	255	0.56*	0.45	0.95**
7	113	0.68**	0.45	0.93**
8	488	0.58*	0.30	0.88*
9	309	0.22	0.79**	0.84*
10	534	0.59**	0.60*	0.89*
11	371	0.68**	0.52	0.81*
12	394	0.66**	0.61*	0.81*
13	691	0.61**	0.33	0.83*
14	471	0.53*	0.90**	0.95**
15	781	0.87**	0.53	0.97**
16	511	0.69**	0.33	0.83*
17	486	0.68**	0.39	0.79*
18	319	0.72**	0.52	0.87*
19	216	0.48*	0.35	0.72
20	301	0.54*	0.87**	0.99**

* Significant at .05 level.
**Significant at .01 level.

Table 16. Amount of variation of total calls attributable to variables tested for each individual station, Route 2, 1965. (R^2=fraction of variation attributable to regression of x's on Y).

Station	Total Calls	R^2 of Variables		
		Time Factors	Meteor. Factors	Total Factors
1	58	0.30	0.75**	0.87**
2	38	0.46*	0.58*	0.91**
3	43	0.44*	0.30	0.77*
4	185	0.55**	0.61*	0.71*
5	217	0.51*	0.46	0.75*
6	188	0.58**	0.31	0.75*
7	161	0.28	0.59*	0.96**
8	431	0.59**	0.48	0.83*
9	601	0.78**	0.59*	0.87**
10	348	0.73**	0.60*	0.80*
11	420	0.84**	0.66*	0.89**
12	232	0.79**	0.55*	0.92**
13	155	0.44*	0.22	0.64
14	193	0.44*	0.45	0.63
15	402	0.51*	0.16	0.93**
16	481	0.57**	0.88**	0.93**
17	272	0.35	0.75**	0.85**
18	464	0.81**	0.90**	0.97**
19	230	0.56**	0.58*	0.79*
20	134	0.36*	0.32	0.91**

* Significant at .05 level.
**Significant at .01 level.

Table 17. Analysis of factors influencing whistling of bob-white quail Route 1, 1963 stations combined b= regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data(1)			Post-Peak Data(2)		
Variables	b	Sb	t	b	Sb	t
T:D	-0.044	0.015	2.92**	-0.034	0.023	1.46
D:Y	0.403	0.033	12.32**	0.130	0.180	0.72
W	-0.653	0.225	2.91**	0.202	0.508	0.40
L	0.000	0.000	0.40	-0.000	0.000	1.65
BP	-0.007	0.006	1.17	0.030	0.023	1.01
T	0.242	0.119	2.04*	-0.422	0.860	0.50
RH	0.280	0.064	4.37**	-0.498	0.344	1.45
T:D	-0.020	0.026	0.79	0.021	0.055	0.40
D:Y	0.484	0.055	8.74	-0.022	0.267	0.08
W	-0.066	0.212	0.31	0.183	0.644	0.28
L	0.000	0.000	0.63	-0.000	0.000	1.57
BP	0.005	0.006	0.81	0.035	0.034	1.02
T	-0.223	0.122	1.83	-0.611	1.008	0.61
RH	-0.091	0.073	1.29	-0.536	0.406	1.32

(1)Number observations for pre-peak data=300.
(2)Number observations for post-peak data=100.
* Significant at .05 level.
** Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 18. Analysis of factors influencing whistling of bobwhite quail Route 2, 1963 stations combined b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data(1)			Post-Peak Data(2)		
Variables	b	Sb	t	b	Sb	t
T:D	-0.054	0.014	3.81**	-0.012	0.022	0.53
D:Y	0.249	0.035	7.22**	-0.075	0.141	0.54
W	-0.143	0.163	0.88	-0.985	0.652	1.51
L	0.000	0.000	0.70	0.000	0.000	0.17
BP	-0.009	0.004	2.09*	-1.023	0.172	5.95**
T	0.104	0.073	1.44	-0.005	0.345	0.02
RH	0.353	0.063	5.64**	0.129	0.120	1.08
T:D	-0.068	0.021	3.24**	0.003	0.026	0.10
D:Y	0.217	0.047	4.58**	-0.204	0.178	1.15
W	-0.062	0.167	0.37	-0.809	0.670	1.21
L	0.000	0.000	1.56	-0.000	0.000	0.60
BP	0.004	0.005	0.81	-1.068	0.176	6.06**
T	-0.033	0.082	0.40	0.292	0.437	0.67
RH	0.155	0.073	2.11*	0.099	0.125	0.79

(1)Number observations for pre-peak data=280.
(2)Number observations for post-peak data=120.
* Significant at .05 level.
**Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 19. Analysis of factors influencing whistling of bob-white quail Route 1, 1964 stations combined b= regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data(1)			Post-Peak Data(2)		
Variables	b	Sb	t	b	Sb	t
T:D	-0.042	0.018	3.33**	-0.076	0.030	2.46*
D:Y	0.490	0.038	12.96**	-0.661	0.092	7.17**
W	0.343	0.326	1.05	-1.644	0.524	3.14**
L	0.000	0.000	0.08	0.000	0.000	0.02
BP	0.183	0.044	4.12**	-1.064	0.190	5.59**
T	0.409	0.083	4.94**	-3.077	0.596	5.16**
RH	0.503	0.117	4.28**	-0.970	0.234	4.15**
T:D	-0.060	0.032	1.86	0.066	0.050	1.32
D:Y	0.698	0.065	10.74**	-0.665	0.092	7.19**
W	0.352	0.272	1.29	-0.754	0.479	1.57
L	0.000	0.000	1.67	0.000	0.000	0.66
BP	0.033	0.039	0.83	-1.127	0.174	6.47**
T	-0.524	0.116	4.54**	-2.610	0.591	4.41**
RH	0.120	0.102	1.95	-0.455	0.234	1.94

(1)Number observations for pre-peak data=279.
(2)Number observations for post-peak data=198.
* Significant at .05 level.
**Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 20. Analysis of factors influencing whistling of bob-white quail Route 2, 1964 stations combined b= regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data[1]			Post-Peak Data[2]		
Variables	b	Sb	t	b	Sb	t
T:D	-0.045	0.020	2.25*	-0.079	0.022	3.56**
D:Y	0.477	0.045	10.58**	-0.257	0.073	3.53**
W	-0.424	0.266	1.59	0.567	0.429	1.32
L	0.000	0.000	0.72	0.000	0.000	0.17
BP	0.051	0.020	2.57*	-0.543	0.127	4.26**
T	0.569	0.119	4.77**	-0.374	0.212	1.76
RH	0.341	0.118	2.88**	0.226	0.130	1.73
T:D	-0.106	0.031	3.36**	0.004	0.033	0.13
D:Y	0.611	0.082	7.42**	-0.446	0.077	5.79**
W	-0.077	0.244	0.32	0.619	0.395	1.57
L	0.000	0.000	1.91	0.000	0.000	0.17
BP	0.042	0.018	2.39*	-0.630	0.126	5.02**
T	-0.140	0.159	0.88	-0.894	0.224	3.99**
RH	-0.220	0.130	1.70	0.264	0.120	2.20**

(1)Number observations for pre-peak data=260.
(2)Number observations for post-peak data=180.
* Significant at .05 level.
**Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 21. Analysis of factors influencing whistling of bob-white quail Route data 1965 all stations combined b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Route 1(1)			Route 2(2)		
Variables	b	Sb	t	b	Sb	t
T:D	-0.090	0.028	3.22**	-0.095	0.025	3.75**
D:Y	0.184	0.072	11.28**	0.654	0.062	10.50**
W	-0.347	0.133	2.61**	0.113	0.445	0.25
L	-0.000	0.000	1.10	0.000	0.000	0.97
BP	-1.240	0.438	2.83**	0.247	0.103	2.39*
T	0.632	0.210	3.01**	0.609	0.203	2.99**
RH	0.181	0.205	0.88	0.594	0.181	3.27**
T:D	-0.008	0.042	0.19	0.068	0.043	1.59
D:Y	1.181	0.108	10.85**	0.862	0.010	8.62**
W	-0.564	0.110	5.11**	-0.072	0.387	0.19
L	-0.000	0.000	1.02	0.000	0.000	0.01
BP	-3.560	0.358	0.99	0.325	0.113	2.88**
T	-1.404	0.266	5.28**	0.515	0.240	2.14*
RH	-0.342	0.172	1.99*	0.002	0.170	0.01

(1)Number observations for route 1=217.
(2)Number observations for route 2=240.
* Significant at .05 level.
** Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 22. Analysis of factors influencing whistling of bob-white quail Permanent station, 1963 b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data(1)			Post-Peak Data(2)		
Variables	b	Sb	t	b	Sb	t
T:D	-3.316	0.760	4.36**	-1.393	0.995	1.40
D:Y	0.883	0.117	7.53	-1.801	0.380	4.74**
W	-2.383	0.817	2.91**	-2.819	0.278	2.20*
L	-0.000	0.000	2.31*	-0.000	0.000	0.76
BP	-0.972	0.456	2.13*	-0.958	0.773	1.23
T	1.529	0.416	3.67**	1.723	1.785	0.96
RH	0.694	0.315	1.98	0.790	0.826	0.96
T:D	-2.354	1.140	2.06*	-0.913	1.928	0.47
D:Y	0.601	0.185	3.24**	-1.739	1.490	1.17
W	-1.606	0.790	2.03*	-1.373	1.541	0.89
L	-0.000	0.000	0.25	0.000	0.000	0.06
BP	-0.652	0.443	1.47	0.469	1.385	0.33
T	0.324	0.517	0.63	1.024	3.562	0.29
RH	-0.043	0.387	0.11	0.682	2.097	0.32

(1)Number observations for pre-peak data=80.
(2)Number observations for post-peak data=40.
* Significant at .05 level.
** Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 23. Analysis of factors influencing whistling of bob-white quail Permanent station, 1964 b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data(1)			Post-Peak Data(2)		
Variables	b	Sb	t	b	Sb	t
T:D	-1.454	0.674	2.16*	-2.703	0.841	3.21**
D:Y	0.435	0.075	5.80**	-0.971	0.134	7.22**
W	-1.611	0.383	4.20**	-4.067	1.027	3.96**
L	-0.001	0.000	3.29**	-0.001	0.000	4.29**
BP	0.623	0.129	4.81**	0.421	0.357	1.18
T	1.349	0.186	7.27**	-1.008	0.520	1.94
RH	-0.607	0.175	3.44**	-2.759	0.563	4.90**
T:D	-0.616	0.954	0.65	-0.415	1.495	0.28
D:Y	0.008	0.144	0.06	-0.708	0.187	3.78**
W	-1.553	0.447	3.47**	-3.850	0.953	4.01**
L	-0.001	0.000	1.70	-0.001	0.000	1.71
BP	0.625	0.145	4.31**	0.057	0.355	0.16
T	1.327	0.301	4.41**	-0.953	0.491	1.94
RH	-0.579	0.223	2.60*	-1.756	0.591	2.97**

(1)Number observations for pre-peak data=128.
(2)Number observations for post-peak data=90.
* Significant at .05 level.
**Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 24. Analysis of factors influencing whistling of bob-white quail Permanent station, 1965 b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

Variables	b	Sb	$t^{(1)}$
T:D	-1.800	0.510	3.52**
D:Y	0.641	0.062	10.40**
W	-2.390	0.467	5.12**
L	-0.001	0.000	2.10*
BP	0.150	0.137	1.10
T	0.383	0.230	1.67
RH	-0.334	0.156	2.14*
T:D	-0.342	0.885	0.39
D:Y	0.821	0.099	8.32**
W	-0.741	0.419	1.77
L	-0.000	0.000	1.03
BP	-0.284	0.123	2.31*
T	-1.014	0.251	4.03**
RH	0.219	0.134	1.63

(1)Number observations for pre-peak data=120.
* Significant at .05 level.
**Significant at .01 level.
T:D=Time of day.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 25. Analysis of factors influencing whistling of bob-white quail Pooled data of permanent station, 1963, 1964 and 1965 b=regression coefficient, Sb=standard deviation and t=student's t value without regard to sign.

	Pre-Peak Data(1)			Post-Peak Data(2)		
Variables	b	Sb	t	b	Sb	t
T:Y	-2.052	0.363	5.66**	-2.830	0.826	3.43**
D:Y	0.513	0.050	10.24**	-0.575	0.139	4.13**
W	-1.885	0.287	6.57**	-5.447	0.806	6.75**
L	-0.000	0.000	3.00**	-0.000	0.000	2.14*
BP	0.160	0.091	1.75	0.663	0.323	2.05*
T	0.793	0.132	6.02**	-0.500	0.481	1.04
RH	-0.205	0.100	2.06*	-1.529	0.497	3.08**
T:Y	-2.248	0.525	4.28**	-2.676	1.168	2.29*
D:Y	0.374	0.075	4.95**	-0.532	0.163	3.26**
W	-1.248	0.285	4.38**	-4.791	0.799	6.00**
L	0.000	0.000	0.83	0.000	0.000	0.80
BP	0.048	0.097	0.50	0.593	0.310	1.91
T	0.219	0.175	1.25	-0.570	0.500	1.14
RH	-0.264	0.097	2.72**	-0.953	0.514	1.85

(1)Number observations for pre-peak data=301.
(2)Number observations for post-peak data=130.
* Significant at .05 level.
**Significant at .01 level.
T:Y=Time of year.
D:Y=Day of year.
W =Wind velocity.
L =Light intensity.
BP=Barometric pressure.
T =Temperature.
RH=Relative humidity.

Table 26. Change of whistling activity from 1963-1964 and 1964-1965 as depicted during various times of the year showing percent change before and after correction factors were applied.

Basis	Percent change 1963-1964				Percent change 1964-1965			
	Route 1	Route 2	Permanent Station	Total	Route 1	Route 2	Permanent Station	Total
May and June uncorrected	6.17	36.65	-1.96	19.60	41.13	61.19	1.64	36.93
May and June corrected	11.13	34.46	0.08	18.62	44.90	59.97	-15.59	31.55
Entire Year before peak uncorrected	34.97	118.42	80.12	62.79	65.08	45.08	-44.44	24.94
Entire Year before peak corrected	6.83	3.37	20.71	43.79	45.02	80.32	-41.48	23.08
Entire Year after peak uncorrected	72.12	9.75	35.97	35.93	- - - - - - - - No data - - - - - - - -			
Entire Year after peak corrected	84.26	157.32	16.17	72.21	- - - - - - - - No data - - - - - - - -			

INVESTIGATIONS OF SOME FACTORS INFLUENCING WHISTLING OF BOBWHITE QUAIL IN NORTHEASTERN KANSAS

by

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B. S., Kansas State University, 1964

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To determine the effects of time of year, time of day, wind velocity, barometric pressure, light intensity, temperature and relative humidity on rate and intensity of bobwhite quail (Colinus virginianus) whistles, whistle counts were conducted during the spring and summer of 1963, 1964 and 1965.

Studies were conducted on two 10-mile routes and a permanent station in Riley County, Kansas. The total quail whistles heard during 20, 5-minute periods for the routes and 10, 5-minute periods for the permanent station for each week were compared to the corresponding meteorological conditions and times by the multiple linear regression method. A total of 51,091 quail whistles were analysed.

The R^2, fraction of variation of quail whistles attributable to variables tested, varied from 0.03 to 0.99 for separate station analyses.

When the data were combined and pooled from 20 to 60 percent of the variability of quail whistles could be explained by the factors examined.

The primary factors influencing whistles in their descending order of importance were: time of year, time of day, wind velocity, relative humidity and temperature.

The first calls of the season were generally heard around the first of April. The peak of whistling activity varied from 15 June to 17 July.

The daily peak of whistling varied from sunrise to 20 minutes after, number of calls decreasing thereafter.

Wind velocity was important only when the stations were exposed to the wind and was negatively correlated to whistles as was relative humidity.

Temperature correlations were erratic but generally, positively correlated to whistles before the seasonal peak of whistling activity and negatively correlated after. Barometric pressure and light intensity had little influence on number of whistles heard.

Rate of calling of individual birds when periods between active calling were included averaged 2.87 calls per minute. Actively calling birds varied from 3 to 6 calls per minute, averaging 4.3.

No correlations between intensity of calls and any variables were noted.

Both the growth of vegetation in the spring and type and density of vegetation affected the radius of audibility of quail whistles.

Correction factors for adjusting the results of quail whistle counts were determined from correlation coefficients of the pooled permanent station data for the important variables. Recommendations were made for conducting whistle counts in northeastern Kansas.