Bobwhite Wing and Gizzard Fat as Predictors of Body Fat

Robert J. Warren,[1] *Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409*

Bradley J. Gruver, *Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409*

Fred S. Guthery,[2] *Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409*

Abstract: Forty bobwhites (*Colinus virginianus*) were collected in late winter of 2 years from a variety of habitats in northwestern Texas to evaluate the use of wing fat and gizzard fat as predictors of body fat. No differences were found in body fat between sexes or between years. Regression analyses revealed that the best predictor of body fat was wing fat, which was related to body fat in an exponential, rather than linear, fashion. A logarithmic model ($Y = e^{-0.06 + 0.17X}$, $R^2 = 0.68$, $P < 0.0001$) best described the observed curvilinear relationship between body fat (g) and wing fat (%). The model provides a simplified index that may be useful in evaluating nutritional condition of bobwhites.

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Fat indices are useful indicators of nutritional condition in wild mammals (Kirkpatrick 1980). However, little research has been published on their use in evaluating nutritional condition of wild birds. Previous researchers (Robel 1969, 1972; Dabney and Dimmick 1977; McRae and Dimmick 1982) have used total body fat to indicate nutritional status of bobwhites. This nutritional index is useful in research but less practical in management situations, because hunters are generally unwilling to donate an entire quail for body-fat analysis. Therefore, a nutritional index that is more easily obtained and determined than total body fat is needed by wildlife managers. For example, wing fat is directly

[1] Present address: School of Forest Resources, University of Georgia, Athens, GA 30602.

[2] Present address: Caesar Kleberg Wildlife Research Institute, Campus Box 218, Texas A&I University, Kingsville, TX 78363.

related to carcass fat in ruffed grouse (*Bonasa umbellus*) (Norman and Kirkpatrick 1981); also, it and gizzard fat have been used to indicate nutritional status in ring-necked pheasants (*Phasianus colchicus*) (Dowell and Warren 1982). The objective of this study was to determine how accurately wing fat and gizzard fat predict total body fat in bobwhites.

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Methods

The study was conducted on the Pitchfork Ranch in northwestern Texas. Webb and Guthery (1982, 1983) described soils and vegetation of the area, which are characteristic of the rolling plains habitat type (Gould 1975).

Bobwhites were collected from a variety of habitats, some of which were managed for bobwhites by spring discing, construction of brush shelters (Webb and Guthery 1982) and provision of supplemental feed and water. A 1:1 mixture of high-protein ration (Purina Game Bird Layena) and corn or sorghum had been provided in some of the collection sites. Thus, the collections were designed to obtain bobwhites with a range of body fat reserves.

Walk-in traps, baited with corn and sorghum, were used in the collections. The traps were operated during 5 4-day periods in February and early March 1982 and 1983. Traps were set at about 0500 hours, checked about 0900 hours, and emptied before 1030 hours each day.

Twelve quail of each sex were collected in 1982 ($N = 24$); 8 of each sex were collected in 1983 ($N = 16$). Quail were sacrificed and frozen on dry ice immediately after being removed from the traps. Birds were thawed and dissected to remove crop, gizzard, and intestinal contents. The emptied organs were returned to the body cavity prior to determining whole body weights.

Gizzard fat was considered to be the weight of the fat adhering directly to the gizzard expressed as a percentage of the weight of the emptied gizzard (Dowell and Warren 1982). The right wing was removed for fat analysis. The entire wing (including bones and feathers) was homogenized in a meat grinder and extracted in a Soxhlet apparatus using anhydrous ether (Warren and Kirkpatrick 1978). The gizzard and gizzard fat were returned to the body, which then was homogenized (minus the right wing). Duplicate samples (5 to 10 g each) of the homogenized body were extracted to determine percentage fat content, which was used to calculate body fat. Additional samples were analyzed if duplicates varied more than 5%. Right-wing fat then was added to body fat to obtain total body fat (g, dry-weight basis). Wing fat was expressed as a percentage of the weight of the wing.

Data were analyzed by analysis of variance, using the general linear models procedure of Barr et al. (1976), to test for differences between sexes and years. Spearman's coefficient of rank correlations was used to determine the relationships among fat indices. Simple linear regressions were calculated to predict total body fat (g) from wing fat (%) or gizzard fat (%).

Results and Discussion

Neither sex nor year influenced ($P > 0.05$) body, wing, or gizzard fat; therefore, data were pooled. Mean (±SE) body fat for males was 4.95 ± 0.73 g (9.36 ± 1.27% fat) ($N = 20$), compared to 5.28 ± 0.82 g (9.64 ± 1.28% fat) ($N = 20$) in females. In 1982, body fat averaged 5.19 ± 0.76 g (9.47 ± 1.18% fat) ($N = 24$), compared to 5.00 ± 0.77 g (9.55 ± 1.41% fat) ($N = 16$) in 1983. The range in body fat reserves observed varied from a low of 1.05 g (2.53% fat) to a high of 13.08 g (24.53% fat). These data on bobwhite body fat reserves fall within the range of values reported by other researchers (Robel 1969, 1972, Dabney and Dimmick 1977, McRae and Dimmick 1982) for bobwhites in other areas of the United States.

Wing fat and gizzard fat were significantly but not strongly correlated ($r = 0.45$, $P < 0.01$, $N = 40$), possibly because these 2 fat indices reflected different stages of fat mobilization. In Canada geese (*Branta canadensis*) (Raveling 1979) and ruffed grouse (Norman and Kirkpatrick 1981), abdominal fat is mobilized faster than subcutaneous fat; subcutaneous deposits are the last to be depleted. Thus, gizzard (abdominal) fat might be expected to be more readily depleted (i.e., more labile) than wing (subcutaneous) fat. The relative variation for these 2 fat indices supports this conclusion. The coefficient of variation (C) was greater for gizzard fat ($C = 85.8\%$, $\bar{x} = 2.89$, $s^2 = 6.15$) than for wing fat ($C = 37.3\%$, $\bar{x} = 8.93$, $s^2 = 11.08$).

Body fat was correlated with wing fat ($r = 0.81$, $P < 0.001$, $N = 40$) and with gizzard fat ($r = 0.67$, $P < 0.001$, $N = 40$). Similarly, Norman and Kirkpatrick (1981) reported a significant correlation ($r = 0.82$) between carcass fat and wing fat in spring-collected ruffed grouse. Regression analyses also revealed significant relationships between body fat and fat indices (Figs. 1, 2). The relationship between body fat and wing fat appeared to better fit an exponential, rather than linear, equation; thus, body-fat data were transformed (natural logarithm) and reanalyzed (Draper and Smith 1981). The resulting logarithmic model [$y = e^{-0.06 + 0.17X}$, $R^2 = 0.68$, $P < 0.0001$, where Y = body fat (g) and X = wing fat (%)] predicted values for body fat that fit the observed values more closely than those predicted by the linear model (Fig. 1).

Similar results were obtained when the regression analyses were conducted using percent body fat rather than grams of body fat (Figs. 1, 2) as the dependent variable in the model. The models resulting from these analyses were as follows: $Y = e^{0.75 + 0.15X}$, $R^2 = 0.68$, $P < 0.0001$, the logarithmic

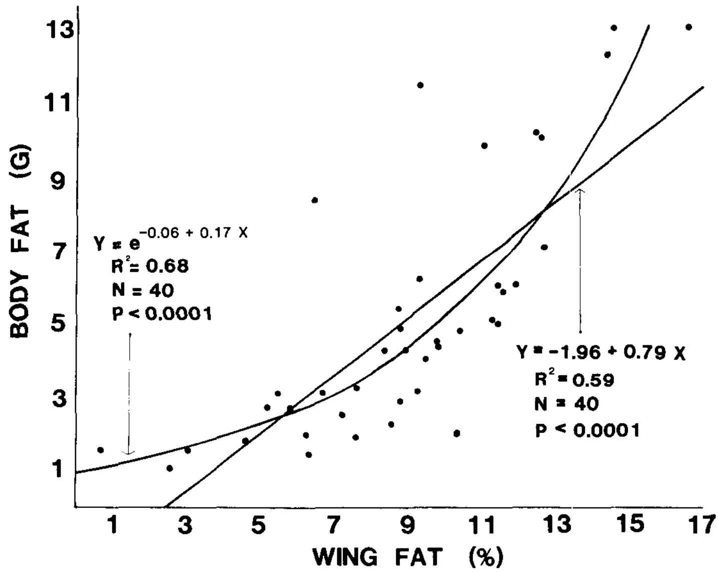

Figure 1. Regression of body fat (Y) on wing fat (X) for male and female bobwhites collected during late winter 1982 and 1983 from different habitats in northwestern Texas.

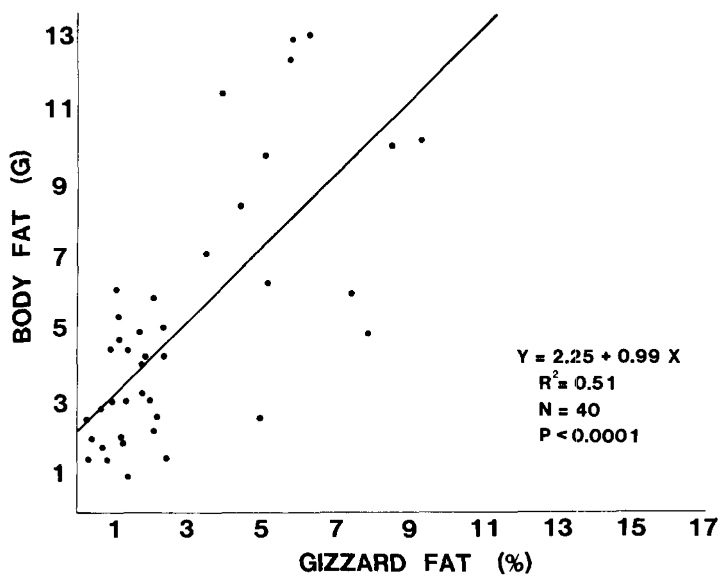

Figure 2. Regression of body fat (Y) on gizzard fat (X) for male and female bobwhites collected during late winter 1982 and 1983 from different habitats in northwestern Texas.

model where Y = body fat (%) and X = wing fat (%); Y = −2.50 + 1.34X, $R^2 = 0.63$, $P < 0.0001$, the linear model where Y = body fat (%) and X = wing fat (%); and Y = 4.75 + 1.64X, $R^2 = 0.52$, $P < 0.0001$, the linear model where Y = wing fat (%) and X = gizzard fat (%).

Conclusions and Management Implications

Wildlife managers who wish to monitor nutritional status of bobwhite populations can collect wings from hunter-killed birds for fat analysis in order to estimate total body fat. This technique could be used to compare the nutritional condition of bobwhites from different habitats or locations, evaluate the effects of food plantings, determine the influence of changes in land use or habitat management, etc. Higher fat reserves likely would indicate better habitat quality.

Sex-related variations in body fat and wing fat were non-significant. Therefore, field-collected bobwhites need not necessarily be segregated according to sex, provided that collections occur during winter. Significant sex-related variations in body fat reserves have been reported for bobwhites collected during other seasons of the year (McRae and Dimmick 1982). The potential effect of age-related variations in body fat and wing fat of bobwhites has not been determined and merits investigation.

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