Age-Specific Distance between White-tailed Deer Cast Antler Pairs

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Abstract - White-tailed Deer (*Odocoileus virginianus*) antlers are grown and cast annually, triggered by photoperiod and the subsequent decrease in testosterone. The timing of complete casting and the distance apart an individual deer's antlers are cast can vary. Age and environmental stressors can influence the timing of antler casting and therefore may influence the distance antlers are dropped from each other. To our knowledge, no studies have evaluated the distance apart an individual's antlers are cast in a free-ranging White-tailed Deer population. Our objective was to determine the age-specific distance between antlers from an individual, and we hypothesized age-specific differences would occur (i.e., distance apart for antlers from 1.5-year-old deer would be greater than for ≥2.5-year-old deer). We collected cast antlers from the Central Nebraska Platte River Valley (2010–2022) as part of a long-term monitoring project. We identified cast antler pairs (match sets) based on common measurable antler metric similarities and observable characteristics between sides. Our hypothesis was not supported, as the mean distance between antler pairs of ≥2.5-year-old deer was significantly greater ($W = 793$, $P = 0.002$) and they were found twice as far apart as antler pairs from 1.5-year-old deer. However, two pieces of evidence give us pause; first, fewer antler pairs of 1.5-year-old deer were collected than ≥2.5-year-old deer, and second, more than 70% of antler pairs from 1.5-year-old deer were found at distances less than 10 m (compared to <41% of ≥2.5-year-olds). This may suggest a potential bias against finding the smallest antler pairs at greater distances based on size detectability but also potentially due to a larger winter core area and longer timeframe for 1.5-year-olds to complete casting, resulting in unavailable casts either in time or space (e.g., off study site).

Introduction. Antlers are unique, fast-growing appendages that are grown and cast every year (Demarais and Strickland 2011). *Odocoileus virginianus* Zimmermann (White-tailed Deer) cast antlers can be useful for a variety of purposes ranging from evaluating management strategies based on antler quality comparisons between populations (Ditchkoff et al. 2000) to impacts of environmental stressors on deer health (Peterson et al. 2019). Antler growth and casting is asynchronously controlled by the change in androgen levels (Bubenik 1990a). In cervids, age and health in males can be attributed to the timing of antler casting (Bubenik 1990a, b; Bubenik et al. 1987; Goss 1982), with older (Behrend and McDowell 1967, Putman 1988, Siegler 1968) less healthy individuals under poor nutritional conditions typically casting earlier (Jacobson and Griffin 1982) than younger, healthy individuals. In *Cervus elaphus* Linnaeus (Red Deer), individuals of high social rank (Lincoln 1972) with high energy costs during the breeding season and aggressive males have an earlier date of casting (Bartoš 1990). Forand et al. (1985) found that within a captive herd of White-tailed Deer, dominance rank and not age influenced the timing of antler casting with the most dominant males casting their antlers later than subdominant males. Heffelfinger (2006) found that younger deer cast their antlers later due to a less dramatic decrease in testosterone, but also smaller, lighter antlers are retained until the connection from the pedicle is completely eroded by the osteoclasts. A literature review conducted by Forand et al. (1985) found that casting based on age can vary based on geog-

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raphy, with older individuals casting early in the north while retaining antlers longer than younger deer in the mid-west and southeast. From camera trap captures and cast antlers collected within Nebraska, we observed that an earlier casting timeframe typically occurs in individuals with larger antlers; however, these data have not been formally evaluated. The date individual deer cast antlers tends to be consistent each year regardless of an individual's age and the size of the antler (Behrend and McDowell 1967), with individuals casting within approximately 4 days in subsequent years (Jacobson and Griffin 1982).

The timing of complete casting can have an impact on the distance between antler pairs from an individual. The timing of complete antler casting can vary for White-tailed Deer and could occur simultaneously, over a few days (Goss et al. 1992), or may take weeks (Michael 1965). The distance antlers are cast from each other may vary based on a variety of indirect factors including size of winter home range (Tierson et al. 1985), mild or severe winter conditions (snow depth and duration) that encourage or discourage movement, the distance between bedding and seasonally available food sources, or disturbances by predators (Bates et al. 2021). To our knowledge, no studies have evaluated the distance an individual's antler sides are cast in a free-ranging White-tailed Deer population. Our objective was to determine the age-specific distance between antlers from an individual. We hypothesized age-specific differences would occur and that the distance apart for antler pairs of 1.5-year-old deer would be greater than for ≥2.5-year-old deer.

Methods. We collected naturally cast White-tailed Deer antlers while searching the best quality or most probable White-tailed Deer overwintering habitat in the Central Nebraska Platte River Valley (February-April; 2010–2022), best described as wooded riparian habitat bordered by agricultural fields (Peterson et al. 2019, 2021; Schoenebeck and Peterson 2014). Properties searched (n = 38) ranged from 16 to 384 ha and averaged 80 ± 12 ha. Search effort ranged from 1 to 8 hrs and averaged 2 hrs per search effort, which ranged in distance searched from 1.7 to 24 km and averaged 4.9 km per property.

We identified cast antler pairs (match sets) based on measurable antler metric similarities between sides (i.e., main beam length, circumference, diameter, pedicle seal depth and shape; Peterson et al. 2019, Schoenebeck et al. 2013, Schoenebeck and Peterson 2014) and observable antler characteristics (i.e., antler coloration, burring pattern and tine branching angles; Schoenebeck and Peterson 2014). Each antler was classified as fresh or old (based on presence of a skin ring, presence of blood, or lack thereof on the pedicle seal). Genetic protocols have been recently developed to determine individuality of cast antlers (Carter et al. 2022); however, associated costs were beyond the means of this investigation, so we used common antler metric similarities and characteristics between sides to determine antler pairs (Schoenebeck et al. 2013, Schoenebeck and Peterson 2014). We augmented the data set with freshly cast antlers collected from the study area by cast antler collecting hobbyists if collected during purposeful searches (i.e., seeking cast antlers) and antler pairs met the above criteria. We estimated the age group for all cast antlers using the main beam length antler metric (≤364.0 mm cut-off value defined for this region; Schoenebeck et al. 2013) to differentiate antlers from 1.5-year-old deer from ≥2.5-year-old deer. Main beam cut-offs were developed using known aged deer and this antler metric was a consistent predictor of age group over an eight-year period within the Platte River valley (Peterson et al. 2019). If one side of a cast antler pair was above and one below the defined main beam length cut-off, we used circumference (≤ 84 mm) as a secondary antler metric cut-off (Schoenebeck et al. 2013) to differentiate 1.5-year-old and ≥2.5-year-old age groups (n = 7).

We estimated the distance antler pairs were cast from each other to the nearest m by stepping off the distance if within 40 m. We used Google Earth Pro© to estimate larger distances

to the nearest meter. We tested if the distance antler pairs were collected from each other differed between the two age groups (1.5-year-old deer and those ≥2.5-year-old deer) using a Wilcoxon Rank Sum Test ($\alpha = 0.05$).

Results. We collected 1,059 naturally cast White-tailed Deer antlers between 2010 and 2022. 47% of all collected cast antlers were from 1.5-year-old deer, while 53% were antlers from ≥2.5-year-old deer. We collected equal numbers of freshly cast antlers (50.4%; cast spring of year collected) compared to old antler casts (49.6%; ≥1 year in the environment). Collection of antler pairs (both antler sides) from an individual represented 13.4% of all cast antlers collected. From all antler pairs collected, 77.5% were from freshly cast antlers, 16.9% were from old cast antlers, and 5.6% were from antlers with one fresh and one old side. More than 2.5 times as many antler pairs from ≥2.5-year-old deer (73.2%) were collected than 1.5-year-old deer (26.8%; Table 1).

Over the course of the 13-year study, we collected distances on 113 cast antler pairs. Distances between paired cast antlers ranged from <1 m to >1,144 m and averaged 115 ± 21 m apart. The mean distance between antler pairs was 2.5 m for the closest 50% of antlers collected during searches, with the mean distance being 226.0 m for the other 50%. The distance a pair of antlers from an individual deer were found from each other differed by age ($W = 793$, $P = 0.002$), as antlers from 1.5-year-old deer were cast an average of 46 ± 24 m ($n = 31$) apart while antlers from ≥2.5-year-old deer were cast significantly farther apart (142 ± 27 m; $n = 82$). Over 70% of antler pairs from 1.5-year-old deer were found within 10 m of each other (compared to 41% of ≥2.5-year-olds), while over 59% of antler pairs from ≥2.5-year-old deer were found greater than 10 m from each other (Table 2).

Discussion. The distance between an individual's antler sides varied by age, but contrary to our hypothesis, pairs of antlers from younger deer (1.5-year-old) were found in closer proximity to each other compared to ≥2.5-year-old deer. The difference in distance between age groups may be attributed to several factors, including the time between complete casting, core home range size between age groups, and detectability related to antler size. Because of these factors, the average distance between antler pairs in this study were likely

Table 1. Age-specific White-tailed Deer (*Odocoileus virginianus*) cast antlers and cast antler pairs collected during searches in the Central Nebraska Platte River Valley (2010–2022).

	Total	Pairs	% Paired
Cast antlers collected			
Antlers collected	1059	142	13.4%
1.5-yr-old	464	38	8.2%
≥2.5-yr-old	529	104	19.7%
Antler pairs, fresh vs old			
Fresh		110	77.5%
Old		24	16.9%
1 fresh/1 old		8	5.6%
Antler pairs by age group			
1.5-yr-old		38	26.8%
≥2.5-yr-old		104	73.2%

Table 2. Percentage (and number) of White-tailed Deer (*Odocoileus virginianus*) cast antler pairs, distance apart (in meters), and age group. Cast antler pairs collected during searches in the Central Nebraska Platte River Valley (2010–2022).

Distance (m)	All casts	1.5 Y.O.	≥2.5 Y.O.
0 to 10	50% (56)	71% (22)	41% (34)
11 to 100	24% (27)	19% (6)	26% (21)
101 to 500	20% (23)	6% (2)	26% (21)
501 to >1000	6% (7)	3% (1)	7% (6)
Average distance (m)	115 ± 21	46 ± 24	142 ± 27

underestimated for both age groups and especially for younger deer. Yearling deer typically retain their antlers longer than older, larger antlered males in some regions (Behrend and McDowell 1967, Zagata and Moen 1974), due to a less dramatic decrease in testosterone but also smaller, lighter antlers that are retained until the connection from the pedicle is completely eroded by the osteoclasts (Heffelfinger 2006). Additionally, younger males typically have larger home ranges and core areas than older males (Lesage et al. 2000, Nelson and Mech 1984, Webb et al. 2007), potentially leading to antlers being cast farther apart as a consequence of moving around larger areas. Therefore, yearlings may still have been carrying one side during the timeframe the area was searched or could have cast one side outside of the searchable area. By the time of complete casting in late-spring, spring green up makes finding smaller sized antlers more difficult. These influences suggest that distances observed in this study may be underestimated.

A relatively small number of the total cast antlers collected over the 13-year collection effort resulted in both antlers from an individual (13.4%), which was similar to a 2-year study (7.7%) conducted in Texas (Michael 1965). Michael (1965), however, did not classify antlers as a pair if they were more than 5 m apart, likely underrepresenting the percentage of antler pairs. Within an enclosed 174-ha deer research facility and using systematic searches and prescribed burns over a 7-year period, cast antler detection rates were only 38% (17–51% per year) of available casts (Deig 2020). These detection rates for cast antlers and cast antler pairs demonstrate the difficulty in locating naturally cast antlers from both sides of an individual. This low antler pair detection rate by both age groups and the fact we collected cast antlers the following year suggest that search efficiency is well below 100%. Many reasons could explain this, including: the other antler from an individual deer may still be attached and not yet shed at the time of searching, not visible or overlooked, collected prior to search effort, relocated by scavengers, or cast out of the searchable area or off our study site.

Antler characteristics such as size and number of antler tines increases with age, which increases antler visibility and makes them easier to locate (Deig 2020, Michael 1965). Within our study region and timeframe, antlers from ≥2.5-year-olds had approximately 1.6 times larger main beam lengths (438 vs 273 mm) and 1.4 more antler points (4.3 vs 2.9; Peterson et al. 2019) than 1.5-year-olds, potentially making them easier to locate. Deig (2020) found that larger antlered, older male cast antlers were overrepresented in samples and therefore may not accurately represent the deer population; however, for all cast antlers (not just antler pairs) we collected during the 13-year study, we found both age groups in nearly equal proportions. We collected 2.5 times more cast antler pairs from ≥2.5-year-old deer than from 1.5-year-old deer, which is comparable to findings by Deig (2020) as cast antler detection rates based on size were 1.2 times higher with a 10 mm increase in main beam length and a 2.4 times higher detection rate with each antler

point increase. Our findings support Deig (2020), who suggested that young males with smaller antlers were less detectable; however, a direct comparison could not be made, as age-specific cast antlers were not defined in Deig (2020).

Our cast antler search effort was spatially and temporally limited, as searches were limited by property size (not deer movement) and needed to be conducted before spring vegetation growth inhibited detection. We focused on searching the best quality or most probable White-tailed Deer overwintering habitat, which may have contributed to more cast antlers collected from mature deer (≥2.5-year-old). Although we have a high degree of confidence in the pairs of antlers included in the analysis, we also acknowledge that error in misclassifying a pair of antlers could impact the conclusions drawn. While not practical for the current study due to the large sample size of antler pairs, the authors are currently pursuing, and recommend for future studies, additional means to confirm antler pairs, including more efficient genetic testing in addition to the suite of antler metric data and characteristics utilized. Our findings are novel, as other studies have not investigated the age-specific distance between antler sides. This study serves as a baseline for future comparisons spatially and temporally as data are collected across landscapes, vegetation types, and environmental conditions.

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