——— 1954a. The Fair Isle apparatus for collecting bird ectoparasites. *British Birds*, **47**: 234-235 and plate.
——— 1954b. The migration of the Iceland Merlin. *British Birds*, **47**: 434-441.
——— 1955. Migrational drift. Acta XI Congressus Internationalis Ornithologici, 179-186. Basel.

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WEIGHTS OF WILD BOBWHITES IN CENTRAL MISSOURI

BY MAX HAMILTON

Existing publications on weights of bobwhites *(Colinus virginianus)* are based principally on data collected during fall and winter months, although Stoddard (1931) and Reeves (1954) presented some data for other seasons. This paper presents a series of 360 weights obtained throughout the year for 244 individual, wild bobwhites. The birds were captured on the University of Missouri's Ashland Wildlife Research Area in Boone County, central Missouri, during the period June, 1953 to June, 1954. With one exception, the weights were of live bobwhites.

The birds were caught in two types of traps: modifications of the cock-and-hen trap developed by Stoddard (1931) and a modified clover-leaf trap as described by Low (1951).

A grain mixture was used as bait during the fall, winter and spring, and in late spring and summer female bobwhites were used as decoys in trapping males, as described by Stoddard (1931:446-450).

All birds were weighed to the nearest gram on a dietetic spring scale. No restraining device was needed; each bird was placed on its back with the head hanging over the edge of the platform. In this position it lay quite still while the weight was determined.

The birds were marked with serially numbered aluminum leg bands, and released.

For analysis of the weights, the following three age-categories were used:

1. Juveniles: all young through completion of the post-juvenal molt; 0 to about five months of age.
2. First-year-adults: all birds which had completed the post-juvenal molt, but which had not replaced primary coverts in the first post-nuptial molt; about five months to 18 months of age. This category included birds breeding for the first time.
3. Adults: birds which had replaced the primary coverts in the post-nuptial molt; about 18 months of age or older.

For computation of average weights of age groups and of the two sexes, only the first weight of each bird was used, because several

[1]Contribution from the Missouri Cooperative Wildlife Research Unit: U. S. Fish and Wildlife Service, Wildlife Management Institute, Missouri Conservation Commission, Edward K. Love Foundation and University of Missouri cooperating. The writer is indebted to T. S. Baskett under whose direction this study was made, and to C. P. Agee, P. W. Frank, and Wm. H. Elder.

weights of an extremely heavy or light bird would distort the average. However, where trends rather than averages were of principal interest, all weights obtained for each bird were used. Re-weighings of banded individuals were employed in determining rates of growth of juveniles and first-year-adults, and in determining seasonal weight trends.

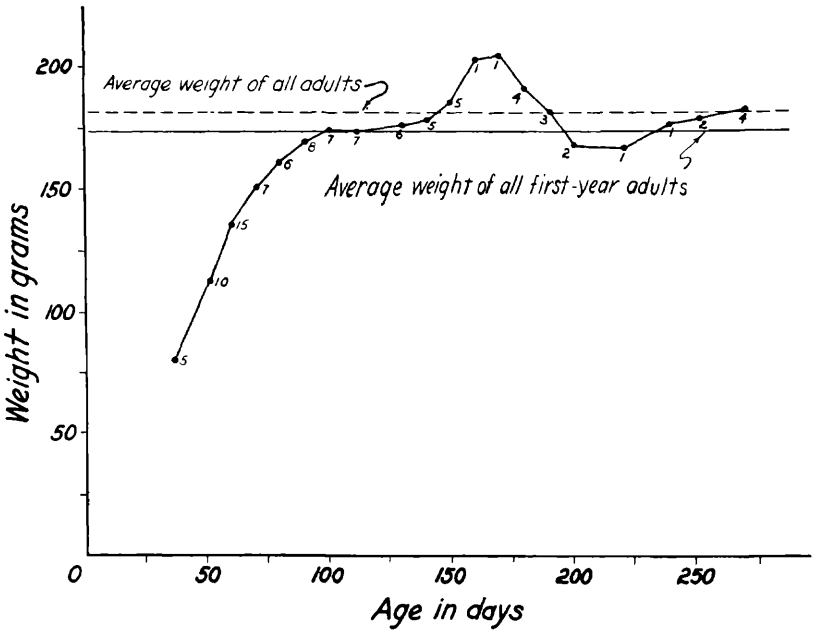

Figure 1. Age-weight relationships for 53 juvenile and first-year-adult bobwhites, based on 100 measurements. (Small figures on curve show sample size.)

GROWTH OF JUVENILES AND FIRST-YEAR-ADULTS

One hundred weights were obtained for 53 young quail ranging in age from about 37 to 275 days; ages were determined from the progress of molting of primaries, according to tables presented by Petrides and Nestler (1952). Weights of the young quail are plotted against age in the graph (Fig. 1).

A sharp increase in weight with increasing age was found until the average for first-year-adults (174 grams) was reached. This weight was attained at the age of about 100 days (14 to 15 weeks). After this, growth continued, but data were few and variable, and no conclusions as to exact age of attainment of adult weights could be reached.

These findings agree rather closely with Reeves' (1954:30) statement that the young showed a steady increase for the first 15 weeks, then gradually gained until about 21 weeks. However, Reeves' growth curve (p. 34) actually showed no distinct plateau until considerably later than 15 weeks.

TABLE I

Monthly Weight Averages of Central Missouri Bobwhites

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
First-Year-Adults												
Males												
Number	27	17	12	26	34	31	5	8				3
Average Weight	184.8	178.6	161.8	171.7	170.2	168.4	180.6	175.5				178.7
Standard Error	2.51	2.51	2.71	2.55	2.35	2.47		3.65				
Females												
Number	22	15	6	4	2	2	0	1				3
Average Weight	179.3	179.8	156.2	168.5	195.5	181.5		163.0				162.3
Standard Error	2.62	2.62	4.71									
Adults												
Males												
Number	11	5	0	2	5	10	0	4	2	2	3	0
Average Weight	191.5	175.2		186.0	175.8	178.6		161.5	178.5	180.0	177.3	
Standard Error	4.15					5.68						
Females												
Number	11	0	1	2	0	0	0	0	0	4	3	0
Average Weight	198.0		196.0	191.0						181.5	179.7	
Standard Error	2.71											

DIFFERENCES IN WEIGHTS DUE TO AGE

Differences in weights of adults and first-year-adults evidently persist as long as the winter months. for thirteen adult males were found to average 2.9 grams heavier than 36 first-year-adult males for the months of January and February (the only months in which an adequate sample of adult males was obtained). This difference was significant at the 95 per cent level of confidence ($t = 2.189$ with 47 d.f.).

Six adult females averaged 16.5 grams heavier than 20 first-year-adult females during January. This difference is significant at the 99 per cent level ($t = 2.875$ with 24 d.f.).

This effect of age upon weights has also been shown in earlier studies. A. S. Leopold (1945) found that adults shot in December averaged seven to eight grams heavier than first-year-adults of the same sex, while Buss, Mattison and Kozlik (1947) found adult cocks trapped in winter to be three grams heavier than first-year-adult cocks, and adult hens seven grams heavier than first-year-adult hens. Stoddard (1931:75) found that 32 adults shot in February averaged 3.2 grams heavier than 69 first-year-adults. However, Stoddard did not separate weights of the two sexes in his analysis. Reeves' (1954:35) findings do not agree with those of this study or of other studies reported: he found almost no difference between weights of first-year-adult and adult birds in the four years of his study.

DIFFERENCES IN WEIGHTS DUE TO SEX

Thirty-six first-year-adult males averaged 4.3 grams heavier than thirty-two first-year-adult females during the months of January and February, the only months when sufficient data were obtained for first-year-adult females. However, this difference is not significant at the 95 per cent level of confidence ($t = 1.4098$ with 66 d.f.).

The lack of a significant difference in the weights of the two sexes among first-year-adults has also been indicated by other work. Buss, Mattison and Kozlik (1947) and Reeves (1954:30) found no significant weight difference between first-year-adult cocks and hens. Stoddard (1931:75) stated that from eight to 10 weeks of age to maturity, cocks weigh slightly more than hens. However, he did not define maturity. A. S. Leopold (1945) found 54 first-year-adult males shot in November and December in southern Missouri to average two to three grams *lighter* than 69 first-year-adult females. However, he remarked that these differences were probably not significant because of the variability of the sample.

SEASONAL DIFFERENCES IN WEIGHTS

Seasonal weight fluctuations were found for all groups: first-year-adult males and females and adult males and females. Relevant data are presented in Table I.

The first-year-adult males attained their greatest average weight during January: 184.8 grams. The weights were still high in February, averaging 178.6 grams. The lowest average weight of the year was

found in March: 161.8 grams. The average monthly weight then gradually increased, and the other months for which adequate samples were available remained close to an average of 171.4 grams, still considerably lower than the winter weight. The variation from this average ranged only from 4.1 grams to 0.3 grams in April, May, June, and August, during which months samples of more than five bobwhite weights were obtained.

A drop in weight through the spring for male bobwhites has been recorded by other workers. Stoddard (1931:76) found that the average weight of 43 cocks trapped during the last week in April and the first week in May was 10.4 grams less than it was in winter. Reeves (1954:98-99) also noticed this weight decline. A peak in weights for bobwhites during the winter was found by Nice (1938) and by Wickliff (1932).

The females, like the males, attained their highest average weights during January and February: 179.3 grams and 179.8 grams respectively. They also reached their lowest average weight in March: 156.2 grams. After March, data were obtained on only four birds for April and two birds each for May and June. April weights remained low with an average of 168.5 grams, while May weights increased to 195.5 grams and June weights remained fairly high, averaging 181.5 grams. While these data are admittedly few, they do seem to indicate the same trend found by Stoddard (1931:76) who reported that hens gained weight as the breeding season approached. Twelve hens weighed by him between April and September averaged six grams more than did those of his winter sample.

As shown by Table I, too few data were available to permit analysis of seasonal trends in adult weights. However, weights of adults of both sexes were highest in January.

BERGMANN'S LAW AND BOBWHITES

When the average weights of all birds handled during this study were lumped and compared with similar averages reported by other workers, a geographic gradient from south to north was found. Relevant data are presented in Table II. This general relationship between latitude and weight of bobwhites has been pointed out previously by several authors (Stoddard, 1931; A. S. Leopold, 1945; Buss *et al.*, 1947; and Nelson and Martin, 1953). It is discussed here because data are now available which were not used by these authors. The relationship is in accordance with Bergmann's Law, which holds that animals from colder climates tend to be larger than closely related forms from warmer regions. Actually, the increase in weight from south to north may reflect differences in soil quality. Schultz (1948) found that bobwhites in glaciated regions of Ohio were significantly heavier than those from unglaciated regions of the same state.

A detailed comparison of the weights of juvenile bobwhites trapped in this study was made with weights obtained by Stoddard (1931) in the southeastern states. Eighty weights were obtained in the present study for 53 juveniles ranging from 37 to 150 days of age. Birds 37

TABLE II

Average Weights of Bobwhites as Related to Latitude

Location	Approximate Latitude (degrees)	Average Weight (grams)	Number of Birds	Source
Florida	25—30	161.6	?	Nelson & Martin (1953)
N. Florida & S. Georgia	30—31	165.0	188	Stoddard (1931)
Beaufort Co., South Carolina	32	176.3	244	Ibid
Batesville, Mississippi	34	176.9	?	Leopold (1933)
S. Missouri	37	186.0	166	A. S. Leopold (1945)
Indiana	38—42	172.9	?	Reeves (1954)
Cen. Missouri	39	176.3	215	This Study
Ohio	39—42	193.0	65	Wickliff (1932)
Columbus, Ohio	40	201.0	30	Nice (1938)
Leetonia, Ohio	41	186.8	108	Stewart (1937)
Worcester, Massachusetts	42	201.7	4	Wetherbee (1934)
Wisconsin	42—46	192.8	?	Nelson & Martin (1953)
Lansing, Michigan	43	194.4	6	Becker & Stack (1944)
Dunn Co., Wisconsin	45	203.0	845	Buss *et al.* (1947)

days old ranged from 75 to 80 grams—considerably higher than those found by Stoddard (pp. 72-73) whose 43-day-old birds (captive and wild) ranged from 55 to 65 grams.

Chicks from 100 to 110 days of age weighed by the writer averaged 178 grams. Birds 106 days old weighed by Stoddard (p. 72) ranged from 140 to 160 grams.

Thus, at any given age, juvenile quail from Missouri were consistently heavier than those reported from Georgia and Florida by Stoddard.

SUMMARY

A study of the weights of central Missouri bobwhites was conducted from June 8, 1953, to June 18, 1954. During the period 360 weight records were obtained for 244 bobwhites.

Juvenile quail attained the average weight of first-year-adults (174 grams) at about 100 days of age.

Adult males were significantly heavier than first-year-adult males during January and February; adult females were significantly heavier than first-year-adult females during the month of January.

All groups showed seasonal weight fluctuations: first-year-adults of

both sexes were heaviest in January and lightest in March. Adults were heaviest in January.

Males remained at a low weight throughout the breeding season, April through August, but during that period, females tended to regain the weight lost in February and March.

Juvenile Missouri bobwhites averaged heavier than birds of the same age from the southeastern states. When the average weights of bobwhites of all ages and sexes are lumped, the data recorded in the literature together with those obtained in this study show a progressive increase in weight from southern to northern United States, following Bergmann's Law.

LITERATURE CITED

BECKER, G. B., and J. W. STACK. 1944. Weights and temperatures of some Michigan birds. *Bird-Banding*, **15**: 45-68.

BUSS, I. O., H. MATTISON, and F. M. KOZLIK. 1947. The bobwhite quail in Dunn County, Wisconsin. *Wis. Cons. Bull.*, **12**(7): 6-13.

LEOPOLD, A. 1933. Game management. Charles Scribner's Sons, New York. 481 pp.

LEOPOLD, A. S. 1945. Sex and age ratios among bobwhite quail in southern Missouri. *J. Wildl. Mgt.*, **9**: 30-34.

LOW, S. H. 1951. Memorandum to all bird-banding cooperators. U. S. Fish and Wildl. Serv., Patuxent Refuge, Laurel, Md. (July 31, 1951), 2 pp.

NELSON, A. L., and A. C. MARTIN. 1953. Gamebird weights. *J. Wildl. Mgt.*, **17**: 36-42.

NICE, M. M. 1938. The biological significance of bird weights. *Bird-Banding*, **9**: 1-11.

PETRIDES, G. A., and R. B. NESTLER. 1952. Further notes on age determination in juvenile bobwhite quails. *J. Wildl. Mgt.*, **16**: 109-110.

REEVES, M. C. 1954. Bobwhite quail investigation. Final Report. Indiana Dept. Cons. P-R Project W-2-R. 151 pp. (mimeographed).

SCHULTZ, V. 1948. Vitamin A as a survival factor of the bobwhite quail *(Colinus v. virginianus)* in Ohio during the winter of 1946-47. *J. Wildl. Mgt.*, **12**: 251-263.

STEWART, P. A. 1937. A preliminary list of bird weights. *Auk*, **54**: 324-332..

STODDARD, H. L. 1931. The bobwhite quail—its habits, preservation and increase. Charles Scribner's Sons, New York. 559 pp.

WETHERBEE, MRS. K. B. 1934. Some measurements and weights of live birds. *Bird-Banding*, **5**: 55-64.

WICKLIFF, E. L. 1932. Game research in Ohio. *Trans. Amer. Game Conf.*, **19**: 351-361.

Nebraska Game, Forestation and Parks Commission, Lincoln.

GENERAL NOTE

Warbler returns.—The recent comment by the editor *(Bird-Banding*, **27**: 208) on the paucity of warbler returns led me to check my own records. At Lincoln, Mass., I have had five returns from 583 warblers banded long enough to have shown returns. This is 0.86 percent or par for the course. No bird has returned more than once nor have I had any recoveries. The returns have come from three species: black and white warbler, ovenbird, and northern yellowthroat. These have been in recent years the most common breeding warblers in my vicinity. Such abundant migrants as myrtle (203 banded) and blackpoll warblers (101) have produced no returns.

In contrast, 160 warblers banded in Jamaica yielded four local returns within the same winter, a rate of 2.5 percent. Here the presence of many terminal migrants as well as winterers seems to make more returns possible.—Charles H. Blake, Museum of Comparative Zoology, Cambridge, Mass.