Estimating Age of White-tailed Deer: Tooth Wear Versus Cementum Annuli

Harry A. Jacobson, *Department of Wildlife and Fisheries, Mississippi State University, MS 39762*

Richard J. Reiner,[1] *Department of Wildlife and Fisheries, Mississippi State University, MS 39762*

Abstract: Ages of 76 known-age white-tailed deer (*Odocoileus virginianus*) were estimated by tooth wear and replacement (TWR) and by incisor cementum annuli (CA) determination. TWR and CA methods gave similar results (75% and 71% correct, respectively). However, accuracy was dependent on deer age, with TWR being more accurate than CA in age classes <3.5 years and CA being more accurate in age classes >3.5 years. Accuracy of 55 southeastern United States biologists in estimating age of 98 known-age deer jaws also was determined. Results indicated biologists were well-skilled in the TWR technique but generally underestimated actual age class >3.5 years. Using their mode response (N = 98), biologists correctly determined age for 71.4% of the jaws; however, when using their estimates given for all jaws (N = 5,390), 62.6% were aged correctly.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:286–291

Two methods used to age white-tailed deer are the TWR technique (Severinghaus 1949) and counting incisor CA (Low and Cowan 1963). The TWR method is highly accurate for ages ≤3.5 years old (Ryle et al. 1961), but drops off rapidly in older age classes. Ludwig (1967) suggested the accuracy of aging deer by TWR is dependent on level of nutrition, grit on the vegetation, soil types, and biologist's training. A number of studies with known-age deer indicated the CA method is a good indicator of age (Low and Cowan 1963, Erickson and Seliger 1969, Thomas and Bandy 1973, 1975). These studies generally used low numbers of known-age deer, failed to indicate if annuli estimates were made without prior knowledge of actual age, or failed to evaluate results by specific age classes.

Comparisons between CA counts and TWR of deer from the northern United States and Canada have been made by several authors (Erickson et al. 1970, Gilbert

[1]Present address: The Nature Conservancy, 785 Market Street, San Francisco, CA 94103.

and Stolt 1970, and Thomas and Bandy 1975). These authors used CA counts as the correct age to evaluate the TWR method, which may be an incorrect assumption.

Accuracy of CA counts has been questioned for white-tailed deer in southern regions (Roseberry 1980). Cook and Hart (1979) reported that CA counts correctly aged only 16% of 25 known-age deer in Texas. Of those aged incorrectly, 90% were aged younger than true age. In contrast, Hackett et al. (1979) reported that CA counts overestimated age of Mississippi deer in comparison to TWR by consistently assigning fawns and yearlings to older age classes. They hypothesized the low accuracy of CA counts may have resulted from false annulations caused by the biannual (summer and winter) nutritional stress periods encountered by deer in the southern United States.

Our study compares the accuracy of aging known-age white-tailed deer from the southeastern United States by TWR using only molar wear measurements outlined by Larson and Taber (1980), to TWR estimated by experienced southeastern United States biologists, and to CA counts of first incisors as assigned by a commercial laboratory.

Support for this study was provided by Federal Aid Project W–48–28–34, by Mississippi Department of Wildlife Conservation, and by the Mississippi Agriculture and Forestry Experiment Station. R. L. Downing provided 8 known-age jaws from Virginia. E. A. Gluesing and D. E. Steffen provided advice on statistical treatment of data. We are particularly grateful to students of Mississippi State University and biologists and game division personnel of the Mississippi Department of Wildlife Conservation who assisted in the capture and tagging of >400 deer for use in this study.

Methods

We obtained lower jaws of known-age white-tailed deer from several locations. Ninety-four were wild deer from southern and central Mississippi which were tagged as fawns and subsequently harvested by hunters in fall and early winter. Eight deer were wild deer tagged as fawns in the Radford Army Ammunition Plant, Virginia. Jaws from these deer were recovered following accidental or natural death. Forty-eight of the jaws, including 11 fawns, were from captive deer raised at Mississippi State University. Captive deer were fed pelleted dairy feed. Captive deer and deer from Virginia died from early fall to spring.

All jaws were assigned ages using TWR criteria as outlined by Larson and Taber (1980). Jaws were aged without prior knowledge of actual age.

Fifty-five professional wildlife biologists at the 1985 Southeastern Deer Study Group meeting aged 98 jaws using the TWR method. All biologists had prior experience aging deer. Jaws were aged without use of reference materials or known-age jaws. The biologists were asked to work alone and to place each jaw into an age category ranging from 0.5 to 10.5 years of age.

One primary incisor was removed from 76 jaws and sent to Matson's Laboratory (Milltown, Mont.) for sectioning, staining, and counting of CA. Fawns were not

included in this sample because they were aged by Matson's Lab based on their physical appearance as milk teeth. The laboratory was given no information on the actual age of the animals prior to their age determination.

A completely randomized block (fixed effects) ANOVA design (Ostle and Mensing 1979) was used to test differences in age estimates between wild and tame deer within aging methods blocked on age classes ($\alpha = 0.05$).

Results and Discussion

Wild and captive deer were aged with equal accuracy for either the TWR or CA methods ($P = 0.59$ and $P = 0.38$, respectively). Therefore, all deer were treated as a single data set for further analysis.

When compared to CA results from the same deer, TWR aging gave slightly better overall results than CA (75% and 71% correct, respectively, $N = 76$). Better accuracy was found for TWR aging in age classes 1.5 and 2.5, but in age classes $\geq$4.5, CA produced a higher percentage of correct responses than TWR (Table 1). When errors in aging occurred, they were generally off by only 1 age class. Exceptions included a 5.5-year-old deer aged as 3.5 by CA, a 2.5-year-old deer aged as 4.5 by CA, and a 6.5-year-old deer aged as 3.5 by both CA and TWR. One 14.5-year-old deer was aged as 11.5 by CA and >10.5 by TWR. Three deer aged only by TWR also had errors of more than 1 year: 1 each 5.5-, 6.5-, and 10.5-year-old deer were aged at 2.5, 4.5, and 7.5, respectively.

When the mode estimates (71.4% correct) for 98 jaws aged by the 55 biologists were compared to results obtained when jaws were aged by strict adherence to TWR guidelines (70.4% correct), the results were almost identical (Table 2). However, the overall percentage of correct responses by all biologists for all jaws (62.6% correct, $N = 5{,}390$) was lower than either the mode response estimates or estimates obtained by TWR measurements.

Table 1. Comparison of tooth wear and replacement (TWR)[a] and first incisor cementum annuli (CA) aging techniques for 76 known-age deer.

Age	Technique	Underaged (%)	Correct (%)	Overaged (%)	Mean age	*N*
1.5	TWR	0	100	0	1.50	34
	CA	6	76	15	1.59	
2.5	TWR	0	100	0	2.50	13
	CA	0	85	15	2.73	
3.5	TWR	27	64	9	3.32	11
	CA	27	64	9	3.22	
4.5	TWR	50	30	20	4.20	10
	CA	30	50	20	4.30	
≥5.5[b]	TWR	75	13	12	6.00	8
	CA	50	50	0	6.25	

[a]TWR estimates were determined as outlined by Larson and Taber (1980).
[b]Average age was 7.25 years.

Table 2. Comparison of tooth wear and replacement (TWR) estimates obtained by strict adherence to the guidelines of Larson and Taber (1980) and age estimates obtained without use of reference materials by 55 biologists for 98 known age white-tailed deer jaws.

Known age class	*N*	Category of estimate	Aged correct (%)	Aged 1+ year below (%)	Aged 1+ year above (%)	Average age estimate (%)
0.5	11	TWR	100	0	0	0.50
		Biologist mode	100	0	0	0.50
		All biologists	96	0	5	0.54
1.5	30	TWR	100	0	0	1.50
		Biologist mode	100	0	0	1.50
		All biologists	87	8	5	1.47
2.5	16	TWR	88	0	12	2.63
		Biologist mode	94	0	6	2.56
		All biologists	77	19	5	2.67
3.5	15	TWR	60	20	20	3.56
		Biologist mode	60	20	20	3.56
		All biologists	48	25	27	3.59
4.5	15	TWR	26	53	20	4.10
		Biologist mode	20	60	20	4.23
		All biologists	23	56	21	3.65
5.5	4	TWR	25	75	0	4.50
		Biologist mode	25	75	0	4.00
		All biologists	12	82	6	4.17
6.5	4	TWR	0	75	25	5.50
		Biologist mode	0	75	25	5.50
		All biologists	15	54	31	6.18
≥7.5[a]	3	TWR	0	67	33	7.83
		Biologist mode	33	33	33	8.50
		All biologists	25	39	36	7.46

[a]Average age was 8.5 years.

Matson's laboratory prepared slides and counted annuli for both Hackett et al. (1979) and our study. In the earlier study, CA overestimated the age of white-tailed deer in Mississippi (74% of 1.5-year-old deer were estimated as being >1.5 years old). Since 1979, refinements have been incorporated into tooth preparation procedures by that laboratory (Matson, pers. commun.). One improvement is "regressive staining," a technique where dye is washed from sectioned teeth with isopropyl alcohol. This procedure increases contrast between cementum lines and facilitates counting of annuli. Improvement in the technique is also attributed to more experience in recognizing the presence of first year cementum bands, which are difficult to define. Our results indicate major improvement was achieved in aging the 1.5 age class by the CA method. Overall accuracy of incisor CA counts in the present study (71%) was much higher than the 16%–17% reported by other southern United States researchers (Cook and Hart 1979, Hackett et al. 1979), but lower than a northern United States study that found about 80% accuracy (Roseberry 1980).

It is apparent that the age composition of a sample affects the overall accuracy

of TWR or CA estimates. TWR was virtually 100% accurate for fawn and yearling age class estimates and high (>88%) for the 2.5 year age class. In the 3.5 year age class, incisor CA and TWR gave similar results. Higher accuracy was obtained for CA counts than TWR for older age classes.

Above 3.5 years old, both the CA and the TWR technique generally underestimated actual age. This tendancy to underage may be influenced by nutritional status of deer. It has been shown that CA in molars is less distinct in low density populations of white-tailed deer and black-tailed deer (*Odocolius hemionus*) than high density populations (D. R. McCullough, pers. commun.).

Our results indicate that most of the 55 biologists tested were skilled in age estimation of white-tailed deer (Table 2). Results between the mode response of biologists and our TWR estimates were only different for 5 of the 98 deer examined. Biologist mode estimates were slightly more accurate than our TWR estimates. However, accuracy of some individual biologists was considerably lower than either the mode estimates by biologists or TWR estimates by the authors. We attribute this to varying degrees of experience between biologists and to the lack of reference material when aging jaws. Additionally, individual biologists from different geographic regions may expect different wear patterns. However, we believe the latter factor had a minimal effect because we observed more individual variation in wear patterns within an area than between areas.

Conclusions

Selecting of an aging technique depends on management or research objectives and the facilities and funds available. We found the TWR technique most accurate in fawn, 1.5 and 2.5 year age classes, whereas, the CA method was most accurate in age classes >3.5. A combination of techniques is recommended to improve accuracy of age estimation for deer in the southeastern United States. However, given the potential for error in technician processing and aging of deer with the CA technique, we strongly recommend quality control procedures be implemented by laboratories through the use of known-age samples before CA results are interpreted.

Placement of deer into 4 age classes (fawn, 1.5 year, 2.5 years, and ≥3.5 years) may be adequate for most decisions related to deer herd management. Our results indicate most southeastern deer managers obtain fairly accurate information with TWR, but results may be improved with additional training and by insuring that reference materials are available. However, managers and researchers who are interested in obtaining age structure data for year classes >3.5 definitely should consider the use of the CA technique.

Literature Cited

Cook, R. L. and R. V. Hart. 1979. Ages assigned known-age Texas white-tailed deer: tooth wear versus cementum analyses. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 33:195–201.

Erickson, J. A. and W. G. Seliger. 1969. Efficient sectioning of incisors for estimating ages of mule deer. J. Wildl. Manage. 33:384–388.

———, Anderson, A. E., D. E. Medin and D. C. Bowden. 1970. Estimating ages of mule deer—an evaluation of technique accuracy. J. Wildl. Manage. 34:523–531.

Gilbert, F. F. and S. L. Stolt. 1970. Variability in aging Maine white-tailed deer by tooth wear characteristics. J. Wildl. Manage. 34:532–535.

Hackett, E. J, D. C. Guynn and H. A. Jacobson. 1979. Differences in age structure of white-tailed deer in Mississippi produced by two aging techniques. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 33:25–29.

Larson, J. S. and R. D. Taber. 1980. Criteria of sex and age. Pages 143–202 *in* Schemnitz, ed. Wildlife management techniques manual. The Wildl. Soc. Inc., Washington. D.C.

Low, W. A. and M. T. Cowan. 1963. Age determination of deer by annular structure of dental cementum. J. Wildl. Manage. 27:466–471.

Ludwig, J. R. 1967. Comparison of age determination techniques for the white-tailed deer of southern Illinois. M.S. Thesis. South. Ill. Univ., Carbondale. 30pp.

Ostle, B. and R. W. Mensing. 1979. Statistics in research. Iowa State Univ. Press, Ames. 596pp.

Roseberry, J. L. 1980. Age determination of white-tailed deer in the midwest—methods and problems. Pages 73–78 *In* R. Hine and S. Nehls eds. White-tailed deer population management in the north central states. Proc. 1979 Symp. North Cent. Sect. Wildl. Soc.

Ryle, L. A., L. D. Fay and R. C. Van Etten. 1961. Validity of age determination in Michigan deer. Mich. Acad. Sci. Arts and Letters, 46:489–316.

Severinghaus, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Manage. 13:195–216.

Thomas, D. C. and P. J. Bandy. 1973. Age determination of wild black-tailed deer from dental annulations. J. Wildl. Manage. 37:232–235.

——— and ———. 1975. Accuracy of dental-wear age estimates of black-tailed deer. J. Wildl. Manage. 39:647–678.