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ABSTRACT—Electronic deer check systems offer state natural resource agencies alternatives to mandatory in-person check stations, resulting in potential savings in money and personnel. However, a reliable means for hunters to classify the age of harvested antlered deer must be established so that important management indices such as antlered yearling harvest can continue to be used to set future management goals. Therefore, we evaluated the use of six different antler metrics to predict age class of white-tailed and mule deer (1.5 and ≥2.5 years). We used discriminant analysis to determine the number of deer correctly classified into each age class based on the antler metric with the greatest degree of separation for each species. Of those evaluated, main beam length and inside spread were the two most accurate measurements for both species. For white-tailed deer, 93% (114 of 123) of the 1.5-year age class and 93% (251 of 271) of the ≥2.5-year age class were correctly classified using main beam length with a cutoff of 364 mm. For mule deer, 100% (12 of 12) of the 1.5-year age class and 97% (35 of 36) of the ≥2.5-year age class were correctly classified using main beam length with a cutoff of 352 mm. Antler metrics of both deer species can be used to accurately classify age class while likely saving funds and personnel hours.

Key words: antler metrics, electronic deer check, mule deer, *Odocoileus virginianus*, *Odocoileus hemionus*, white-tailed deer

INTRODUCTION

Recreational hunting of white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*) contribute millions of dollars annually to state and regional economies. Within Nebraska, deer are the most sought-after big game species, totaling 141,573 deer permits sold in 2010 (Taylor 2011), which generated over $5.9 million in revenue, according to the Nebraska Game and Parks Commission (NGPC) (K.M. Hams, NGPC, pers. comm. 2012).

Since 2009, the NGPC has transitioned from a mandatory, in-person deer check to the use of an automated "Telecheck" program (phone or Internet) for all seasons (i.e., archery, muzzleloader, early and late antlerless firearm seasons), with the exception of the nine-day November firearm season. Although optional during 2009, the Telecheck program became mandatory during 2010 and 2011 for all deer seasons outside the nine-day November firearm season. From 2009 to 2011, deer checked by the Telecheck program increased from 16% to 26% (Taylor 2012). In 2011, 64,447 deer were checked by hunters at NGPC-sponsored check stations while 22,162 deer were checked via the Telecheck program (Taylor 2012). The mandatory, in-person deer check process requires hunters to transport their harvested deer to the nearest NGPC-sponsored check station. Some of these check stations are staffed by NGPC personnel to collect species-, age-, and sex-specific harvest information for population dynamics and diseases testing (e.g., tuberculosis and chronic wasting disease). In addition, the NGPC contracts additional manual check stations, but because these contracted stations are not staffed by NGPC biologists, ages of harvested deer and samples for disease testing are not collected. In both types of manual check stations and the Telecheck program, hunters are asked to provide information on their harvested deer, including date, county, public or private land, species, and sex. From the data collected, the NGPC are able to make informed recommendations for the following year (Taylor 2010).

Because deer hunting occurs in rural areas across Nebraska, it is costly for both the NGPC to operate and for hunters to travel to NGPC-sponsored check stations during the nine-day November firearm season. State agencies

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($n = 43$) spent $110,374 on average annually assessing deer harvest in 1998 dollars (Rupp et al. 2000). Similarly, Nebraska spent $100,000 in personnel-related costs at check stations during 1998, equaling $1.74 per hunter checked (Rupp et al. 2000). By comparison, the Telecheck program cost the NGPC only $0.80 per deer to operate in 2010 (K.M. Hams, NGPC, pers. comm. 2012). With 26% of all deer being checked by the Telecheck program, the NGPC observed cost savings of $11,000, while hunters estimated savings through reduced transportation costs of $400,000 (Taylor 2011). The Missouri Department of Conservation estimated savings of $667,000, or a reduction in cost by 85%, when Telecheck was implemented in place of in-person checking for deer and turkey (Hansen et al. 2006). Similar reductions in cost could be expected if the NGPC could employ the Telecheck program for all deer seasons.

In-person deer check provides the NGPC with valuable information regarding population dynamics of the deer herd. Similar to what is done in other states, the NGPC uses harvest information, including number of yearling bucks harvested, to set future deer management goals (Roseberry and Wolf 1991; Evans et al. 1999; Taylor 2012). If the NGPC is to transition from an in-person check to the Telecheck program for all seasons, it must find ways to provide accurate population age structure dynamics. Antler metrics may provide a reliable means to index age of deer because antler size has been shown to increase with age in Alaskan moose (*Alces alces*) (Bowyer et al. 2001) and white-tailed deer (Ditchkoff et al. 2001). If basic antler metrics can be used by hunters to accurately classify deer age class (1.5 and ≥2.5 years), the Telecheck program would be able to provide the NGPC with important harvest data. The goal of this study was to investigate the use of antler metrics to accurately predict white-tailed and mule deer age class.

MATERIALS AND METHODS

Our study area was located in south-central Nebraska, which is composed of two physiographic regions: the Central Nebraska Loess Plains and the Platte River Lowland (Weaver and Bruner 1948). White-tailed deer were harvested proximal to the river valleys while mule deer were harvested in the upland plains.

Harvested deer were brought by hunters to the NGPC Kearney Field Office where we measured antlers and determined the age of deer. Deer checked by hunters during the 2009–11 November firearm seasons were identified to species, and age was determined by one of three experienced NGPC wildlife biologists by analyzing tooth wear and replacement similar to methods described in Severinghaus (1949). Initially, in 2009, we sampled deer to test whether significant differences (using paired *t*-tests) occurred between antler sides. Thereafter, we randomly sampled known-aged deer antler metrics using the most accessible antler. We used six antler metrics, including inside spread (of main beams), main beam length, two main beam diameters, and two main beam circumferences. We measured the inside spread using a measuring tape to the nearest 2.5 cm using procedures described by the Boone and Crockett Club (Nesbit and Wright 2009). We measured main beam length and circumferences 1 and 2 using a measuring tape to the nearest 1 mm as specified by the Boone and Crockett Club (Nesbit and Wright 2009). We measured diameters 1 and 2 (2010 and 2011 only) using digital calipers to the nearest 0.01 mm at the same locations as those used for the circumference measurements.

Because all six antler metrics were significantly different between the 1.5-year and ≥2.5-year age classes for both species ($P < 0.05$) using classical statistics (*t*-test), we determined the best antler metric by quantifying the means and variability between age classes. Simply, the antler metric with the greatest distance between the upper 95% confidence interval for the 1.5-year-old age class and the lower 95% confidence interval for the ≥2.5-year-old age class provide the greatest degree of separation, with half of this distance serving as a cutoff. We then used discriminant analysis to determine the number of deer correctly classified into each age class based on the antler metric with the greatest degree of separation for each species.

RESULTS

We measured 108, 108, and 185 white-tailed deer and 22, 9, and 17 mule deer in 2009, 2010, and 2011, respectively. We pooled the mule deer metrics over the three-year study due to low sample size ($n = 48$). Antler sides were not significantly different when we measured main beam length ($t = 0.19$, df = 17, $P = 0.84$), circumference 1 ($t = -0.56$, df = 17, $P = 0.58$), circumference 2 ($t = 0.47$, df = 16, $P = 0.64$), and diameter 1 ($t = -0.38$, df = 17, $P = 0.71$).

Main beam length had the greatest degree of separation of all six antler metrics measured for both deer species, with inside spread having the second largest degree of separation. The cutoff separating age classes using main beam length averaged 364 mm and ranged from 363 to 366 mm among years for white-tailed deer (Table 1) and was 352 mm for mule deer (Table 2). The cutoff sepa-

TABLE 1.
DIFFERENTIATING YEARLING WHITE-TAILED DEER FROM THOSE ≥2.5 YEARS OLD IN SOUTH-CENTRAL NEBRASKA FOR EACH ANTLER METRIC USING CUTOFF VALUES, 2009–11

		Age 1.5 yr			Age ≥2.5 yr			
Metric (mm)	**Year**	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Cutoff**
Inside spread	2009	238	224	252	367	354	380	303
	2010	229	209	249	362	346	378	297
	2011	223	206	239	369	362	377	300
Main beam length	2009	296	281	310	435	421	449	366
	2010	270	250	290	449	436	463	363
	2011	271	251	290	447	438	457	364
Diameter 1	2009	22	22	23	32	31	33	27
	2010	21	20	23	34	33	35	28
	2011	22	21	23	34	33	34	28
Diameter 2	2009	—	—	—	—	—	—	—
	2010	21	19	22	29	28	30	25
	2011	21	19	22	29	28	30	25
Circumference 1	2009	72	69	75	99	96	102	85
	2010	66	61	70	102	99	105	84
	2011	67	64	70	99	97	102	84
Circumference 2	2009	61	57	65	87	85	90	75
	2010	59	55	63	89	86	92	75
	2011	60	56	63	87	85	89	74

TABLE 2.
DIFFERENTIATING YEARLING MULE DEER FROM THOSE ≥2.5 YEARS OLD IN SOUTH-CENTRAL NEBRASKA FOR EACH ANTLER METRIC USING CUTOFF VALUES, 2009–11

	Age 1.5 yr			Age ≥2.5 yr			
Metric (mm)	**Mean**	**Lower**	**Upper**	**Mean**	**Lower**	**Upper**	**Cutoff**
Inside spread	241	219	264	390	365	414	314
Main beam length	262	234	290	436	414	457	352
Diameter 1	19	17	21	28	27	30	24
Diameter 2	14	9	20	25	23	27	21
Circumference 1	59	55	63	89	83	94	73
Circumference 2	43	35	50	78	73	83	61

rating age classes using inside spread averaged 300 mm and ranged from 297 to 303 mm among years for white-tailed deer (Table 1) and was 314 mm for mule deer (Table 2). We pooled the white-tailed deer data for discriminant analysis due to low variability among years. For white-tailed deer, 93% (114 of 123) of the 1.5-year age class and 93% (251 of 271) of the ≥2.5-year age class were correctly classified using main beam length. For mule deer, 100% (12 of 12) of the 1.5-year age class and 97% (35 of 36) of the ≥2.5-year age class were correctly classified using main beam length.

DISCUSSION

While many factors influence antler characteristics (e.g., range quality and genetics), Bender et al. (1994) suggested that if antler characteristics can discriminate ages within a local population, it could be used as an assessment tool for managers. Antler metrics were able to correctly classify 1.5-year-old bull elk (*Cervus elaphus*) 100% of the time (Bender et al. 1994). Similarly, all six metrics evaluated were reliable at determining 1.5-year-old from ≥2.5-year-old bucks for white-tailed deer and mule deer. Main beam length and inside spread were the most accurate metrics when determining 1.5-year-old from ≥2.5-year-old bucks for both white-tailed deer and mule deer. Based on our results, main beam length may provide state natural resource agencies with a tool to provide reliable age classification of antlered males. However, because antler characteristics are likely to vary by region, managers must evaluate their own regional cutoffs to most accurately classify age class within their deer populations.

The potential for variability in antler metrics among both years and regions exists and should be considered. Strickland and Demarais (2000, 2008) have demonstrated geographic differences in antler metrics of white-tailed deer. Therefore, antler metrics from this study may not reflect those in different regions of Nebraska or in other states. Information should be collected statewide prior to implementation so that statewide cutoffs can be determined. Results from this study suggest future efforts should focus on the main beam length and inside spread metrics. In addition, antler metrics may change among years, given that forage quality and quantity and environmental variables change among years (Ditchkoff et al. 2000, 2001; Harris et al. 2002).

Several considerations should be taken into account by natural resource agencies before the full implementation of an electronic deer check system. First, educational efforts to teach hunters proper measuring methods should be developed to ensure reliable data. Traditional sources of hunter education like state-maintained web pages, big game regulation publications, and youth hunter education programs should be utilized. In addition, standardized methods (i.e., instrumentation needed, ability of hunters to replicate methods) of metric measurements should be developed. While obtaining metrics such as diameters may not be practical because of the instrumentation involved (i.e., digital calipers), others such as main beam length and inside spread need only a measuring tape. Managers may consider transitioning the contracted stations to the Telecheck program prior to those staffed by NGPC personnel, as this would allow for comparison between biologist- and hunter-measured data. In addition, the continued use of high traffic stations as mandatory in-person check stations while closing low traffic stations in favor of an electronic deer check could serve to (1) sample disease, (2) increase public outreach and education, and (3) provide biologist-verified harvest-age dynamics to compare to an electronic deer check system.

In conclusion, antler metrics of both white-tailed and mule deer provide an accurate means of classifying harvest-age dynamics. While other considerations must be evaluated prior to implementation, the use of antler metrics via an electronic deer check system could save state natural resource agencies both funds and personnel hours. The need for the NGPC to save funds and time must be balanced with the need for accurate harvest data to ensure proper deer management; an electronic deer check system may provide that balance.

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