Predicting Neonatal Age of White-Tailed Deer in the Northern Great Plains

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ABSTRACT -- Hoof growth has been used to estimate neonatal age in free-ranging white-tailed deer (*Odocoileus virginianus*). Studies evaluating hoof growth as a predictor of neonatal age have been conducted on captive white-tailed deer in Alabama (*O. v. virginianus*) and Texas (*O. v. texanus*). To our knowledge, no studies have been conducted on white-tailed deer (*O. v. dacotensis* or *O. v. borealis*) inhabiting the Northern Great Plains. Because white-tailed deer located in the south differ in birth mass and growth rate from those located in the north, our objective was to determine if neonatal age estimation equations based on hoof growth used in the southern United States were applicable to white-tailed deer subspecies in the Northern Great Plains. A linear regression equation was developed based on hoof growth and age data for captive white-tailed deer neonates in South Dakota. Age estimates using equations developed in the south overlapped estimates using our equation, with our linear regression model fitting between those developed in the south. Based on our evaluation, hoof growth equations developed for deer subspecies in the south and north were equivalent for estimating age of neonates in the Northern Great Plains.

Key words: Age estimation, hoof growth, neonates, Northern Great Plains, *Odocoileus virginianus*, white-tailed deer.

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Hoof growth has been used to estimate neonatal age in free-ranging white-tailed deer (*Odocoileus virginianus*) (Cook et al. 1971, Huegel et al. 1985, Nelson and Woolf 1987, Whittaker and Lindzey 1999). Other morphometric predictors of neonatal age include body mass, hindfoot length, total body length, chest girth, tail length, head length, ear length, and shoulder height (Haugen 1959, Verme 1963, Zwank et al. 1992, Schultz and Johnson 1995). However, hoof growth was reported to provide the most reliable and accurate aging model and was affected least by gender or maternal nutrition (Sams et al. 1996).

Haugen and Speake (1958) evaluated captive neonate (*O. v. virginianus*) hoof growth in Alabama, and Sams et al. (1996) used the same approach on captive neonates (*O. v. texanus*) in Texas. We were unable to locate similar published studies conducted on white-tailed deer subspecies (*O. v. dacotensis* and *O. v. borealis*) in the Northern Great Plains. In general, birth mass is larger in northern white-tailed deer (Zwank et al. 1992) and neonates heavier at birth have been reported to have higher growth rates (Verme 1963, Schultz and Johnson 1995). In Louisiana, Zwank et al. (1992) reported that mean mass of captive neonates (*O. v. macrourus*) at birth was 2.8 kg with an average mass gain of 0.130 kg/day. Haugen (1959) reported a mean birth mass of 2.7 kg for captive neonates (*O. v. virginianus*) in Alabama. In the north, Verme (1963) reported a mean birth mass of 3.2 kg, and average mass gain of 0.215 kg/day for deer (*O. v. borealis*) in Michigan. Moreover, Robbins and Moen (1975) reported a growth rate of 0.244 kg/day for neonates (*O. v. borealis*) in New York. Although birth mass differs only by approximately 0.5 kg, and growth rates by approximately 0.1 kg/day, using existing equations (Haugen and Speake 1958, Sams et al. 1996), new hoof growth of just 1.0 mm represents a 3-day difference in age estimation. Therefore, a slight change in mass or growth rate might result in a difference in age estimation. Because white-tailed deer located in the south differ in birth mass and growth rate from those located in the north, our objective was to determine if neonatal age estimation equations based on hoof growth used in the southern United States were applicable to white-tailed deer subspecies (*O. v. dacotensis*) in the Northern Great Plains.

METHODS

Hoof growth was measured on neonatal white-tailed deer born to and raised by captive does in 25-m^2 enclosures at the South Dakota State University, Department of Wildlife and Fisheries Sciences Research Facility located in Brookings, South Dakota. Measurements were taken from neonate birth to four weeks of age during May and June 2002. All does were 4 years of age and maintained on an *ad libitum* diet consisting of corn, pelleted soy hulls, and alfalfa prior to and post-parturition (Schmitz 2000). Does were monitored every 4 hours to determine time of parturition. Front hoof growth of neonates was measured to the nearest 0.1 mm by using the technique originally described by Haugen and Speake (1958). New growth on front hoofs was determined by measuring the distance from the hairline to the growth-ring line on the outside edge of a hoof (Fig. 1) with a poly dial caliper (Swiss Precision Instruments, Garden Grove, California). Hoof growth was estimated as the average of two front hoof measurements.

We monitored hoof growth of six (three sets of twins) captive white-tailed deer neonates (one female, five male). Two neonates were bottle-fed and the remaining four neonates were nursed by their mothers. Both bottle-fed and nursed neonates were allowed to feed at similar times. As fawns matured, they were offered horse sweet feed (16% protein), and then corn, pelleted soyhulls (13.4% protein), and alfalfa (*ad libitum*). Facilities and procedures for research regarding captive white-tailed deer followed the guidelines of the Institutional Animal Care and Use Committee at South Dakota State University (Approval Number 02-A038).

Linear regression was used to evaluate the relationship between age and hoof growth. Known neonatal ages were compared to those generated from the equations developed by Haugen and Speake (1958) and Sams et al. (1996). Correlation analyses were used to determine relationships between the three separate age estimation equations. T-tests with a Bonferroni correction were used to determine if significant differences existed between the three separate age estimation equations.

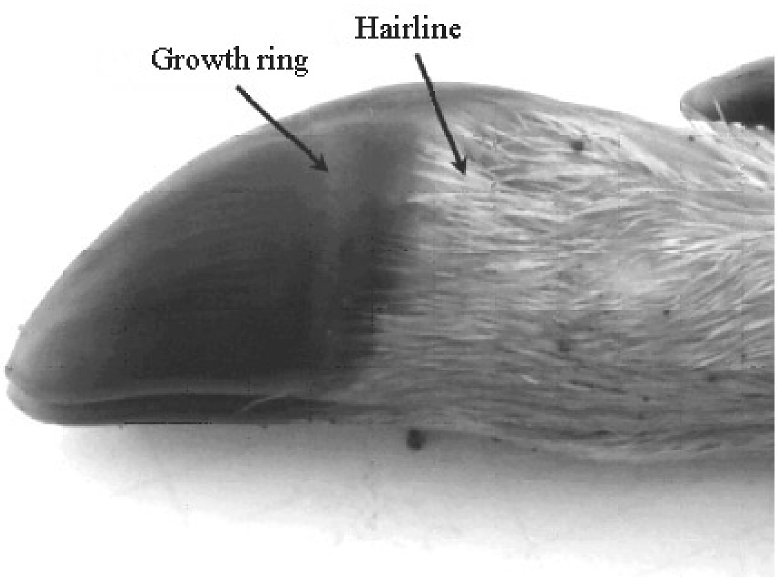

Figure 1. Growth ring and hairline on a hoof of a white-tailed deer neonate raised at the South Dakota State University, Department of Wildlife and Fisheries Sciences Research Facility, South Dakota, spring-summer 2002.

RESULT AND DISCUSSION

From 29 May to 21 June 2002, 46 hoof growth measurements were collected on captive neonates (measurements per neonate, mean = 7.7, SE = 0.88, range = 5 - 10). Mean age of neonate at first measurement was 3 days (SE = 0.68, range = 1 - 5). Mean age of neonates was last measured at 21 days (SE = 2.39, range = 15 - 28).

Using captive neonate hoof growth as the independent variable and age as the dependent, the linear regression formula for the relationship was Y = -5.728 + 3.141X (Fig. 2). About 76% of variation in hoof growth was explained by age. Our regression formula for estimating age from hoof growth accurately classified 15% of the sample, with 37, 57, and 67% of the neonates classified within 1, 2, or 3 days of their true age, respectively. The inverted linear regression model (AGE = (HOOF - 2.262) / 0.273) of Sams et al. (1996) accurately classified 20% of our sample, with 39, 52, and 72% of the neonates classified within 1, 2, or 3 days of their true age, respectively. In comparison, the regression equation (AGE = 0.66 + 2.2 * HOOF) of Haugen and Speake (1958) accurately classified 9% of our sample, with 22, 41, and 57% of the neonates classified within 1, 2, or 3 days of their true age, respectively.

Using our regression formula, hoof growth at birth was estimated at 1.8 mm with a growth rate of 0.32 mm/day. Sams et al. (1996) reported 2.2 mm new hoof growth at birth with a growth rate of 0.27 mm/day. Conversely, using the formula

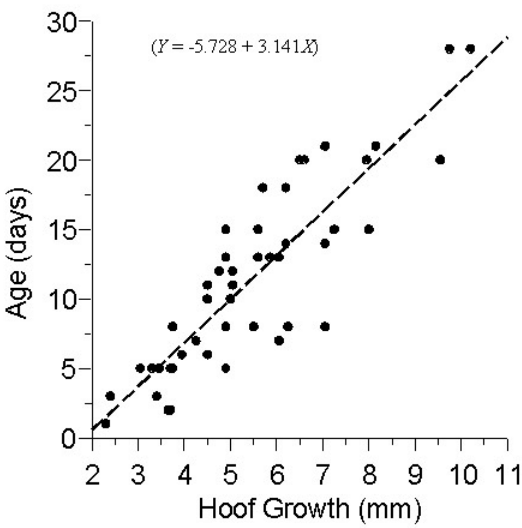

Figure 2. Linear regression (Y = -5.728 + 3.141X) of average hoof growth versus age for captive white-tailed deer neonates (*O. v. dacotensis*) in South Dakota.

of Haugen and Speake (1958), there was negative hoof growth at birth and the growth rate was 0.45 mm/day. Lack of hoof growth at birth reported by Haugen and Speake (1958) likely was attributed to the absence of neonates less than 3 days in their regression analysis.

Age estimations based on our regression formula differed from those generated by using the equations of Sams et al. (1996) ($t = -2.086$, $df = 45$, $P = 0.043$) and Haugen and Speake (1958) ($t = -4.803$, $df = 45$, $P < 0.001$). Although age estimations differed statistically, means differed by 0.3 and 1.2 days from those generated by using the equations of Sams et al. (1996) and Haugen and Speake (1958), respectively. Hence, we suggest differences were minimal and not biologically significant. In addition, the linear regression lines of the three equations overlapped with our linear regression line (slope = 0.76) intermediate between those of Sams et al. (1996; slope = 0.88) and Haugen and Speake (1958; slope = 0.53) (Fig. 3). Thus, the equations could be used interchangeably for white-tailed deer neonates in northern or southern states with similar results.

Although litter size and maternal investment influence birth mass and growth rates of neonates (Verme 1963), these attributes are usually unknown in the wild. Nevertheless, age estimation equations developed in the south were equivalent for estimating neonatal age in the Northern Great Plains.

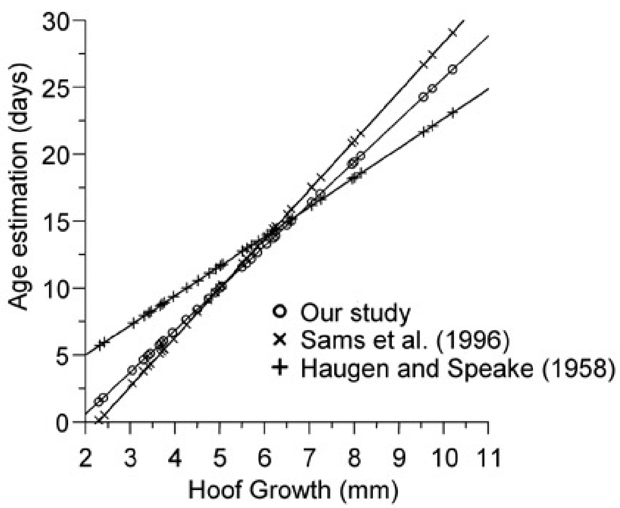

Figure 3. Comparison of neonatal age estimation using the equation based on captive white-tailed deer neonates (*O. v. dacotensis*) from South Dakota with those developed in the southern United States: AGE = -5.728 + 3.141 * HOOF (Our study), AGE = (HOOF - 2.262)/0.273 (Sams et al. 1996) and AGE = 0.66 + 2.2 * HOOF (Haugen and Speake 1958).

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LITERATURE CITED

Cook, R. S., M. White, D. O. Trainer, and W. C. Glazener. 1971. Mortality of young white-tailed deer fawns in south Texas. Journal of Wildlife Management 35:47-56.

Haugen, A. O. 1959. Breeding records of captive white-tailed deer in Alabama. Journal of Mammalogy 40:108-113.

Haugen, A. O., and D. W. Speake. 1958. Determining age of young fawn white-tailed deer. Journal of Wildlife Management 22:319-320.

Huegel, C. N., R. B. Dahlgren, and H. L. Gladfelter. 1985. Mortality of white-tailed deer fawns in south-central Iowa. Journal of Wildlife Management 49:377-380.

Nelson, T. A., and A. Woolf. 1987. Mortality of white-tailed deer fawns in southern Illinois. Journal of Wildlife Management 51:326-329.

Robbins, T. R., and A. N. Moen. 1975. Milk consumption and weight gain of white-tailed deer. Journal of Wildlife Management 39:355-360.

Sams, M. G., R. L. Lochmiller, E. C. Hellgren, W. D. Warde, and L. W. Varner. 1996. Morphometric predictors of neonatal age for white-tailed deer. Wildlife Society Bulletin 24:53-57.

Schmitz, L. E. 2000. Development of lure forages for minimizing winter depredation by deer in South Dakota. M. S. Thesis, South Dakota State University, Brookings.

Schultz, S. R., and M. K. Johnson. 1995. Effects of birth date and body mass at birth on adult body mass of male white-tailed deer. Journal of Mammalogy 76:575-579.

Verme, L. J. 1963. Effect of nutrition on growth of white-tailed deer fawns. Transactions of the North American Wildlife and Natural Resources Conference 28:431-443.

Whittaker, D. G., and F. G. Lindzey. 1999. Effect of coyote predation on early fawn survival in sympatric deer species. Wildlife Society Bulletin 27:256-262.

Zwank, P. J., J. A. Zeno, and J. A. Jenks. 1992. Birth characteristics and body growth of white-tailed deer fawns. Proceedings of the Louisiana Academy of Sciences 55:15-20.

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