COMPARISON OF ANTLER CHARACTERISTICS AND BODY WEIGHTS OF WHITE-TAILED DEER AT 1.5-YEARS-OF-AGE

THESIS

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INTRODUCTION

In recent years, management of white-tailed deer has increased for the following socioeconomic reasons: (1) the economic value of deer to landowners; (2) protection of the range resource; and (3) demand for quality hunting opportunities by sportsmen (Teer, 1984). Due to substantial economic revenue for landowners from hunting of white-tailed deer, there is an economic incentive to manage herds for quality animals. The value wildlife managers and landowners place on white-tailed deer herds on their property will ultimately determine the quality and quantity of deer. The quality of a white-tailed buck is primarily based on the size and configuration of its antlers as well as its body condition and size. Therefore, to meet the economic potential of mature bucks, landowners and managers must manage the habitat so as to produce optimal growth of body and antlers of the deer herd.

Antler development in white-tailed deer is a function of three variables: age, nutrition, and genetics (Baxter et al., 1981; Harmel and Litton, 1981; Cook, 1984; Mattfeld, 1984; Newsome, 1984; Sauer, 1984; Verme and Ulrey, 1984; Harmel et al., 1989; Scribner et al., 1989; Armstrong, 1991; Armstrong et al., 1994; Brothers et al., 1995; Roberts, 1996). The pedicles of white-tailed bucks start to grow at about four months of age. They increase in diameter with age, with bone being laid down annually in concentric layers (Ullrey, 1982). Most bucks grow their first set of antlers at 1.5 years-of-age; however, some fawns may grow small antlers before an age of nine months (Ozoga, 1988). Yearly rhythms in testosterone levels dictate the antler cycle in male white-tailed deer. These levels are dependent on changes in the seasonal photoperiod

(Forand et al., 1985). There is a high correlation between antler size and other body characteristics, especially weight and age, and bucks seldom have an extreme antler size with respect to their weight or age (Smith et al., 1983).

The optimum diet for maximum antler and bone growth of captive reared white-tailed bucks is 16% crude protein with adequate amounts of calcium and phosphorus (Armstrong et al., 1994). A seasonal diet of 13-18% crude protein is an optimal range for body and antler growth depending on the nutrient stress period (Roberts, 1996). A diet below 13% will result in impairment of body growth, antler growth, and production (Baxter et al., 1981; Ullrey, 1982). In deer, the physiological allocation of nutrients and energy for body growth and maintenance takes precedence over antler formation (French et al., 1956). Verme and Ullrey (1984) discovered that antler development was delayed when yearling bucks were placed on restricted diets. Cook (1984) found that body weights and antler measurements declined as population density increased and competition for preferred forage intensified. Body weights and antler characteristics respond in direct proportion to the quality of the diet (Harmel et al., 1989; Armstrong, 1991). Therefore, nutrition is an important factor in antler development, and without adequate nutrition, a deer will not reach its genetic potential for antler configuration and size and body weight.

Yearling bucks can produce as few as two tines (points) or as many as 12 tines depending on range condition and genetic composition of the herd (Mattfeld, 1984; Sauer, 1984; Scribner et al., 1989; Armstrong et al., 1994; Kroll and Jacobson, 1995). Antler growth of white-tailed deer appears to be a curvilinear function of age (Scribner et al., 1989). Mature deer show a greater number of tines, main beam diameter, main beam length, and inside spread of main beams (Scribner et al., 1989). The configuration and size of antlers increase with age and usually reach the greatest development in the 4.5 to 5.5 classes (Schultz and Johnson, 1992; Jacobson, 1995).

As the intensity of management for quality white-tailed deer has increased, attention has focused on several issues. The management of spike-antlered bucks is one of the most controversial issues. Several factors may contribute to the development of spikes. Most spike-antlered yearlings are a result of poor nutrition (Cox, 1982). However, genetics also play an important role in antler development and body size (Brothers and Ray, 1975; Harmel, 1983; Newsome, 1984). Jacobson (1995) found date of birth was important in antler development of captive yearlings. Presumably deer born late in the fawning season have less time to increase body weight before the nutrition levels of plants decrease due to winter dormancy. This results in a conflict of energy allocation between growing the first set of antlers at 1.5 years-of-age and continuing the addition of body mass. It may be difficult to obtain sufficient energy to optimize both processes. Brothers et. al (1995) found that maternal effects contribute to spike-antlered yearlings. When yearling does breed and produce male offspring, those buck fawns may receive inadequate nutrition due to the size and inexperience of their mothers. It is extremely difficult for these does to obtain enough nutrition for their own growth as well as provide milk for their offspring. Another possible maternal effect occurs when a doe produces twins or triplets. In this case, competition for milk among fawns, insufficient lactation by the mother, or limited postnatal care may cause nutritional stress. In both examples, fawns do not reach their potential in body size or antler development at 1.5 years-of-age (Brothers et al., 1995).

Some studies have shown that the differences between the size of antlers and body mass of spike-antlered yearlings and fork-antlered yearlings extend throughout their lives; however, these studies did not address antler size and body mass of younger age bucks (Harmel et al., 1989; Schultz and Johnson, 1992; Williams et al., 1994).

The purpose of this study is to compare the antler size and configuration (size, mass, and number of tines) using the B&C scoring system and body weight of spike-antlered and fork-antlered yearlings. I sought to determine if there is a difference in body weight and antler growth between spike-antlered and fork-antlered yearlings under controlled optimum conditions. The null hypothesis is that there is no difference in body weight and antler size in spike-antlered yearlings and fork-antlered yearlings. The alternative hypothesis stated that spike-antlered yearlings and fork-antlered yearlings have different body weights and antler size.

I also sought to determine whether a two-class system (spike-antlered as a yearling or fork-antlered as a yearling) of classifying yearling white-tailed deer was an over simplification of antler development. To answer this, I classified yearlings into three groups; spike-antlered, 3-5 points yearlings, and 6 or more points yearlings. The null hypothesis stated that there was no difference in body weight or antler size between spike-antlered, 3-5 points, and 6 or more points yearlings. The alternate hypothesis stated that spike-antlered, 3-5 points, and 6 or more points yearlings differ in body weights and antler size.

I also sought to determine if there is an influence of birth date on antler characteristics and body weights. To answer this, the Julian birthdates were recorded for all bucks and the hypothesis of no difference in birthdate between spike-antlered and fork-antlered yearlings was tested.

STUDY HERD:

All data collected for the study were obtained from the Texas Parks and Wildlife Department's pedigreed white-tailed deer herd at the Kerr Wildlife Management Area (KWMA), a facility owned and operated by Texas Parks and Wildlife Department. This herd was established in 1973 with native white-tailed deer captured throughout the state. The herd has been maintained as a closed breeding population and used to study genetic and environmental components of variation in antler and body traits of white-tailed deer. The herd has been maintained as a closed-pedigreed herd since 1974. The antlers of deer used in this study were the result of random mating of spike-antlered as a yearling and fork-antlered as a yearling bucks with does. There was no direct selection or genetic manipulation in the breeding process.

Most bucks used in this study were born in late spring and during summer. As fawns, they were marked with ear tags and given identification numbers, additionally the date of birth, body weight, and sex were recorded.

Bucks used in the study were maintained in 1.62-ha enclosures. A diet of 16%+ crude protein was fed in a pelleted ration ad libitum to all deer. Adequate protein, calcium, phosphorus, vitamins, and trace elements were provided in the ration to ensure optimum growth of body and antlers (Harmel, 1983).

With the completion of antler development in early fall, all bucks were captured and the inside antler spread was measured. Live body weight was recorded. Antlers were removed about 1 cm above the pedicle. The date and the identification number of the buck were placed on each set of antlers.

METHODS

Antlers from 349 yearling (1.5 year-old) male deer born between 1973 and 1991 were examined. Only bucks with complete data sets were included. If data on greatest inside spread, body weight or birthdate were not available those animals were not included in those parts of the analysis. Bucks with sets of older age class anlers but missing the 1.5 year age class antler were not included in the comparison of gross Boone and Crockett scores. Bucks were classified as either spike-antlered or fork-antlered based on the number of tines. The antlers of each buck were measured and scored by the Boone and Crockett system (B&C) to obtain a gross B&C score (Boone and Crockett, 1981). The Boone and Crockett scoring system is the most widely used measuring system to quantify antler characteristics. The B&C score is based on a point system where one inch of antler growth equals one point. Gross B&C (GBC) scores were derived by the following measurements (Fig. 1): (1) greatest inside spread between main beams (SP), (2) length of left and right main beams (LMB & RMB), (3) length of all typical tines (G_1-G_n), (4) four circumference measurements for both antlers (H_1-H_4), and (5) length of all abnormal tines (A_1-A_n). Antler measurements were taken using a 1/4" flexible tape and cable. Gross B&C scores were derived by the formula: $GBC = \Sigma MB + \Sigma G_N + \Sigma H_N + SP + \Sigma AB_N$; where ΣMB = combined lengths of the main beams of the right and left antlers; ΣG_N = total length of tines G_1 to GN on both the left and right antlers; ΣH_N = total beam circumferences H1 to H4 at the four measurement positions for both the left and right beams; SP = greatest inside spread between the antlers; and ΣAB_N = total length of all abnormal tines. Abnormal points were used in computing GBC scores at 1.5 years but were not further analyzed because so few deer of either class expressed such points. All measurements were recorded in mm and converted to inches to compute GBC scores (standardly expressed in inches). Both right and left antlers were measured for all bucks to yield the summations, ΣMB, ΣG_N, ΣH_N, ΣAB_N. A preliminary comparison of right and left antler characteristics showed no obvious difference in bilateral asymmetry. Tests of normality and tests of equality of variances showed that no transformations were required for any dependent variables analyzed herein (Ott et al., In Press).

Circumferences were taken at the smallest point between the pedicle and the browtine (G_1), between the browtine and the second point (G_2), etc. If there was no browtine, the first and second circumference measurements (H_1, H_2) were taken at the smallest point between the pedicle and the typical second point (G_2). If there was a browtine and no G_2, the first and second circumference measurements (H_1, H_2) were made at the smallest point between the pedicle and the browtine, and the third and fourth circumference measurements (H_3, H_4) were made at the mid-point between the browtine and the tip of the main beam. Circumference measurements (H_1-H_4) for spikes were taken at the mid-point of the main beam due to a lack of normal or abnormal tines.

STATISTICAL ANALYSIS:

Spike-antlered yearlings (SAY) and forked-antlered yearlings (FAY) were compared using GBC scores, live body weights, and Julian birthdates by means of t-tests. Then, using a mixed model analysis of variance (ANOVA), and simple linear regression the following relationships were examined for the two antler classes of bucks: GBC score on live body weight, GBC score on Julian birthdate, and live body weight on Julian birthdate. In addition, the percent contribution of GBC score components were computed and examined for bucks in the two antler classes. For the purpose of comparing percent contribution of score components, all length measurements (sum of main beams and sum of all tine lengths) for individual bucks were combined to provide a total length measurement. The distribution of Julian birthdates was also examined for the two antler classes of bucks.

After comparing bucks in the two antler classes, SAY and FAY, a second analysis was performed by placing bucks into a three-class antler system composed of SAY, 3-5 points, or 6+ points yearlings. GBC scores and live body weights were then compared among the three antler classes by a one-way ANOVA followed by means comparison using the Ryan-Einot-Gabrial-Welsch multiple F test. Again, the distribution of Julian birthdates and percent contribution of GBC score components were computed and examined for the three antler classes.

RESULTS

GROSS B&C SCORES OF SAY AND FAY

The mean GBC score for the 84 SAY was 28.8 (SE = 0.95), while the mean score for the 235 FAY was 56.8 (SE = 0.90, Table 1). There was a highly significant difference in the mean GBC score between the SAY and the FAY ($t_{2, 232} = 21.4$, $P < 0.0001$). There was a 45.3 point difference in the GBC score of the best SAY (45.8) and the best FAY (91.1, Table 1). Ten (12%) SAY had scores ≥ 40 points, while 209 (89%) FAY had scores ≥ 40 points (Fig. 2).

LIVE BODY WEIGHTS OF SAY AND FAY

The mean live body weights of SAY (43.4, SE = 0.59 kg, Table 1) was significantly lower than those of FAY (51.5, SE = 0.42 kg, Table 1; $t_{2, 310} = 10.5$, $P < 0.0001$). Ten (12%) of the SAY weighed more than 50 kg, while 123 (54%) FAY exceeded 50 kg (Fig. 3). There was a 16.4 kg difference in live body weight between the heaviest SAY and heaviest FAY (54.4 kg and 70.8 kg, respectively; Table 1).

JULIAN BIRTHDATE OF SAY AND FAY

The mean Julian date of birth for SAY was day 179, SE = 2.65 while the mean date of birth for FAY was day 165, SE = 1.36 (Table 1). FAY were born significantly earlier than SAY ($t_{2, 143} = 4.88$, $P < 0.0001$). Of the total sample, 172 (70%) FAY were born on or before day 171, while 45 (48%) SAY were born before this date.

DISTRIBUTION OF JULIAN BIRTHDATES FOR SAY AND FAY

Only 1 (1%) SAY was born prior to day 135, and 22 (9%) FAY were born during this same period. During the period day 136 to day 171, 44 (47%) SAY and 152 (62%) FAY were born. Thirty-five (38%) SAY and 65 (26%) FAY were born during the period day 172 to day 207. After day 208, 13 (14%) SAY and 8 (3%) FAY were born (Table 2, Fig. 4).

Of the bucks born on or before day 135, 22 (96%) were FAY. Of the 196 bucks born during the period day 136 to day 171, 152 (78%) were FAY. Sixty-five percent (65) of the bucks born during the period day 172 to day 207 were FAY. Of those bucks born on or after day 208, eight (38%) were FAY (Table 2, Fig. 5).

RELATIONSHIP OF GBC SCORE AND LIVE BODY WEIGHT FOR SAY AND FAY

A comparison of the slopes of the regression of GBC score on live body weight for both SAY and FAY showed that the slopes of both were significantly different from zero ($t_{2,1} = 5.36$, $P < 0.0001$, $R^2 = 0.27$ for SAY; $t_{2,1} = 11.95$, $P < 0.0001$, $R^2 = 0.39$ for FAY). Moreover, the slopes of SAY and FAY differed from each other, and FAY had a larger slope than SAY ($F_{2,3} = 5.84$, $P < 0.01$; Fig. 6). When all SAY and FAY were combined regression of GBC on live body weight explained a large portion of the variation in antler traits ($R^2 = 0.69$, $P < 0.0001$).

RELATIONSHIP OF GBC SCORE AND JULIAN BIRTHDATE FOR SAY AND FAY

Regression of GBC score on Julian birthdate for both SAY and FAY showed that the slopes were significantly different from zero for each class of buck ($t_{2,1} = 3.00$, $P <$

0.004, $R^2 = 0.09$ for SAY, Fig. 7; $t_{2,1} = 6.71$, $P < 0.0001$, $R^2 = 0.16$ for FAY, Fig. 8). When all SAY and FAY were combined, regression of GBC score on Julian birthdate explained only a small portion of the variation in antler traits ($R^2 = 0.19$).

RELATIONSHIP OF LIVE BODY WEIGHT AND BIRTHDATE FOR SAY AND FAY

Regression of live body weight on Julian birthdate for both SAY and FAY showed that the slope for FAY was significantly different from zero ($t_{2,1} = 4.29$, $P < 0.0001$, $R^2 = 0.08$; Fig. 9) but no relationship for SAY ($t_{2,1} = 0.61$, $P < 0.54$, $R^2 = 0.004$). For all deer in the sample combined, regression of live body weight on Julian birthdate explained only a small portion of the variation in live body weight ($R^2 = 0.1$).

CORRELATION AMONG COMPONENTS OF GROSS B&C SCORES FOR SAY AND FAY

Pearson correlation coefficients between the components of GBC scores were calculated for SAY, FAY, and all bucks combined. For SAY (Table 3), there were significant positive correlations between spread and main beam (0.75), spread and sum of H's (0.60), and main beam and sum of H's (0.80).

For the FAY bucks there were highly significant positive correlations between spread and main beam (0.75), spread and sum of G's (0.57), spread and sum of H's (0.51), main beam and sum of G's (0.76), main beam and sum of H's (0.65), and sum of G's and sum of H's (0.73). Additionally, the correlation between sum of H's and abnormal points was significant (0.12) for FAY (Table 4).

When all yearling bucks were combined, there were highly significant correlations between spread and main beam (0.84), spread and sum of G's (0.67), spread and sum of H's (0.70), main beam and sum of G's (0.79), main beam and sum of H's (0.82), sum of G's and sum of H's (0.75), and sum of H's and abnormal points (0.14, Table 5).

CONTRIBUTION OF GBC COMPONENTS TO GROSS B&C SCORE FOR SAY AND FAY

Total length measurements (main beam length, tine length, and abnormal tine lingth) accounted for 54% of the overall GBC score for FAY, while for SAY it accounted for 36% of the score. Circumference measurements contributed the most (44%) to the score of SAY, while it contributed only 30% to the overall GBC score for FAY. Inside spread contributed the least (Fig. 10) to the overall score for both SAY (20%) and FAY (16%).

GROSS B&C SCORES OF SPIKE-ANTLERED, 3-5 POINTS AND 6+ POINTS YEARLINGS

The mean GBC score of yearling bucks with ≥ 6 points was 65.4 (SE = 0.94, n = 130) points. While the mean GBC score of 3-5 point yearling bucks was 46.06 (SE = 0.84, n = 105) points and the mean GBC score of spike-antlered yearlings was 28.76 (SE = 0.95, n = 84). The means of the three groups were all significantly different ($P < 0.0001$) using Ryan-Einot-Gabriel-Welsch multiple $\underline{F}$-test (Table 6).

Of the 6+ points yearling bucks, 129 (99%) scored over 45 GBC points, while only 58 (55%), 3-5 points yearlings and one (1%) SAY scored over 45 GBC points. No 6+ points yearlings scored below 35 GBC points, while 11(10%), 3-5-points yearlings and 64 (76%) SAY scored less than 35 GBC points (Fig. 11).

LIVE BODY WEIGHT OF SPIKE-ANTLERED, 3-5 POINTS AND 6+ POINTS YEARLINGS

Of the 6+ points yearling bucks, 86 (68%) weighed over 50 kg, while 38 (37%), 3-5 points yearlings and 10 (12%) SAY weighed over 50 kg (Fig. 12). The mean live body weight of the 127, 6+ points yearlings was 53.83 (SE = 0.56) kg. While the mean live body weight of the 102, 3-5 points yearlings was 48.59 (SE = 0.49) kg and the mean live body weight of the 83 SAY was 43.37 (SE = 0.59) kg. The means for all three groups were significantly different ($P < 0.0001$, Table 7).

CONTRIBUTION OF GBC COMPONENTS TO GROSS B&C SCORE FOR SPIKE-ANTLERED, 3-5 POINT AND 6+ POINT YEARLINGS

Total length measurements accounted for 58% of the overall GBC score for 6+ points yearling bucks, 49% for 3-5 points, and 36% for SAY. Circumference measurements contributed the most (44%) to the score of SAY, while it contributed only 27% to the overall GBC score for 6+ points yearlings and 34% for 3-5 points yearlings. Inside spread contributed the least to the overall score for SAY (20%), 3-5 points (17%) and 6+ points (15%, Fig. 13) yearlings.

DISTRIBUTION OF JULIAN BIRTHDATES FOR SPIKE-ANTLERED, 3-5 POINT AND 6+ POINT YEARLINGS

Only one (1%) spike-antlered yearling was born prior to day 135. Five (4%) 3-5 points, and 17 (13%), 6+ points yearlings were born during this same time. During the period day 136 to day 171, 44 (47%) SAY, 65 (57%) 3-5 points, and 87 (66%) 6+ points yearling bucks were born. Thirty-five (38%) SAY, 39 (34%) 3-5 points and 26 (20%) 6+ points yearlings were born during the period day 172 to 207. After day 208, 13 (14%) SAY, 6 (5%) 3-5 points, and 2 (1%) 6+ points yearlings were born (Table 8, Fig. 14).

Of bucks born on or before day 135, 17 (74%) were 6+ points yearling bucks. There were 196 bucks born during the period day 136 to day 171 of which 87 (44%) were 6+ points yearlings. Twenty-six percent of all bucks born during the period day 172 to day 207 were 6+ points yearlings. Of those bucks born on or after day 208, 2 (10%) were 6+ points yearlings (Table 8, Fig. 15).

DISCUSSION

The results of this study indicate that there are substantial and significant differences in live body weight and antler characteristics of spike-antlered yearling white-tailed bucks compared to fork-antlered yearling bucks. Fork-antlered yearlings had significantly larger gross Boone and Crockett scores as well as live body weights. Antler characteristics show a highly significant positive relationship with live body weight, indicating that physical condition plays a significant role in the variability of antler characteristics (Scribner et al., 1989). This suggests that selection for increased antler development also selects for increased body weights (Williams et al., 1993). The animals used in this study were fed an optimal diet that allowed their physical condition to reach its potential for their age. This eliminated nutrition as a limiting factor in antler growth of the deer used in the study. By using only one age class, 1.5 years-of-age, I was able to eliminate age as a variable in antler development. Genetics remained as the last major factor in antler development in the study.

The GBC score showed significant substantial differences between SAY and FAY. The mean GBC score for fork-antlered yearlings was 28 points higher than the mean GBC score of spike-antlered yearlings. The live body weights of the two antler classes showed similar results, with the mean live body weight of fork-antlered yearlings being 8.1 kg (18 pounds) heavier than spike-antlered yearlings. This result contrasts with findings by Schultz and Johnson (1992) who found no significant difference in live body weight at any age between spike-antlered and fork-antlered yearling bucks in a captive herd of white-tailed deer in Louisiana. The results do concur with the findings of Smith et al. (1983) and Ott et al. (In Press) that antler size and configuration increase relative to increased live body weight.

Based on the analysis of data from this study, the null hypothesis that there was no difference in live body weight or antler characteristics between spike-antlered and fork-antlered yearling bucks was rejected.

Jacobson (1995) found that date of birth was important in antler development in yearling white-tailed deer. I found that spike-antlered yearlings were born an average of 14.6 days later than fork-antlered yearlings. Based on the analysis of data from this study, the null hypothesis that there was no difference in birthdate between spike-antlered and fork-antlered yearlings was rejected. However, 48% of all spike-antlered deer were born early in the fawning season. I also examined the data for a determination of the percentage of spike-antlered and fork-antlered bucks born during four time periods (< Day 135, Day136-171, Day172-207, and > Day 208). If the data were examined in this manner, it would give the impression that most spike-antlered bucks were born extremely late in the fawning season.

I also examined the relationships of Julian birthdate and GBC score, and Julian birthdate and live body weight. The relationship between birthdate and GBC score was significant for both spike-antlered and fork-antlered yearling bucks; however, the relationship explained very little of the total variation in GBC score ($R^2 = 0.19$). The relationship of birthdate and live body weight existed for fork-antlered yearlings only. Again, this relationship was very weak explaining only a very small portion of the total variation in live body weight for yearling white-tailed deer. Based on this data, date of birth alone is not a plausible explanation to account for the presence of spike-antlered yearlings in a deer herd.

Scribner and Smith (1990) reported that antler size and shape were a function of age, but the problem was to understand the importance of genetic and environmental factors and how antler growth patterns change through specific age classes. The inference of my data supports the theory that spike-antlered yearlings are genetically inferior to fork-antlered yearlings. In the context of this study, the term inferior refers to those bucks that produce small antlers and low body weights. These bucks are less desirable than large antlered heavy-bodied bucks due to the economic return from the resource. Moreover, due to the heritability of these traits inferior bucks will produce offspring with these undesirable traits.

Williams et al. (1993) reported that yearling bucks with less than 6 antler points were genetically inferior for antler development and would produce inferior antlers for the second and third set of antlers. Due to the substantial differences in the two-group antler classification for yearlings, I reclassified them into three antler groups based on number of tines. The data of my study support the theory that yearlings with < 6 antler points are inferior in live body weights and antler characteristics when compared to yearling bucks with ≥ 6 points (Williams and Harmel, 1984; Williams et al., 1993).

Mean GBC scores were significantly different between the three classes of yearlings. Yearlings with 6 or more points had a mean GBC score 19.3 points greater than 3-5 points yearlings and 36.6 points greater than spike-antlered yearlings. Similarly, differences in live body weights were also significantly different between the three classes of yearlings. Yearlings with 6 or more points had a mean live body weight that was 5.2 kg (11.5 pounds) heavier than 3-5 points yearlings and 10.4 kg (22.9 pounds) heavier than spike-antlered yearlings. Thus the null hypothesis that there was no difference in live body weight or antler size between spike-antlered, 3-5 points, and 6 or more points yearlings was rejected.

Percent contribution of GBC components to overall GBC score was also examined for both the two antler classes and the three antler classes. For bucks other than spike-antlered, length measurements (main beam, and tine lengths) contributed most to the overall GBC score. Circumference measurements contributed the most to the overall scores of spike antlered yearling bucks. Greatest inside spread composed the smallest portion of the overall GBC score for all yearling bucks.

Highly significant positive correlations were found for almost all combinations of GBC score components for fork-antlered yearlings and when all deer were combined. Significant positive correlations between spread and main beam, spread and circumference, and main beam and circumference were found for spike-antlered yearlings. This indicates that size GBC score components are closely related. Typically bucks with long main beams will have larger circumference measurements, greater inside spread, and longer tine lengths than bucks with shorter main beam lengths.

MANAGEMENT IMPLICATIONS

Wildlife management practices used in white-tailed deer management can be classified into two types. Goals are similar for each type; however, the objectives used to reach these goals are different. One type of management is population management. With this type of management, the entire population of a targeted species is considered when planning management practices and evaluating their success. For example, if the goal of management is to produce large antlered, heavy bodied white-tailed deer, then methods of harvest and habitat management that improve live body weight and antler characteristics would be used in herd management. To evaluate the success of the program, the mean values for antler characteristics and live body weight for all bucks harvested would be calculated. The management objective would be to shift these means through time toward higher values. The other type of management is individual management. The same management goal of larger deer would be part of the management plan; however, managers would look only at one or two bucks to evaluate the success of the management program. Overall herd improvement for larger antler characteristics and live body weights would not be a management objective.

This study clearly supports the population management style of white-tailed deer management. If selection pressure through harvest were placed on spike-antlered bucks, the data suggest that the buck population as a whole would have larger antlers and heavier live body weights, if bucks reached maturity before harvest. The success of the management goal could be seen in the evaluation of all harvested mature bucks.

On the other hand, my data neither support nor reject the alternate management style. In this case, spike-antlered bucks would not be intentionally removed from the population. The mean GBC score of the entire herd would remain the same. On evaluation of harvested mature bucks, my data suggest that the mean GBC score overall will be lower than the population management style. However, evaluation of this management style is based on one or two bucks.

Dr. Harry Jacobson at Mississippi State University (MSU) asserted that there is no correlation between the size and configuration of a buck's first set of antlers compared to future sets and concluded, that the spike antler trait is not inferior, resulting from inadequate nutrition and genetics (Kroll, 1992). Ott et al. (In Press) found that at maturity, spike-antlered yearlings were inferior to fork-antlered yearlings, and that the yearling classification (spike-antlered or fork-antlered) could be used in predicting antler characteristics and live body weight at maturity.

Data in the present study show clear differences in the quality of antlers and live body weight of spike-antlered and fork-antlered yearlings. It provides a valuable tool to landowners, managers, biologists, and hunters who are interested in producing quality white-tailed deer. With this information, those wishing to improve the GBC score of their white-tailed deer population should institute an intensive culling program. Through time there should be increases in antler size and live body weight under optimal conditions and even suboptimal conditions. In order to see the best results, managers should not initiate a culling program until adequate nutrition, proper population densities (domestic and wildlife), and good range conditions are in place (Cox, 1982). Under an intensive management plan, all bucks with < 6 points, regardless of their age, would be culled. A less intensive management plan would be to remove all spike-antlered bucks from the population. In both cases, GBC scores for the entire population should increase over time because of selection pressure on specific segments of the buck population. As wildlife management to produce quality white-tailed deer becomes increasingly expensive, this inexpensive practice should achieve the desired results.

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Table 1. Means and summary statistics for gross Boone and Crockett score (inches), live body weight (kg), and Julian birthdate for spike-antlered and fork-antlered yearlings from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

	Spike-antlered				Fork-antlered			
Variable	N	x	SE	Range	N	x	SE	Range
GBC score	84	28.7	0.95	3.1-45.8	235	56.7	0.90	18.2-91.1
Live Body Weight	83	43.3	0.59	29.9-54.4	229	51.5	0.42	34-70.8
Birthdate	93	179	2.65	134-273	247	165	1.36	117-262

Table 2. Distribution by periods of birthdates by Julian day for spike-antlered and fork-antlered yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

	Spike-antlered			Fork-antlered		
Period	N	% in period	% of Total	N	% in period	% of Total
≤ 135	1	4	1	22	96	9
136 - 171	44	22	47	152	78	62
172 - 207	35	35	38	65	65	26
≥ 208	13	62	14	8	38	3
Total	93		100	247		100

Table 3. Pearson correlation coefficients (r, above), levels of significance (P, middle) and N (below) of B&C score components for spike-antlered yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

Component	Spread	Main Beam	Circumference
Spread	1.0	0.75	0.60
	0.0	0.0001	0.0001
	84	84	84
Main Beam		1.0	0.80
		0.0	0.0001
		96	96
Circumference			1.0
			0.0
			96

Table 4. Pearson correlation coefficients (r, above), levels of significance (P, middle) and N (below) of Boone and Crockett score components for fork-antlered yearlings from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

Component	Spread	Main Beam	Sum of G's	Circum.	Abnml Pts.
Spread	1.0	0.75	0.57	0.51	-0.05
	0.0	0.0001	0.0001	0.0001	0.47
	235	235	235	235	84
Main Beam		1.0	0.76	0.65	-0.005
		0.0	0.0001	0.0001	0.94
		248	248	248	248
Sum of G's			1.0	0.73	0.003
			0.0	0.0001	0.95
			248	248	248
Circum.				1.0	0.12
				0.0	0.05
				248	248
Abnml Pts.					1.0
					0.0
					249

Table 5. Pearson correlation coefficients (r, above), levels of significance (P, middle) and N (below) of Boone and Crockett score components for all yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

Component	Spread	Main Beam	Sum of G's	Circum	Abnml Pts.
Spread	1.0	0.84	0.67	0.70	0.03
	0.0	0.0001	0.0001	0.0001	0.47
	319	319	319	319	319
Main Beam		1.0	0.79	0.82	0.07
		0.0	0.0001	0.0001	0.94
		344	344	344	344
Sum of G's			1.0	0.75	0.07
			0.0	0.0001	0.18
			344	344	344
Circum.				1.0	0.14
				0.0	0.007
				344	344
Abnml Pts.					1.0
					0.0
					345

Table 6. Gross Boone and Crockett scores (inches) for spike-antlered, 3-5 points, and 6 or more points yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd. Results based on ANOVA ($R^2 = 0.71$, $P < 0.0001$) followed by means comparison using Ryan-Einot-Gabriel-Welsch multiple F-test. Means followed by different letters indicate significant difference at P = 0.05.

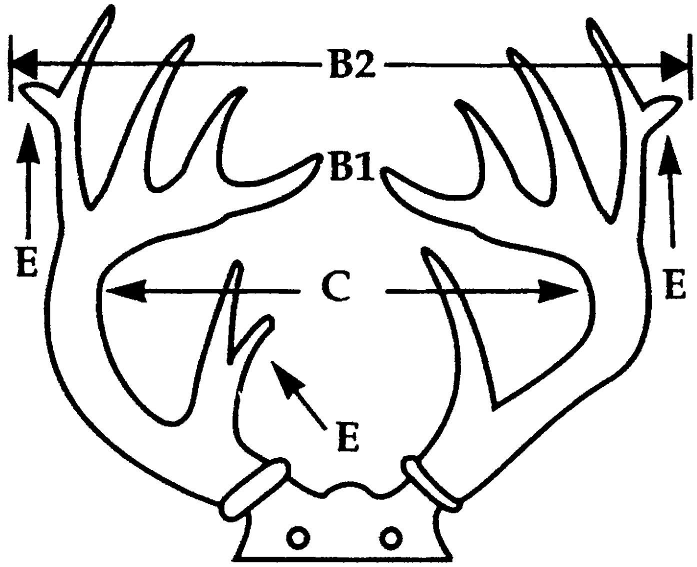
Antler Classification	N	GBC score	SE
Spike	84	28.7^{A}	0.95
3-5 points	105	46.1^{B}	0.84
6+ points	130	65.4^{C}	0.94

Table 7. Live body weights (kg) for spike-antlered, 3-5 points, and 6 or more points yearlings from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd. Results based on ANOVA ($R^2 = 0.36$; $P < 0.0001$) followed by means comparison using Ryan-Einot-Gabriel-Welsch multiple F-test. Means followed by different letters indicate significant difference at $P = 0.05$.

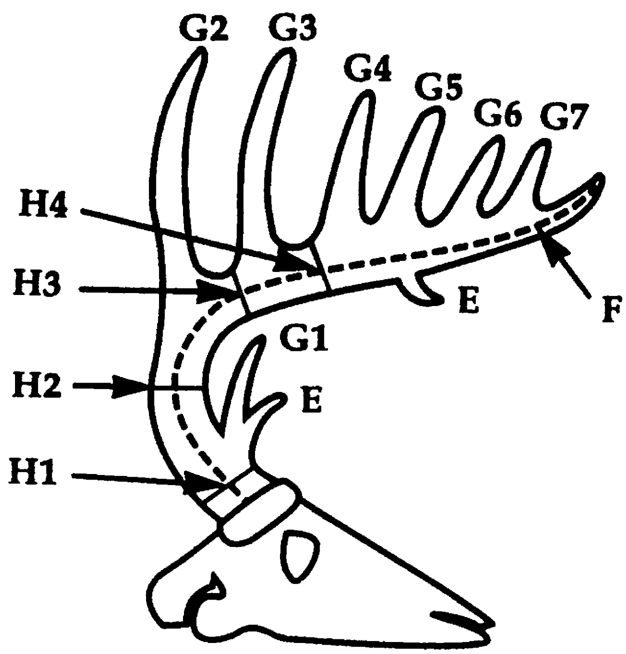
Antler Classification	N	Live Body Weight	SE
Spike	83	43.4^{A}	0.59
3-5 points	102	48.6^{B}	0.49
6+ points	127	53.8^{C}	0.56

Table 8. Distribution by periods of birthdates by Julian day for spike-antlered, 3-5 points, and 6 or more points yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

	Spike-antlered			3-5 points			6+ points		
Period	N	% in period	% of Total	N	% in period	% of Total	N	% in period	% of Total
≤ 135	1	4	1	5	22	4	17	74	13
136 - 171	44	22	47	65	33	57	87	44	66
172 - 207	35	35	38	39	39	34	26	26	20
≥ 208	13	62	14	6	29	5	2	9	1
Total	93		100	115		100	132		100



(a)



(b)

Figure 1. (a) Frontal and (b) lateral views of antler measurements used in the calculation of the gross Boone and Crockett (GBC) score. Where H1, H2, H3, H4 are circumference measurements; G1, G2, G3, G4, G5, G6, G7 are typical tine lengths; F is main beam length; E are abnormal tine lengths; C is the greatest inside spread; B1 is the tip to tip spread; and B2 is the greatest outside spread.

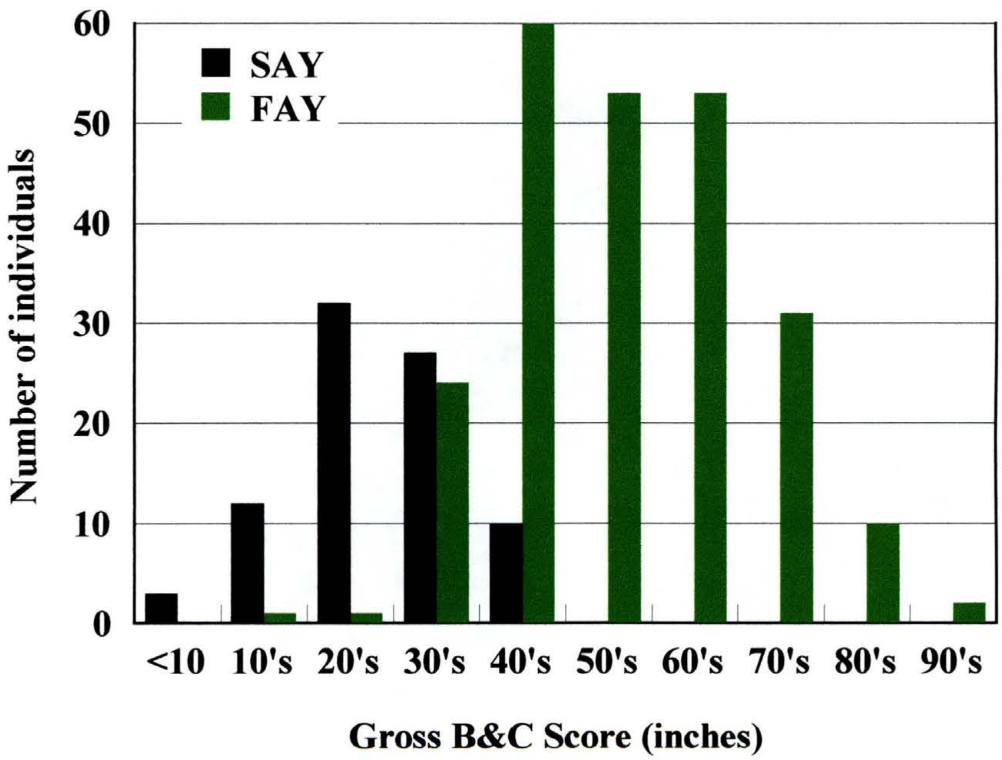


Figure 2. Distribution of gross Boone & Crockett scores of spike-antlered (SAY; n = 84) and fork-antlered yearling (FAY; n = 235) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

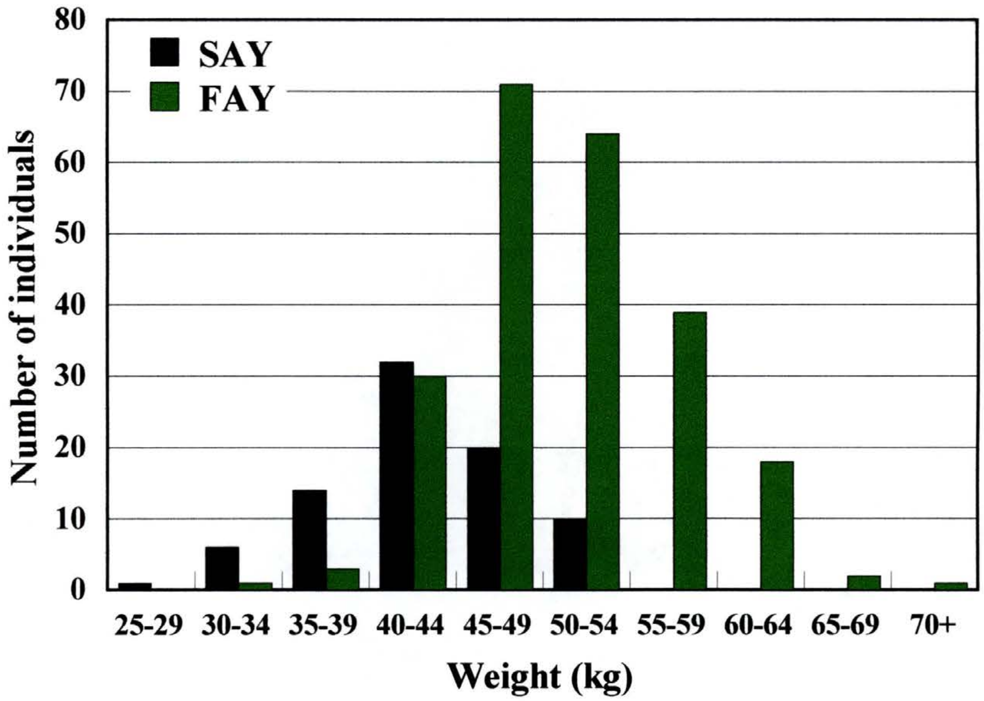


Figure 3. Distribution of live body weights of spike-antlered (SAY; n = 83) and fork-antlered yearling (FAY; n = 229) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

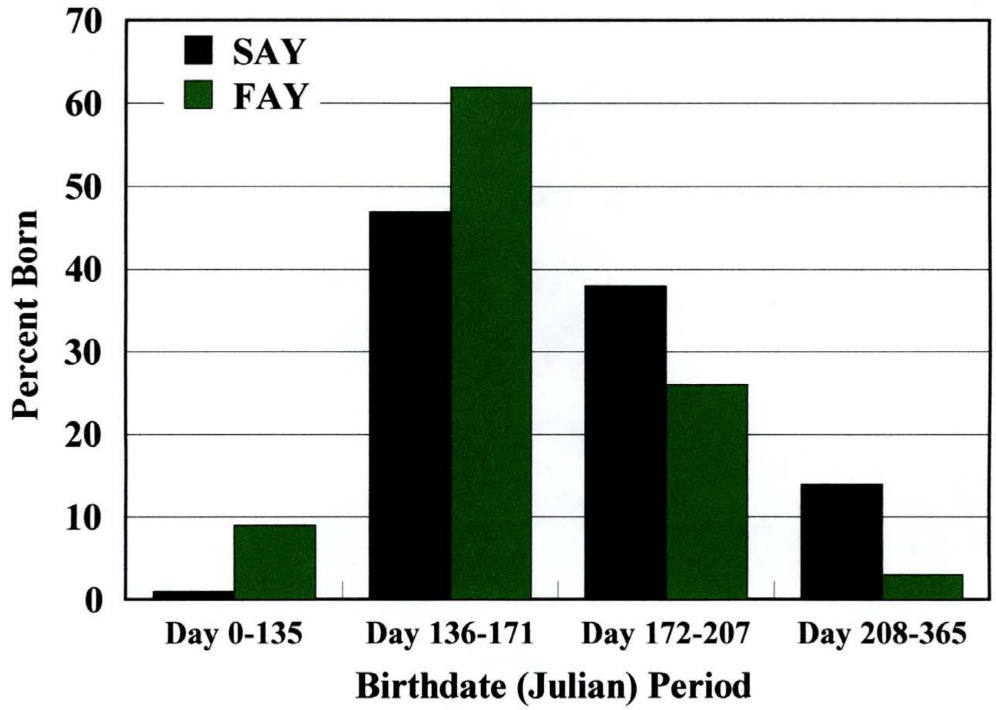


Figure 4. Percent of all spike-antlered (SAY, n = 93) and all fork-antlered yearling (FAY, n = 247) bucks born during 4 time periods at the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

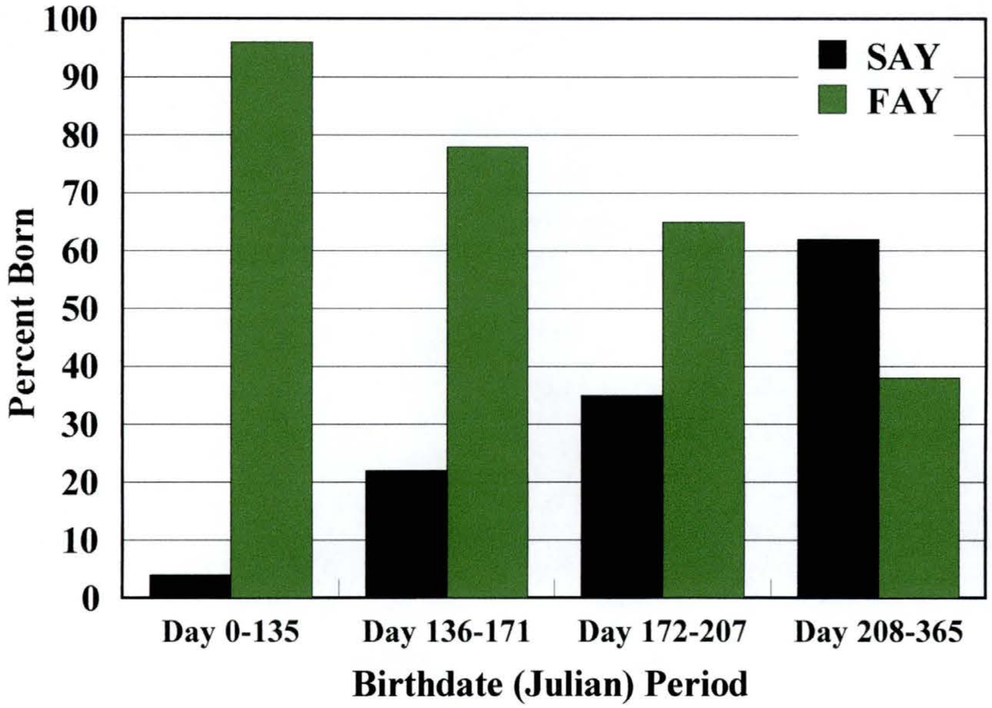


Figure 5. Percent of spike-antlered (SAY; n = 93)and fork-antlered yearling (FAY; n = 247) bucks born during periods at the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

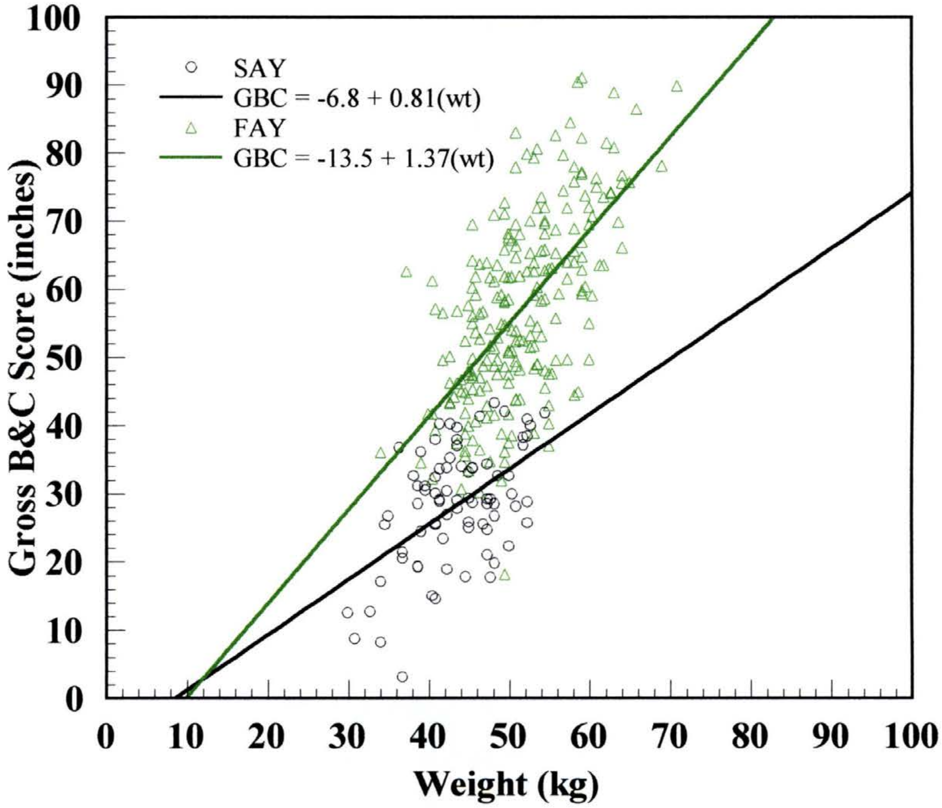


Figure 6. Regression of GBC score on live body weights of spike-antlered (SAY; n = 83; $R^2 = 0.27$) and fork-antlered yearling (FAY; n = 229; $R^2 = 0.39$) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

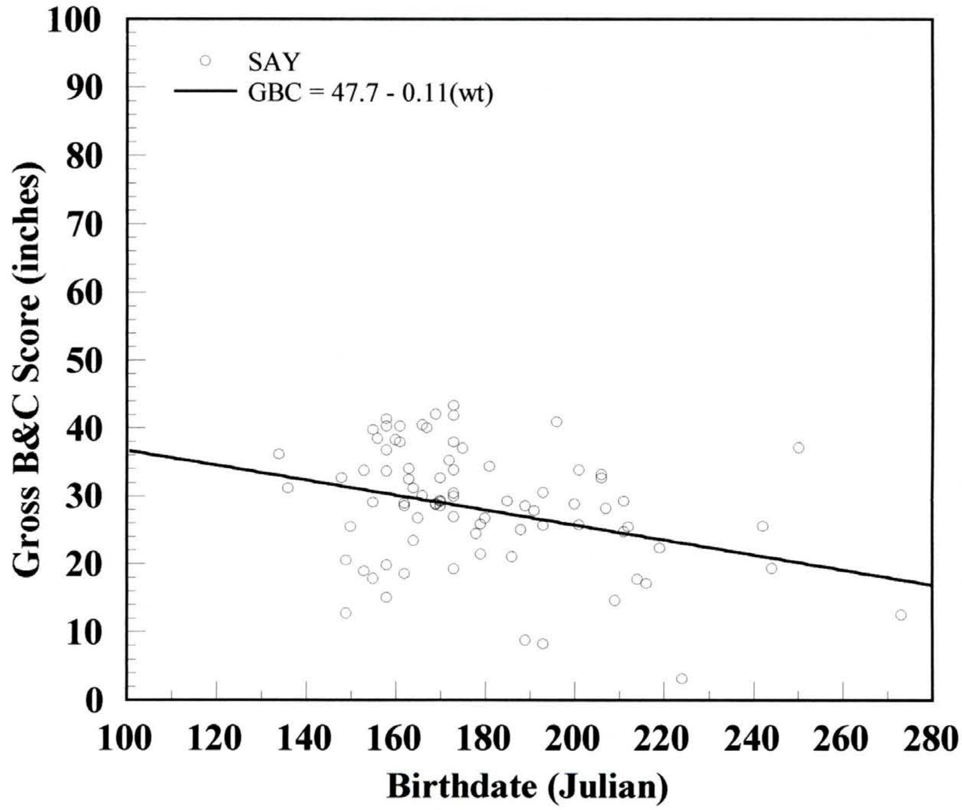


Figure 7. Regression of GBC score on birthdate of spike-antlered yearling (SAY; n = 84; R^2 = 0.09) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

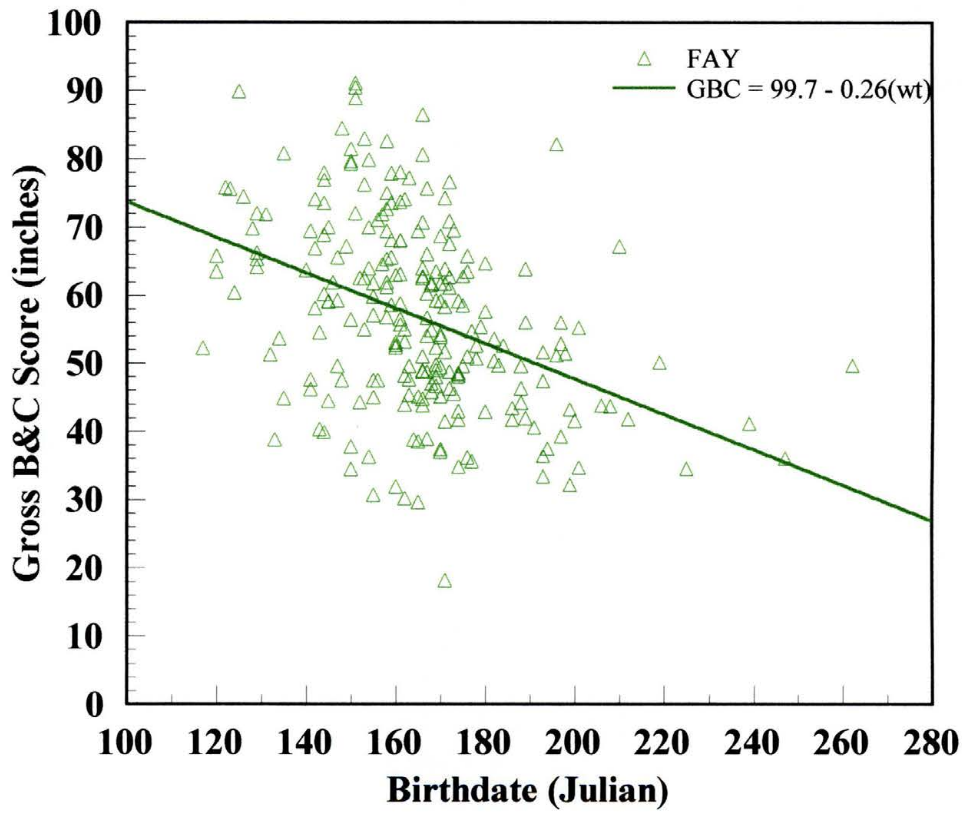


Figure 8. Regression of GBC score on birthdate of fork-antlered yearling (FAY; n = 235; R^2 = 0.16) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

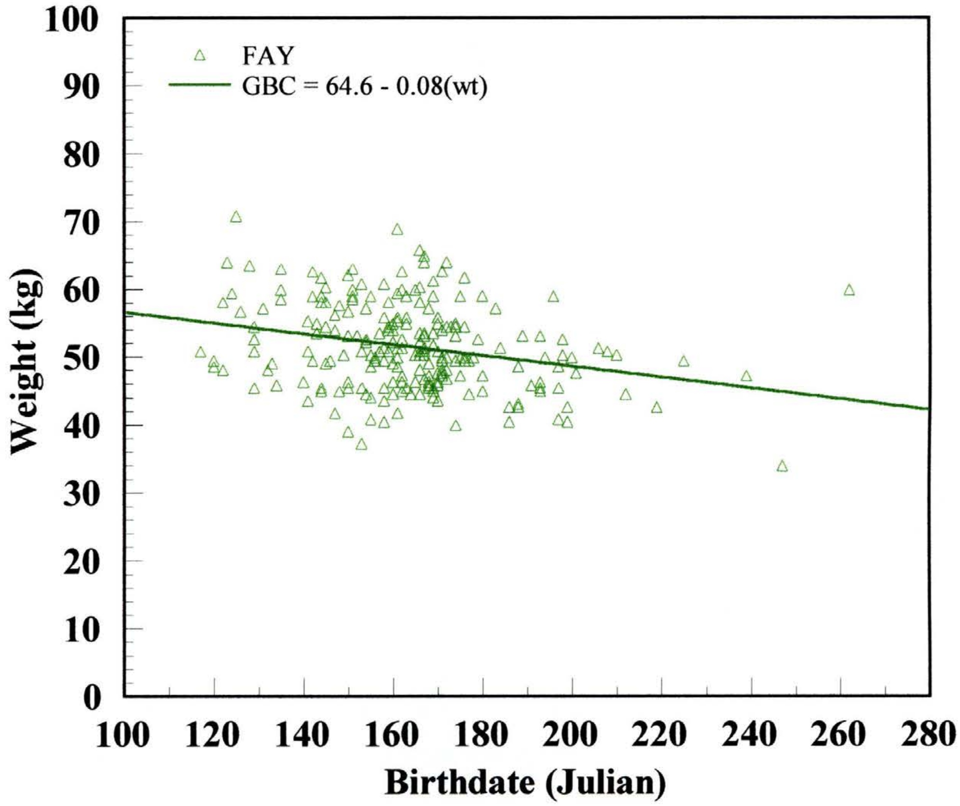


Figure 9. Regression of live body weight on birthdate of fork-antlered yearling (FAY; n = 229; R^2 = 0.08) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

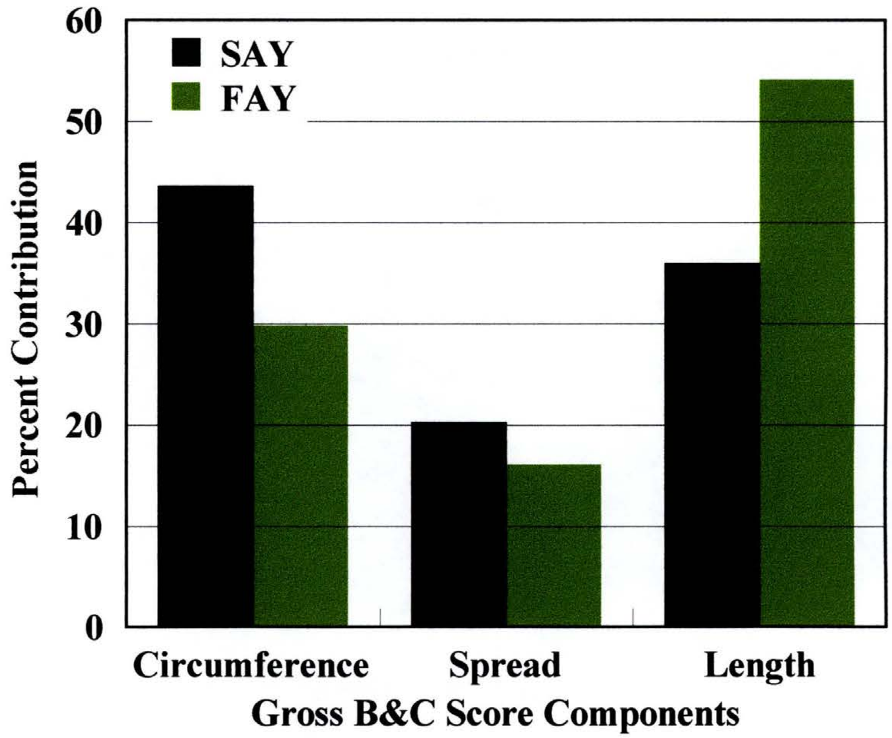


Figure 10. Percent contribution of GBC components to overall GBC score for spike-antlered (SAY, n = 84)and fork-antlered yearling (FAY; n = 235) bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd. Length is the value for the sum of main beam length, normal tine length, and abnormal tine length.

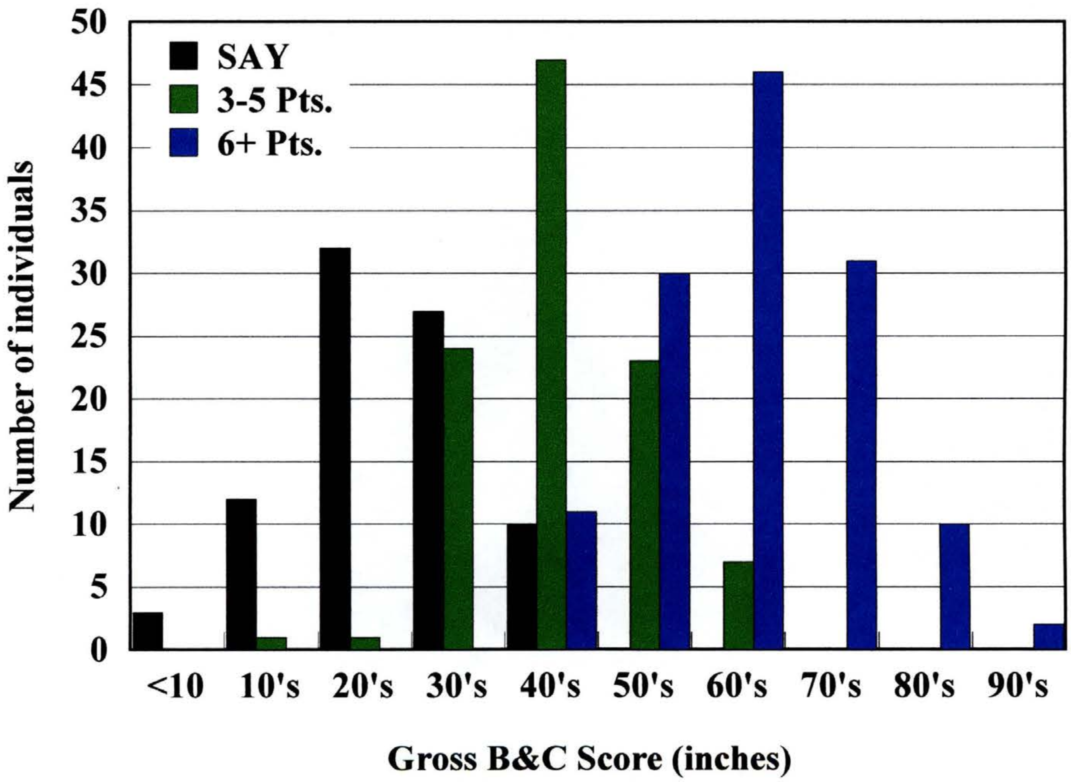


Figure 11. Distribution of gross Boone & Crockett scores of spike-antlered (SAY; n = 84), 3-5 points (n = 105), and 6 or more points (n = 130) yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

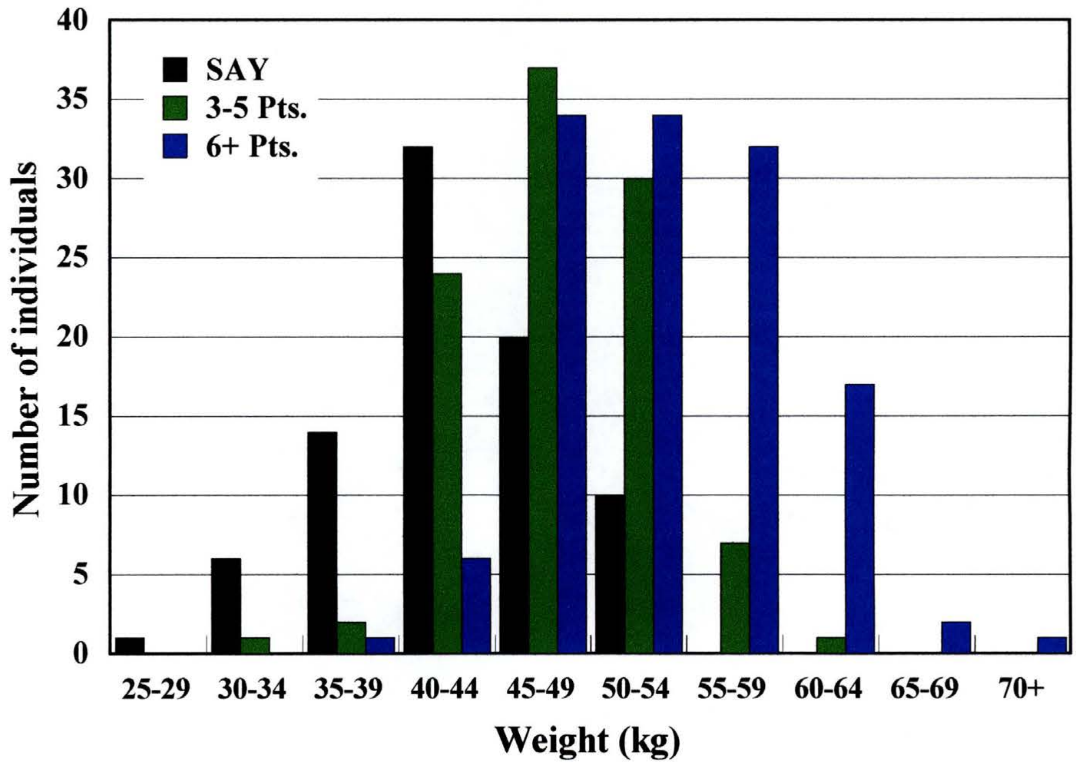


Figure 12. Distribution of live body weights of spike-antlered (SAY; n = 83), 3-5 points (n = 102), and 6 or more points (n = 127) yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

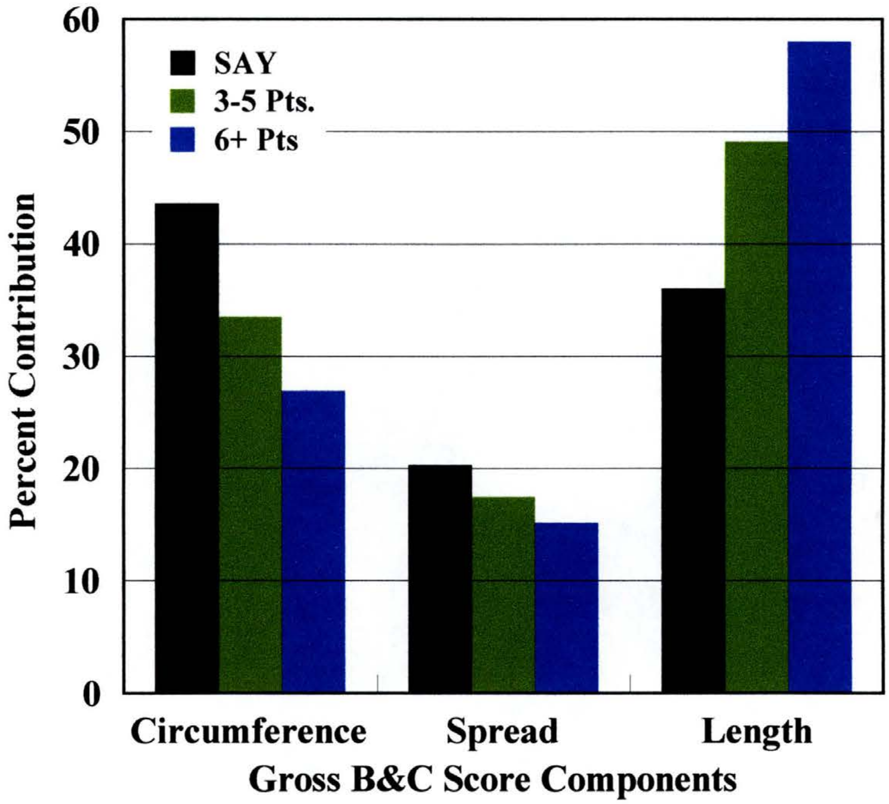


Figure 13. Percent contribution of GBC components to overall GBC score for spike-antlered (SAY; n = 84), 3-5 points (n = 105), and 6 or more points (n = 130) yearling bucks from the Kerr Wildlife Management Area's pedigreed white-tailed deer herd. Length is the value for the sum of main beam length, normal tine length, and abnormal tine length.

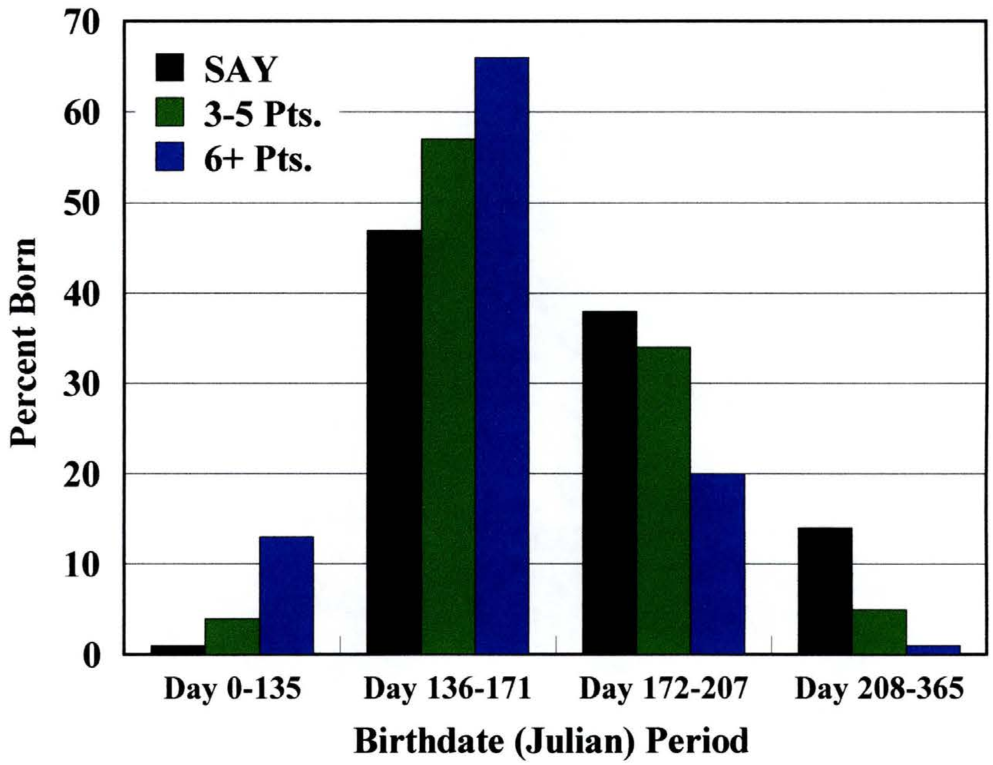


Figure 14. Percent of all spike-antlered (SAY; n = 93), 3-5 points (n = 115), and 6 or more points (n = 132) yearling bucks born during 4 time periods at the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.

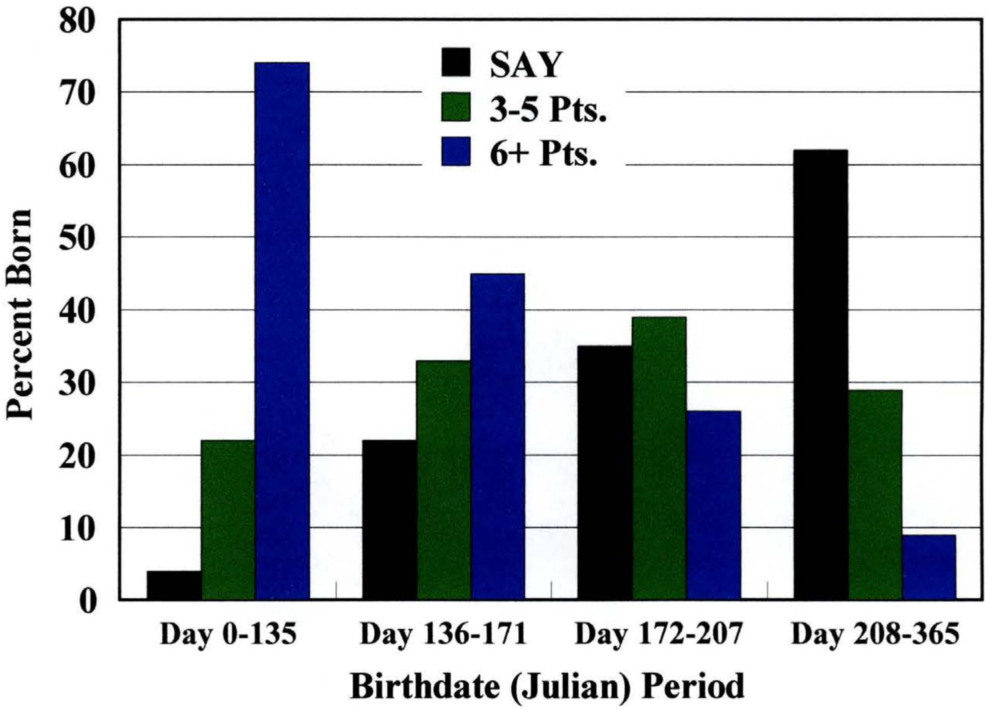


Figure 15. Percent of spike-antlered (SAY; n = 93), 3-5 points (n = 115), and 6 or more points (n = 132) yearling bucks born during periods at the Kerr Wildlife Management Area's pedigreed white-tailed deer herd.