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QUAIL, LAND USE, AND WEATHER IN ILLINOIS, 1956-70

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Abstract:

Bobwhite quail (Colinus virginianus) populations were at a 15-year high in 1968 and 1969 in Illinois. Analysis indicated that quail abundance over the years from 1956 through 1970 was significantly correlated with changes in land use and weather. Adverse effects associated with increased acreages of row crops and reduced acreages of oats appeared to be offset by aspects of land use, favorable to quail, that were associated with reduced acreages of harvested hay. Quail also appeared to be adversely affected by heavy snow, above-normal rainfall in late winter and spring, heavy summer rains, and drought in summer and fall.

The objective of this analysis was to use stepwise and multiple correlation techniques to identify some of the population, land-use, and weather parameters associated with fluctuations in the abundance and harvest of bobwhites in Illinois during the years from 1956 through 1970. This paper represents a preliminary examination of highly complex relationships.

The concept of the analysis was that abundance and harvest reflect the quality of the environment for quail and that changes in abundance and harvest reflect changes in the environment. Environmental effects were categorized under 2 primary headings: (A) population fluctuations resulting from man's changing use of the land and (B) the modifying influences of weather on the biotic community.

This analysis was made possible by the recent publication of 15 years of data on the abundance and harvest of upland game in Illinois. W. L. Preno, who directed the collection of data for the Department of Conservation, Department personnel who assisted the project, and R. L Labisky, who wrote the report and supervised its publication, are to be congratulated for their fine work. I express my appreciation to Glen C. Sanderson and Helen C. Schultz for editing this manuscript.

Methods

Data on the relative abundance and harvest of bobwhites used in this analysis were those of Preno and Labisky (1). These data include: (A) the mean number of bobwhites per 1,000 acres as determined by censuses conducted on 8 selected study areas with pointing dogs during January and February; (B) the mean number of individual male bobwhites heard whistling during 20, 2-min periods along 39, 20-mile census routes (20 stops per route) run twice annually during late May and June; and (C) the calculated statewide quail harvest for Illinois as determined from annual mail surveys of 8,000 to 12,000 resident small-game licensees.

One may question the accuracy of estimates based on hunter questionnaires, particularly county estimates. However, when findings from hunter questionnaires are viewed as indices to statewide harvest, the problem of possible effect of bias on accuracy is reduced. The fact remains that Preno and Labisky (1) provide 1 of the best long-term series of data on upland game currently available. Until better data become available, it remains the responsibility of those of us concerned with the dynamics of game abundance to use the data that are available.

Statistics on land use were obtained from Illinois Agricultural Statistics (2), Bulletins 56-1 through 71-1 (1956-71 inclusive). Preliminary analysis revealed possibly significant correlations with the quail population data for only 3 land-use parameters: (A) harvested acreage of corn, (B) harvested acreage of oats, and (C) total acreage of hay. The total acreage of hay represents a summing of the acreages of harvested hay and the acreages of legumes and grasses harvested for seed.

Weather data were compiled from Climatological Data Illinois (3), Vols. 60 through 75 (1955-70 inclusive). Parameters considered in this analysis were (A) mean monthly temperature, (B) mean monthly precipitation, (C) mean monthly snowfall, and (D) an index of monthly precipitation effectiveness derived according to Setzer (4). This index (Q) is obtained from the equation: $Q=P/1.07^t$, where P is the monthly precipitation in mm, t is the monthly mean temperature in degrees (C), and 1.07 is a constant derived by Setzer (4).

Weather data used in these analyses are statewide averages. These averages were used because the quail data were believed related to trends in harvest and abundance of the statewide quail population.

Testing and modeling of the data were severely restricted because the population data spanned just 15 years. A minimum of 30 years of data is desirable to obtain valid estimates of variability and response. Stepwise correlation was used to screen the environmental data to identify parameters closely associated with abundance and harvest. Variables that were considered to be associated with fluctuations in the population data were combined for multiple correlation. Analysis was performed by computer facilities of the University of Illinois, Urbana.

Several problems are inherent with an analysis of this type using only 15 years of census data. First there is the problem of relationships that would be recognized as significant if the data were more precise or if they spanned a longer period of years. Because of this problem it seems pointless to hold strictly to an arbitrary rule that a probability of less than 5% is necessary for rejection of hypotheses. I am more impressed with the nature and consistency of relationships than with the size of a particular test statistic. A closely related problem is that if enough parameters are examined, several will be found that are closely correlated simply on the basis of chance. There is no basis for eliminating these other than the rather arbitrary view of the worker as to whether they make sense and are consistent with other findings. There are also instances where the correlation coefficient between a particular independent variable and the dependent variable has 1 sign while the coefficient of regression from multiple correlation for that particular independent variable has the opposite sign. This difference in signs makes it risky to attribute a positive effect to a variable on the basis of the beta value when the correlation coefficient is negative.

A desirable objective is to combine apparently significant population, land use, and weather factors into 1 analysis that gives some idea of the relative importance of the factors and provides a model for predicting relative quail abundance. We have a problem here in that with only 15 years of data we can expect at best only 4 or 5 variables to produce test statistics significant at the 5% level. In reality, several times that number of variables are undoubtedly significant. At the same time, merely adding enough vectors of random numbers as predictors would reduce criterion variance to a very low level giving an inflated and misleading R^2.

Attempting to evaluate the relationships between weather and quail abundance and harvest using only 15 years of data has proved difficult. The analyses were complicated by the fact that weather unfavorable to quail may reflect either above or below normal conditions and may develop at any time during the year. For example, drought in July or August might be a problem at 1 time and torrential summer rains and flooding could be critical at another time.

The question can be raised as to what constitutes a high or low value for a given weather factor. The answer here undoubtedly relates to the normal climatic conditions to which the species is genetically adapted and to those prevailing weather conditions to which the individual has become acclimated. In the long run, thermoregulation and bioenergetics of organisms become critical. Conditions that create less favorable energy relations are undoubtedly less advantageous for the population than conditions that create a more desirable energy situation.

Findings

Preno and Labisky (1:25) concluded that the abundance of bobwhites in Illinois was markedly greater in 1968 and 1969 than at any other time during the 15 years of their data (Fig. 1, Table 1). However, they pointed out that this high was evident throughout western and southern Illinois, but was not noted in intensively farmed counties in east-central and northern Illinois.

The first phase of this analysis was to determine possible relationships with the abundance of quail, as indicated by a particular census, with quail abundance during previous census periods. In general, the relative abundance of quail as indicated by a given census was poorly correlated with trends in abundance evidenced by the census that preceded it. For example, only about 10% of the annual fluctuations in quail harvest could be associated with changes apparent in the 4 censuses that immediately preceded.

The conclusion drawn from this phase of the analysis is that we cannot satisfactorily predict changes in the abundance or harvest of quail on a statewide basis simply by using trends in abundance indicated by previous censuses. Two hypothesis can be drawn from this conclusion: (A) the censuses are not useful predictors of harvest, and (B) the statewide quail population or harvest is responding sharply to changing patterns of landuse, or weather, or both.

Land Use

The magnitude and rate of change in land use and man's effect on the environment over the past 15 years are difficult if not impossible to conceive. Some idea of the changes in land use can be obtained from the agricultural statistics for Illinois (Tables 2 and 3). Many potentially significant parameters of land use remain unmeasured. To name a few, these parameters include use of insecticides and herbicides, fall and winter plowing, mowing for weed control, stubble shredding, shifting from corn pickers to combines, and removing fences and fencerows.

The impression gained from agricultural statistics and from the changing appearance of farmland is that the carrying capacity of Illinois for quail should have been greatly reduced since 1955. With the possible exception of the intensively farmed counties in east-central and northern Illinois, this impression does not fit with the available data on quail abundance and harvest.

Of the land-use parameters for which data were available for the 15 years, only corn, oats, and hay demonstrated relatively high correlations with the quail harvest. Of these 3 crops, it appeared that quail abundance was most closely associated with the acreage of hay and least well correlated with corn. The test statistics indicate the relationships for both hay and oats with quail abundance to be significant.

The regression coefficients suggest that the decline in the acreages of oats over the last 15 years has been associated with conditions making the environment less favorable for quail. At the same time, the negative regression coefficient for hay suggests that the reduction in haying was somehow associated with habitat conditions more favorable for quail. However, we are undoubtedly dealing with very complex relationships, and at this time I will not attempt to speculate on what might be involved.

Weather

Snowfall

Snowfall data were examined on the basis of monthly averages for (A) the individual months of November through April, (B) early winter--total snowfall for November through January, C) late winter--total snowfall for February through April, and (D) total snowfall for the winter.

The analysis of the snowfall data indicates that quail harvest was negatively correlated with total snowfall during the months of February through April (r_{14} = -0.718; t_{13} =-3.721). This finding suggests that above-normal snowfall in late winter and early spring is related to reduced quail harvest in the succeeding fall. This information, coupled with the absence of a strong correlation between snowfall and whistle counts, suggests further that effect of snowfall was somehow manifested through reproduction or survival of juveniles rather than survival of adults.

Rainfall

Although tests of correlation of rainfall with indices of the population and harvest were not highly significant, a pattern did emerge from the analyses that suggested a positive relationship between rainfall in fall and early winter and quail abundance.

The strongest correlation between monthly rainfall and quail per 1000 acres on study areas in February was for the month of December (r = 0.496; t = 3.134). The maximum monthly precipitation for November through January was also positive and was ranked high by step-wise analysis using both quail per 1000 acres and whistle counts as dependent variables. Rainfall in October prior to hunting and the maximum monthly precipitation in early winter of the previous year were ranked first and third, respectively, in step-wise analyses of rainfall with estimated harvest of quail. Again, both of these relationships were positive.

A positive correlation between rainfall in fall and early winter and quail abundance is logical in that we would expect delayed harvest of corn and soybeans and delayed or reduced fall plowing to be associated with increased rainfall. Thus, improved habitat conditions would be associated with increased rainfall in fall and early winter. A second possibility would be that an increase in rainfall in fall and early winter would decrease hunting and thereby quail mortality thus resulting in more birds on areas in February and more whistling birds (potential breeders) in June and thus more quail the following hunting season.

Temperature

Correlation of quail population indices and harvest estimates with mean monthly temperatures failed to indicate any consistent pattern for the 15 years. Although temperatures may have been a contributing factor in fluctuations of abundance and harvest of quail, the evidence does not indicate that temperature in itself was critical during 1956-70.

Precipitation Effectiveness (PE)

Because of the generally weak correlation of temperature and precipitation with the indices of quail abundance and harvest, the next step in the evaluation of the effects of weather on the statewide Illinois quail population was an attempt to account for the combined effects of monthly mean temperature and precipitation. Setzer (4) provided an index that combines those 2 primary weather parameters into a single number. This PE index is positive with respect to precipitation and negative with respect to temperature.

Correlations of indices of abundance and harvest of quail with PE values were in general agreement with the interpretation of the analyses of the precipitation data except that the PE values generally indicated higher correlations. The analyses suggested that low precipitation or high temperatures, or both, in summer, fall, and early winter were related to low populations and harvests as were high precipitation or low temperatures, or both, in late winter and early spring.

Discussion

Several tentative conclusions may be drawn from the analyses presented above. The first is that changes in the abundance and harvest of quail in Illinois over the past 15 years were associated with changes in land use and with weather.

It appears that adverse effects on quail, associated with reduced acreages of oats and other small grains and increased acreages of corn and row crops, were somehow offset by favorable conditions associated with decreased acreages of hay. These changes in land use, plus favorable weather conditions, were apparently related to the generally high quail populations over much of Illinois during the late 1960's.

In general, it appears that a reduced quail population index can be expected with some combination of (A) heavy winter snowfall, (B) a combination of low temperatures and high precipitation in winter and spring, (C) a combination of high temperatures and low precipitation in summer, and (D) heavy summer rains. Although 15 years are not enough to evaluate fully the effects of weather, the above conditions could logically occur--and affect quail--with a relatively high frequency. However, the factors studied by no means cover the full range of weather conditions that could be expected to affect quail in Illinois.

The major conclusion to be drawn from this attempt to analyze the effects of weather on bobwhites in Illinois is that we must not expect to find a single key weather parameter or a particularly critical time in the annual cycle. In the final accounting, we will certainly find significance of intensity, frequency, duration, and timing of events. I am certain that weather is favorable or unfavorable depending on whether it places quail in a favorable or unfavorable position with respect to bioenergetics and thermoregulation. Weather effects may involve the population directly through metabolic responses of individual animals or indirectly through the variety, quantity, and quality of quail food and cover or the availability of food and cover. Any departure from normal climatic conditions is potentially limiting.

Even though weather and changes in land use are largely unpredictable, the biologist possessing data on current land use, recent quail populations, and prevailing weather conditions may soon be able to predict harvest and offer sound theories on the causes of fluctuations in quail abundance. The key to prediction will be continuity in a long-term series of quail population data.

Changes in land use in Illinois have been so great over the past 15 years that it does not seem possible that quail could be as abundant today as they were in 1955. The high quail populations of 1968 and 1969 may have been induced by particularly favorable climatic conditions or by whatever factors trigger a cyclic high (if such exists for quail). My personal view is that we will never again see quail as abundant in Illinois as they were in 1968 and 1969. Only time and more years of data can tell us if this appraisal of the effects of land use and weather is essentially correct.

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Table 1. Indices of abundance and estimated harvest of bobwhites in Illinois, 1956-70 (1:26-27).

Year	Quail per 1,000 acres in february	Current index as percent of previous index	Mean number of whistling cocks per 20, 2-minute stops	Current index as percent of previous index	Quail harvest in 100 thousands	Current index as percent of previous index
1956	60	---	24.5	---	2503	---
1957	62	103	23.6	96	2350	94
1958	59	95	26.1	111	2846	121
1959	56	95	32.9	126	2360	83
1960	59	105	28.2	86	1502	64
1961	38	64	25.8	91	1652	110
1962	43	113	24.2	94	2359	143
1963	48	111	27.0	112	2619	111
1964	62	129	25.9	96	1730	66
1965	64	103	29.5	114	1360	79
1966	62	97	23.5	80	2087	153
1967	77	124	28.5	121	1726	83
1968	82	106	32.7	115	2436	141
1969	.80	98	42.3	129	2388	98
1970*	76	95	33.6	79	2218	93

*Personal communication, W. L. Preno

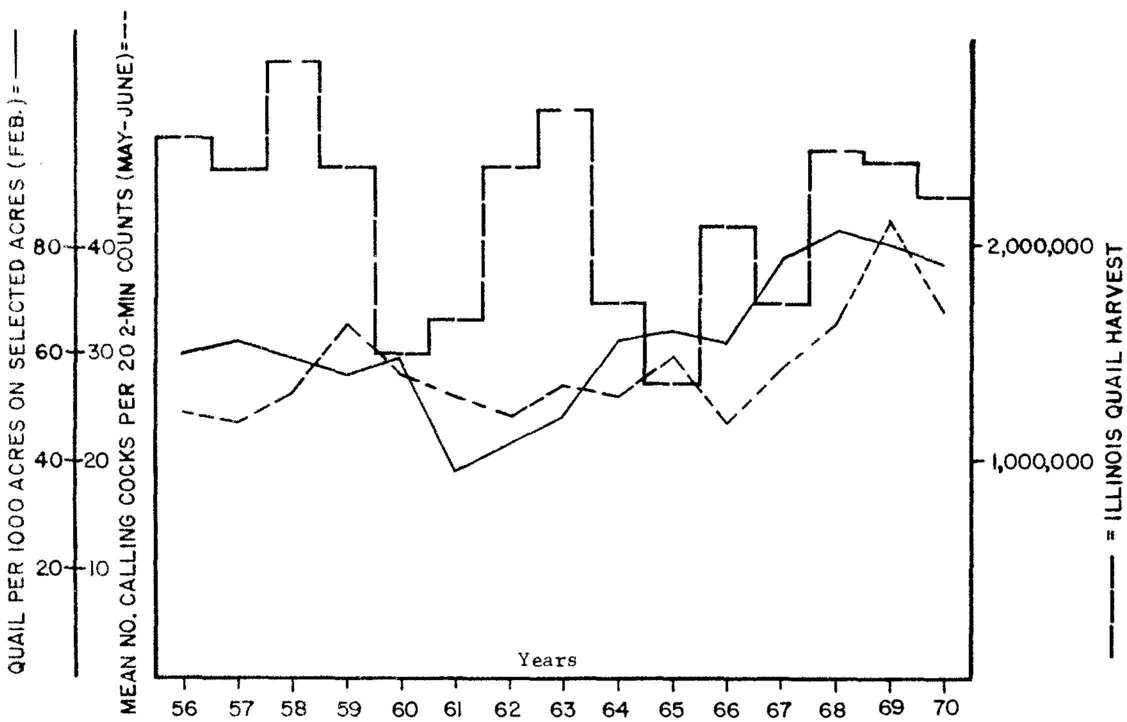

Fig. 1. Indices of Abundance and Estimated Harvest of Bobwhite in Illinois, 1956-1957 (1)

Table 2. Changes in selected agricultural statistics for Illinois, 1955-69 (2).

	Item	1955	1970	Change
1.	Average farm acreage	176	234	+33%
2.	Thousands of farms	178	126	-29%
3.	Thousands of cattle	4,028	3,278	-29%
4.	Thousands of sheep	528	295	-46%
5.	Thousands of acres total cropland	21,222	20,412	- 4%
6.	Corn	9,171	9,940	+ 8%
7.	Soybeans	4,328	6,865	+59%
8.	Oats	3,168	612	-81%
9.	Wheat, rye & barley	1,839	1,033	-44%
10.	All hay	2,520	1,260	-50%
11.	Grass & legumes for seed	229	100	-56%

Table 3. Harvested acreages (in thousands) of corn, oats, and hay in Illinois, 1955-70 (2).

Year	Corn	Oats	Hay
1955	9171	3168	2749
1956	8712	3057	2865
1957	8189	2568	2695
1958	8517	2427	2667
1959	10050	2233	2525
1960	9985	1867	2423
1961	8188	1634	2226
1962	8270	1503	2261
1963	8849	1386	2186
1964	9114	1123	2090
1965	9777	889	1921
1966	10342	907	1704
1967	10788	756	1523
1968	10088	756	1425
1969	9698	703	1341
1970	9940	612	1360