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EFFECTS OF THE 1988 DROUGHT ON BOBWHITES IN SOUTHERN ILLINOIS

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ABSTRACT

Severe drought conditions occurred throughout much of the United States during summer 1988. Using a 39-year record of bobwhite population and weather data as a baseline, it appeared that the drought adversely affected bobwhite reproduction and subsequent fall abundance in southern Illinois.

INTRODUCTION

The Northern bobwhite's (*Colinus virginianus*) geographic range includes virtually the entire United States east of the Rocky Mountains and south of the mixed coniferous-hardwood forest (Rosene 1969). Populations are most stable in the Southeast where annual rainfall >125cm and snowcover is rare; elsewhere, short-term fluctuations are often related to weather perturbations. In the Southwest, abundance is primarily determined by annual and seasonal precipitation (Jackson 1962, Lehmann 1984). In the Midwest, bobwhites are most affected by winter weather, especially duration of snowcover (Kabat and Thompson 1963, Stanford 1972, Roseberry and Klimstra 1984). Summer conditions, especially drought, can also be occasionally harmful (Stanford 1972, Roseberry and Klimstra 1984). The summers of 1930, 1934, 1936, 1952 and 1953 reportedly affected Midwestern bobwhite populations (Leopold and Ball 1931, Errington 1935, Bennitt and Nagel 1937, Wade 1938, Stanford 1953).

In 1988, a severe drought occurred over much of the United States. The objective of this paper is to describe the apparent effects of this climatological phenomenon on bobwhite reproduction and abundance in southern Illinois.

METHODS

Bobwhite population data were obtained as part of a separate, long-term study conducted by the Cooperative Wildlife Research Laboratory, SIU-C. From 1950

through 1988, a select group of quail hunters throughout the southern 34 counties of Illinois submitted an average 3,700 wings annually from harvested birds along with sex, date, and county where taken. Kill/effort data and subjective opinions regarding relative abundance were also obtained from 100-150 cooperators annually. Age of harvested quail was determined by appearance and molt of primary and covert wing feathers (Leopold 1939, Haugen 1957, Petrides and Nestler 1952). Hatching chronology was determined by backdating estimated age from date of kill. Young:adult ratios served as a measure of reproductive success the previous breeding season (Roseberry 1974), while hunter opinions and kill/effort data were used to assess relative population abundance.

Weather data (maximum and minimum daily temperature and precipitation) were obtained from approximately 30 weather-recording stations throughout southern Illinois for the period 1950-1988 (U.S. Dept. Commerce 1950-1988) and the years 1930, 1934, and 1936 (U.S. Dept. Agriculture 1930, 1934, 1936). Total precipitation, average daily temperature, and maximum daily temperature were computed for the following segments of the bobwhite's reproductive season: April (prenesting); 21 April-18 August (egg laying); 1 May-19 July (peak egg laying); 10 June-28 August (hatching); 20 June-18 August (peak hatching).

FINDINGS

1988 Drought

Cumulative precipitation for the 3-month period January-March, 1988 was above normal throughout southern Illinois. The months of April, May, and June, however, were extremely dry. Accumulated precipitation deficit for the 3-month period ending 30 June was approximately 60% (7.4″ deficit from 12.3″ normal). The drought was partially broken the 2nd week in July and precipitation for the month was slightly above average for the area as a whole. As is common in summer, however, there was considerable local variation. For example, Carmi in White County received 10.9″ of rainfall while Dixon Springs in Pope County recorded only 1.5″. Generally dry conditions returned in August with a monthly precipitation deficit of about 45% over most of the area.

To better assess the relative severity of the 1988 drought, precipitation during critical periods of the bobwhite's reproductive season was compared with the 1950-1987 mean and with historic drought years (U.S. Dept. Agriculture 1930, 1934, 1936). The 1988 egg laying season (21 April-18 August) was the driest recorded during the 39-year study (9.0″ rainfall or 56% of normal), while the hatching season (10 June-28 August) was the 7th driest (7.6″ rainfall or 77% of normal). Neither season was as dry as comparable periods in 1930 or 1936 which represent the 2 most severe summer droughts in recorded Illinois weather history (1878-1988). The 1988 egg-laying season was, however, drier than comparable periods in 1934, 1952, and 1953, while the hatching season was drier than 1934 and similar to 1952 (Fig. 1).

Temperatures during summer 1988 were above normal, but did not deviate relatively as much as did precipitation. Mean maximum daily temperatures during the egg-laying season (87.0°F) were the highest recorded during the 39-year period and were 3.4°F above the long-term mean. Temperatures during the hatching season (91.3°F) were also above normal (88.5°F) but were only the 7th highest recorded since 1950. Temperatures during the summer of 1988 were similar to those

of 1952 and 1953 but considerably below those recorded in the 1930s. The mean number of days with maximum temperatures ≥100°F per station in 1988 (9.1) was similar to 1952 and 1953 (7.3-7.4) but much less than 1930 (22.6), 1934 (18.5), or 1936 (36.0).

Bobwhite Population Parameters

The 1988 juvenile:adult harvest ratio of 3.45 was 32.5% below the 1950-1987 mean and the 3rd (tie) lowest recorded for that period. The proportion of males among juveniles was slightly higher than the long-term mean (51.2 vs 50.3%) while representation of males among adults was below average (57.2 vs 60.2%). Hatching chronology, as measured by an index of birds hatched after 29 July, was normal.

Relative abundance of bobwhites in southern Illinois was lower than expected during autumn 1988. Various predictive models based on previous winter conditions, spring call counts, and cyclic tendencies suggested a fall 1988 quail density similar to the previous year (unpubl. data, CWRI.); Illinois Department of Conservation predictions, based primarily on early-summer male whistling counts, were for an approximate 12% increase (Jack Ellis, pers. comm). In 1988, 103 hunters reported harvesting an average 3.36 birds/trip during 2,024 outings. This kill/effort index was down 12.3% from 1987 and was 9.7% below the long-term mean. Subjective hunter opinions regarding comparative abundance in 1988 vs 1987 indicated an even greater population decline. The frequency of response from 115 hunters was: smaller, 72%; same, 17%; and larger, 11%. A computed index of abundance based on these opinions was the 5th lowest recorded since the study was initiated. Many hunters noted that individual coveys tended to be numerically smaller than average. Separate field research by the author in Williamson County confirmed this observation.

DISCUSSION

A general consensus among quail biologists is that cool-moist summers are more conducive to good bobwhite reproduction than are hot-dry summers (Rosene 1969, Roseberry and Klimstra 1984). Positive correlations between summer precipitation and reproductive output have been reported in Florida (Murray 1958), Alabama (Speake and Haugen 1960), Kentucky (Durell 1957), Louisiana (Reid and Goodrum 1960), Texas (Kiel 1976), and Kansas (Robinson 1957). No statistical relationship was evident, however, between summer weather and recruitment rates during a 26-year study of a local southern Illinois population (Roseberry and Klimstra 1984). Similarly, no correlation ($P < 0.05$) was found between various measures of summer precipitation and temperature and either juvenile:adult ratios or indices of abundance for the 1950-1988 regional data set. Errington (1946) likewise could not relate bobwhite recruitment rates to summer weather during a 15-year study in Wisconsin. Lack of statistical correlation could be due to a) the bobwhite's extended nesting season and propensity for renesting following failure, b) inadequate measurement of critical weather parameters and population responses, c) and inherent tolerance of the species to variable weather (Roseberry and Klimstra 1984). In addition, the impact of winter weather in the Midwest may tend to mask more subtle summer effects.

Nevertheless, it appears that extreme drought conditions can and do periodically affect bobwhite reproduction and abundance. According to Leopold and Ball

(1931), the 1930 drought (combined with a severe previous winter) reduced quail populations in Illinois and elsewhere in the Midwest to <50% of normal. The 1934 drought was also reported to have depressed quail populations in Missouri (Bennitt and Nagel 1937) and Iowa (Errington 1935). Wade (1938) noted that Wisconsin quail numbers were down as much as 80% following the 1936 drought (also preceded by a severe winter). Stanford (1953) reported that Missouri bobwhites were adversely affected by consecutive droughts in 1952 and 1953.

Bobwhite recruitment in southern Illinois during 1988, as measured by subsequent juvenile:adult harvest ratio, was >32% below normal and the 3rd lowest recorded since 1950. And, while hunter success was not greatly reduced, a large majority (72%) of responding hunters thought the 1988 population was lower than the previous year. In the absence of concurrent nesting studies, cause and effect relationships with the drought cannot be established with absolute certainty. I believe, however, that the poor reproduction, small coveys, and lower-than-predicted population levels in 1988 were directly attributable to the drought. Overall impact was perhaps not as great as expected given the relative severity of conditions because a) the previous mild winter left breeding populations in good shape, numerically and physically; b) July rains provided some relief; and c) temperatures, while above-average, were not extreme when compared to historic drought years.

The causative mechanisms and reproductive components involved in bobwhite-drought interactions are not fully understood. In the semi-arid Southwest, there is often complete cessation of laying during such periods (Lehmann 1984, Guthery et al. 1988). Early termination of nesting has also been reported in Missouri (Stanford 1972) and Illinois (Klimstra and Roseberry 1975). This is substantiated by a negative correlation ($r = -0.45$; $P < 0.01$) between maximum daily summer temperatures and the relative proportion of late-hatched birds over a 35-year period in southern Illinois. Hot, dry conditions may also increase nest abandonment (Stoddard 1931, Stanford 1972, Klimstra and Roseberry 1975), reduce hatchability of eggs (Stoddard 1931, Murray 1958, Rosene 1969, Stanford 1972), lower chick survival (Haugen 1955, Reid and Goodrum 1960), and possibly increase mortality of adult hens (Stanford 1953, 1972). Occurrence of small coveys in the autumn 1988 population is consistent with poor hatchability of eggs and/or reduced chick survival. Below-normal representation of males in the adult segment would not indicate unusually high mortality of adult hens. Normal representation of late-hatched birds in the 1988 sample seemed contradictory to the above-noted tendency for early-termination of nesting during hot-dry summers. Apparently, both late *and* early hatches were reduced so that chronology appeared normal.

Summer weather can act directly on individual bobwhites or indirectly through their vegetative and insect food supplies. An obvious direct effect would be reduction in surface water. Guthery (1987), however, believed that in non-arid regions, bobwhites do not normally require free water, subsisting instead on metabolic and preformed water. Other direct effects include reduced hatchability of eggs due to high ground temperatures and/or low humidity. More speculative is Cain and Lien's (1985) theory that drought-related environmental conditions may elicit a non-specific stress response that would inhibit reproduction through pituitary-adrenal stimulation. Several authors have noted the potentially detrimental consequences of a reduction in quantity and quality of food (both vegetative and

insect) and cover due to severe drought (Stoddard 1931, Nestler 1946, Haugen 1955, Murray 1958, Reid and Goodrum 1960). Of possible significance too are Leopold et al's. (1976) finding that in dry years, desert vegetation produced increased quantities of phytoestrogens that inhibited reproduction in California quail (*Lophortyx californicus*); or Cain et al's. (1982) suggestion that drought-induced phosphorous deficiencies might contribute to poor reproduction.

Although the 1988 drought may not have resulted from excess carbon dioxide in the atmosphere, i.e., the "greenhouse effect" (Changnon 1988), uncertainty exists as to whether we are experiencing, or are about to experience, a global warming trend (Kerr 1988, 1989). Regardless, the summer of 1988 should remind us that climatic change would almost certainly affect the distribution and abundance of native wildlife. The short- and long-term effects, however, would be difficult to predict. A warming trend in the midwest would probably initially favor bobwhites with milder winters; but hotter, drier summers could ultimately be detrimental. Perhaps the greatest impact on wildlife would come from land use and agricultural changes resulting from altered climatological patterns.

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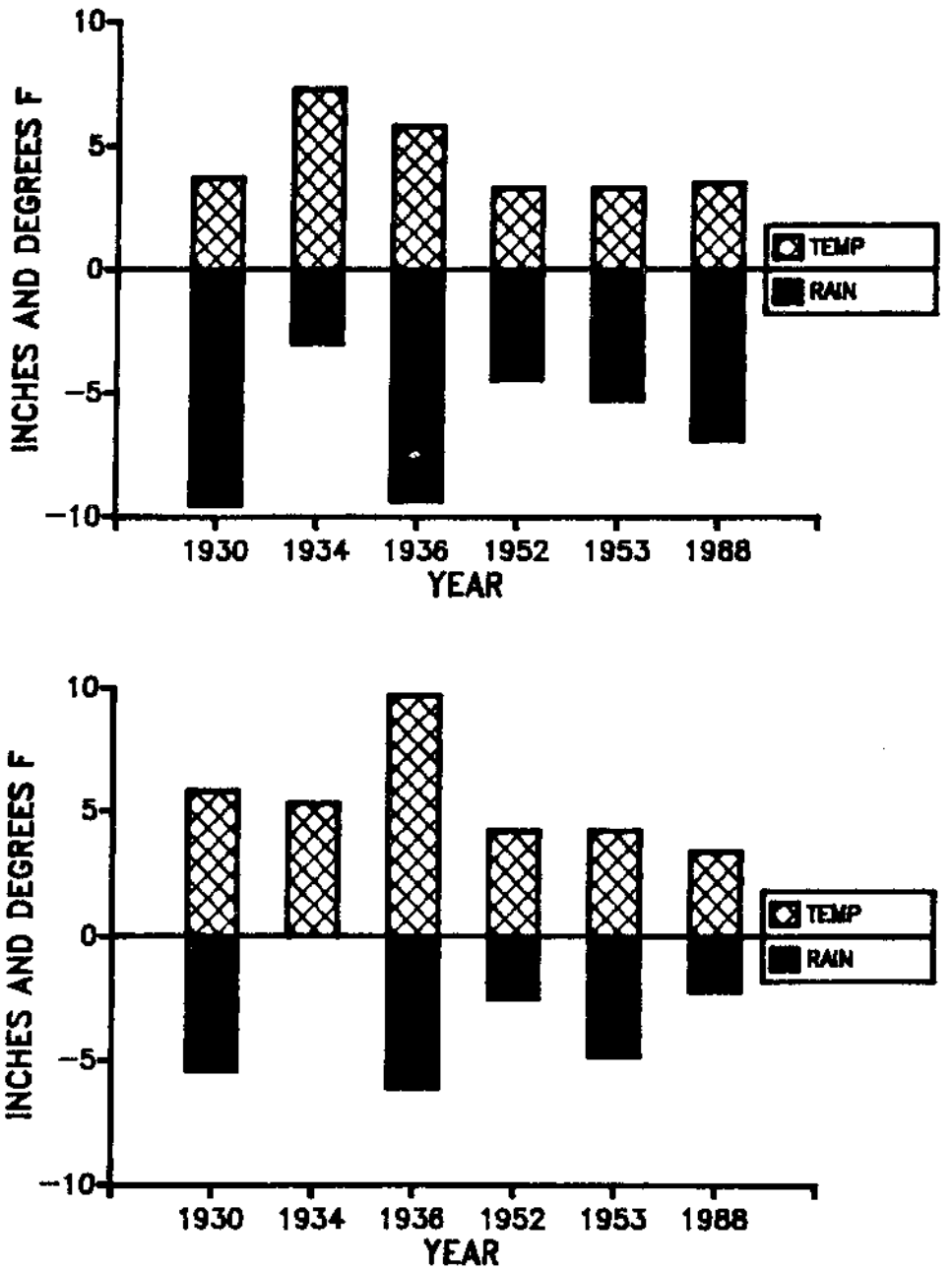

Figure 1. Mean maximum daily temperature and precipitation deviation from normal (1950-1987) for bobwhite egg-laying season, 21 April-18 August (top), and hatching season, 10 June-28 August (bottom).