BODY WEIGHT AND ANTLER SIZE OF WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS) ARE MAXIMIZED TWO YEARS POST-BURN IN EAST TEXAS PINEYWOODS

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BODY WEIGHT AND ANTLER SIZE OF WHITE-TAILED DEER *(ODOCOILEUS VIRGINIANUS)* ARE MAXIMIZED TWO YEARS POST-BURN IN EAST TEXAS PINEYWOODS

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Abstract.–*Odocoileus virginianus* (white-tailed deer) is one of the most recognizable and economically significant keystone herbivores in the United States. To understand the biological repercussions of management activities, and because prescribed fire is one of the most commonly used silvicultural methods in the southeast, we used white-tailed deer harvest records provided by Texas Parks and Wildlife Department, in combination with United States Forest Service prescribed fire history information, to investigate the direct relationship between time since burning and deer body weight and antler size in East Texas. We hypothesized there would be discernable differences in deer body weight and antler dimensions based on prescribed fire history. Data collected by the Texas Parks and Wildlife Department from 549 harvested white-tailed deer from four sites (three Wildlife Management Areas (WMAs), and one National Forest) were cross-referenced with prescribed fire intervals within the WMAs. Demographic data was compared and body weight and antler parameters correlated to years since last prescribed burn. The results suggest that fire is important for white-tailed deer physiology. ANOVA showed a peak in all measurements two-years post fire, indicating the adaptivity of white-tailed deer to fire-dependent ecosystems, and illustrating the benefits of fire for improving deer body weight and antler dimensions. A mosaic of four- to five-year prescribed burning intervals should provide adequate areas of two-years post fire areas on the landscape to provide the level the diversity of habitat requirements for not only optimum white-tailed deer size and antler measurements and harvesting success, but for other wildlife that utilize these habitats.

Keywords: deer physiology, prescribed fire, antler size, fire effects, habitat management, fire regime

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Odocoileus virginianus (white-tailed deer) contribute to an annual multi-billion dollar hunting industry in the United States (Warren & Krysl 1983; Hart 2014) and play an integral role in their respective ecosystems by serving as prey for predators and by manipulating the composition, structure, and abundance of numerous plant species through herbivory (Waller & Alverson 1997; Russell et al. 2001). Management of deer abundance is also biologically critical in order to minimize potentially deleterious impacts such as overbrowsing and transmission of zoonotic diseases (Holsworth 1973; McCarty & Miller 1998; Thompson et al. 2008; Kugeler et al. 2016). With these important economic, ecological, and cultural values, it is important to assess the biological influences and impacts that management activities have on deer populations to maximize the balance between management efficiency, species abundance, fitness, and anthropogenic expectations.

In the southeastern United States, prescribed fire is commonly used to manage and maintain critical habitat components and influence successional stages (Wall et al. 2019; Haines & Busby 2001). Prescribed fires cycle nutrients, promote vegetative growth of grasses and forbs, reduce woody stem and invasive species encroachment, and stimulate the growth and palatability of browse species (Gilliam 1988; Masters et al. 1996; Keeley et al. 2003; Keeley 2006; Miller et al. 2019; Wall et al. 2019; Wall et al. 2020). Deer have a strong reliance on acorns and hard mast, but in areas where acorn production is lacking or unreliable, nutrition can be enhanced by the use of prescribed fire and stand improvement activities to promote more dependable and higher quality forage (Masters et al. 1996).

Larger, robust deer populations and bucks with well-developed antlers are arguably representative characteristics of biologically healthy deer. Body weight, antler size, and other physiological characteristics in cervid populations are dependent upon numerous factors such as genetics, nutrition, habitat quality, forage availability, and landscape composition (French et al. 1955; Scribner et al. 1989; Kruuk et al. 2002; Strickland & Demarais 2008; Henderson et al. 2018). Antler size is a meaningful characteristic to hunters as well as for intraspecific communication (Harris et al. 2002); increased antler measurements are an important fitness correlate that promulgates genetic quality and increases procreative success (Ditchkoff et al. 2001;

Kruuk et al. 2002; Strickland & Demarais 2008). A major limiting factor is poor quality habitat, which can detrimentally affect antler size, reproductive potential, and weight indices. Inferior habitat can be assuaged by the use of prescribed fire to maximize forage quality essential for deer growth and abundance, which can subsequently contribute to an increase in recreational satisfaction for hunters (Masters et al. 1993).

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No known studies have attempted to investigate the relationship between prescribed burn intervals in relation to deer body condition and antler characteristics. Since literature in this subject is lacking and consequences of management activities can have far-reaching influences both economically and ecologically, we examined white-tailed deer body weight and antler size as impacted by prescribed burn frequency in East Texas wildlife management areas.

MATERIALS & METHODS

The Piney Woods ecoregion in East Texas consists of almost 4.9 million ha across numerous habitat types (Griffith et al. 2007; Wall et al. 2019). The WMAs utilized in this study were Bannister, Moore Plantation, and Alabama Creek, located within the Angelina, Sabine, and Davy Crockett National Forests respectively; we also included the entirety of Sam Houston National Forest. The WMAs are managed under a cooperative agreement with the National Forests and Grasslands of Texas of the United States Forest Service (USFS). The cover types associated with our deer harvest records consisted of predominantly mixed-pine and pine-hardwood overstory systems of *Pinus palustris* (longleaf pine), *P. taeda* (loblolly pine), and *P. echinata* (shortleaf pine). Midstory structure contained varying densities of *Liquidambar styraciflua* (sweetgum), *Quercus* spp. (oak), *Callicarpa americana* (American beautyberry), *Carya* spp. (hickory), and *Ilex vomitoria* (yaupon). Understory composition contained elements of *Chasmanthium sessiliflorum* (longleaf woodoats), *Andropogon* spp. (bluestem), *Rubus* spp. (blackberry), as well as numerous pine and hardwood seedlings.

The deer were harvested in autumn between 2010 and 2017 from the WMAs, and the physical deer measurements consisted of 549 observations provided by Texas Parks and Wildlife Department (TPWD). On opening weekend of white-tailed deer rifle season (early November), TPWD establishes check-stations at key locations on the WMAs. Harvested deer are brought to the weigh stations, and measurements included approximate location of harvest, sex, age, field-dressed weight, total points, antler inside spread, antler base, and antler beam length. Antler characteristics were only evaluated for male deer that were 1.5 years of age and older that had >1 point, as yearling bucks, spikes, and nubbin bucks did not have sufficient measurable attributes representative of adult age classes.

Table 1. Summary for white-tailed deer harvested in East Texas National Forests between 2010 and 2017 (n=549)

Variable	Mean	Median	Mode	Std Dev
Age	2.62	2.50	2.50	1.34
Weight (kg)	33.89	30.00	30.00	13.34
Total points	5.44	7.00	8.00	3.46
Total points ≥ 1	6.01	8.00	8.00	3.13
Inside Spread (mm)	269.08	330.00	0.00	139.88
Base (mm)	297.76	350.00	400.00	160.74
Beam (mm)	65.83	80.00	80.00	30.01

Prescribed burn histories were attained from the National forests data files in the USFS prescribed fire reporting programs Interagency Fuel Treatment Decision Support System (IFTDSS) and FFI (FEAT/FIREMON Integrated). These allowed us to identify when prescribed burns were conducted on the WMAs and were then compared to TPWD harvest data in order to classify the appropriate temporal relationship for each record. The location of deer harvests within Sam Houston National Forest could not be reliably obtained and were subsequently removed from correlative analyses but retained for demographic inquiries and descriptive statistics. The remaining harvest records ($n = 260$) were then geo-temporally assigned to the fire histories within their associated geographic compartments at 0, 1, 2, and 3-year intervals since the last prescribed burn.

Analysis was executed using SPSS Statistics for Windows v.23 (IBM Corp., Armonk, NY). Descriptive statistics were analyzed to illustrate general population characteristics (Table 1). Analysis of variance (one-way ANOVA) was employed using an alpha level of 0.10 as well as Tukey's post-hoc comparisons to measure the strength and correlation of the dependent variables (body weight and antler measurements e.g., total points, base, beam, inside spread; Figures 1 and 2) to the independent variable (years since burn).

RESULTS

The sex ratio of harvested deer consisted of 71% male and 29% female (2.3:1 m/f ratio). Most deer were harvested in Sam Houston National Forest (35%) and Moore Plantation within the Sabine National Forest (29.3%). A total of 549 deer were harvested on opening day of rifle-hunting season between 2010 and 2017. Deer age spanned 0.5 years to 6.5 years with the highest proportion (28.9%) of harvested deer falling within the 2.5-year age class; the mean was 2.62 years with a standard deviation of 1.34. Over 30.2% of harvested deer weighed between 30 and 39 kg with a mean body weight of 33.9 kg. Most deer were harvested in an area the same year as a prescribed fire (55.4%); hunter frequency and deer harvests decreased as years since the last prescribed burn increased.

The mean number of antler points for harvested males was six points, however 50% ranged between seven and ten points. Most male deer (32.5%) were ≥ 1.5 years old and had a base measurement ranging from 80–99 mm with a mean base measurement of 65.8 mm. The average beam measurement recorded was 297.8 mm, but the highest proportion ranged between the 400–449 mm class. Inside spread measurements averaged 269.1 mm with the largest class (43.2%) ranged between the 300–399 mm classes.

Deer body weight, total antler points, and antler base were not significantly correlated to prescribed burns, but antler beam and inside spread measurements were. Body weight, total points, and antler base measurements did display a strong positive correlation to time since last fire, with a distinct pattern noted where all variables peaked two years post-fire, regardless of significance.

There were significant differences in antler beam measurements in relation to years since burn ($F = 2.306$, $df = 3$ and 171, $p = 0.079$, post-hoc $p = 0.05$). Ranging between 0 and 600 millimeters, there was a significant difference in antler beam measurements between 0 years post-burn (mean = 297.3 mm) and 2 years post-burn (mean = 388.0

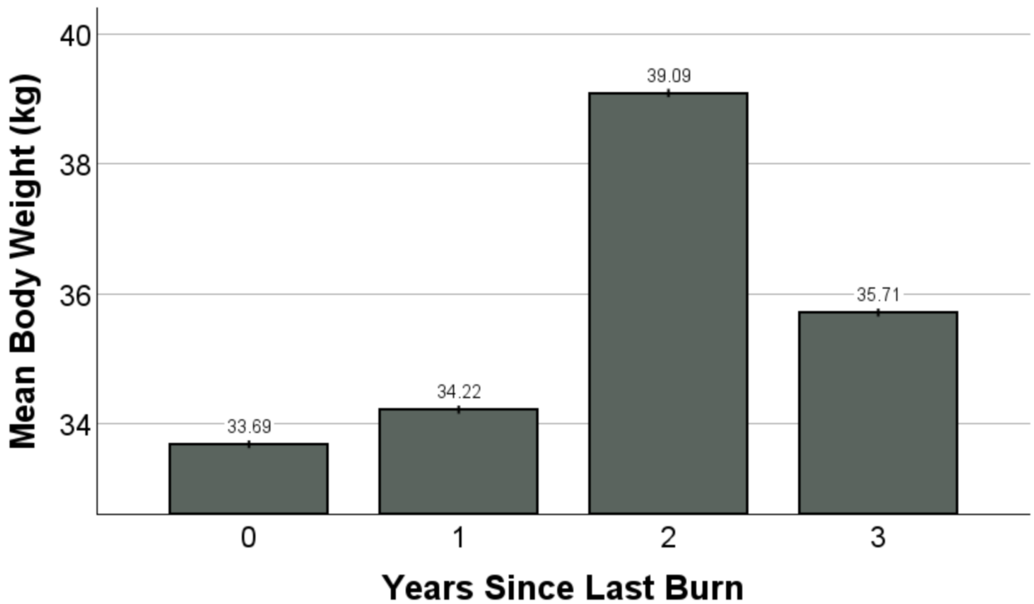

Figure 1. Mean body weight (kg) 0, 1, 2, and 3 years post-burn for deer harvested in East Texas National Forests between 2010 and 2017.

mm), with a mean difference of 90.7 mm. There were also significant differences in antler inside spread measurements in relation to years since burn (F = 2.121, df = 3 and 169, p = 0.099, post-hoc p = 0.07). Ranging between 0 and 510 mm, a statistically significant difference was found in antler inside spread measurements between 0 years post-burn (mean = 261.3 mm) and 2 years post-burn (mean = 300.0 mm), with a mean difference of 38.7 mm. Post-hoc Tukey analysis confirmed significance with a mean difference in antler inside spread measurements of 77.8 mm between 0 and 2 years since a prescribed fire.

No significant differences were found for total body weight. Body weights ranged between 10 and 60 kilograms, where deer weight 0 years since a burn had a mean of 33.7 kg while body weight peaked at 2 years since a burn with a mean of 39.1 kg. There were not significant differences in antler base measurements in relation to years since burn, however, post-hoc testing displayed a similar peak at 2 years (F = 1.885, df = 3 and 171, p = 0.134). Antler base measurements ranged

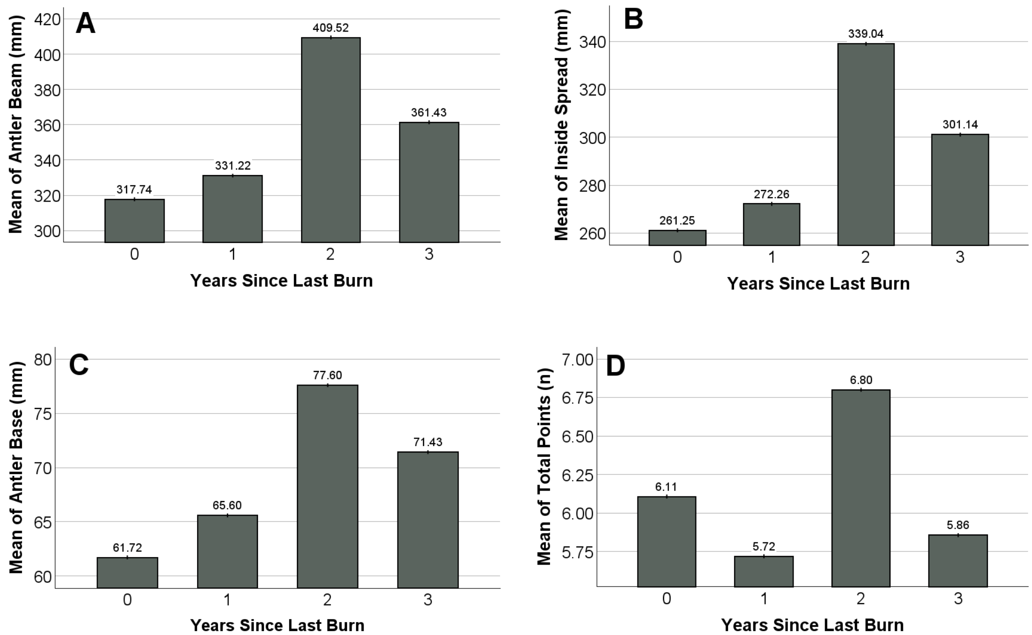

Figure 2. One-way ANOVA means plots displaying white-tailed deer antler characteristics for A. Antler beam (p < 0.1). B. Antler inside spread (p < 0.1). C. Antler base (p = 0.134). D. Total points (p = 0.584) 0, 1, 2, and 3 years post-burn for deer harvested in East Texas National Forests between 2010 and 2017.

between 0 and 140 mm, with a 0 years post-burn of mean of 61.7 mm and 2 years post-burn mean of 77.6 mm, and an average mean difference of 15.88 mm. The differences between total points in relation to prescribed burn years were likewise not statistically significant (F = 0.650, df = 3 and 171, p = 0.584). Total points ranged from 0 to 13, where deer antlers had an average of ~6 points one-year post-burn and peaked two years post-burn with a mean of ~7 points.

DISCUSSION

Since all variables and measurements with significant differences were greater two years post-burn compared to any other year, it suggests a direct correlation between deer body weight, antler size, and prescribed fire. It could be important to the public as well as agencies to recognize that a potential for improved hunting opportunities with a reduction in hunter-to-hunter competition can be found in areas where a few years have lapsed since the last prescribed burn. As the number of years post-burn increased, the number of harvested deer declined significantly. While a multitude of reasons may exist; one hypothesis may be that the observed decrease in harvested deer can be attributed to the possibility that hunters simply are not hunting in areas with denser vegetation and more vertical obstruction.

Another explanation could be that deer in East Texas are displaying behavioral traits explained by predation theory. A study in the Rocky Mountains of the United States suggests that elk may limit occupation of areas with dense vegetation, as it is more difficult to see and escape from predators. White et al. (2003) suggested elk activity increased in areas more recently burned, which may support our explanation for white-tailed deer behavioral patterns, as browse production and nutrient availability in relation to prescribed burns often show an increase in deer browse production and quality for a few years following a fire. Another explanation of these trends is by Masters et al. (1993), who showed peak production of panic grasses, sedges, and forbs consistent with the vegetation found in our study sites two years post-fire in combination with tree harvests and thins.

To obtain more advanced conclusions and correlations, it would be advantageous to add browse surveys to identify vegetation status at varying periods post-fire. Using oxygen bomb calorimetry in combination with vegetation data may likewise aid in deducing the nutritional value and calorie content of preferred deer browse. Extending the "years since burn" and analyze what is occurring environmentally beyond three years, as our study was limited to IFTDSS data availability.

Management objectives for white-tailed deer should include maintaining a mosaic of burn regimes, ensuring appropriate rotations as to include hunter-friendly burn patches alongside areas with a longer fire return interval. Less recently burned patches would provide habitat that affords deer with appropriate escape cover and safety zones, while recently burned landscapes would subsequently cater to early-successional vegetative preferences for both deer and hunters alike.

It may be valuable to the public and agencies to add Boone and Crockett scoring to the harvested bucks at the check stations (Wright & Nesbitt 2003; Strickland et al. 2013). The current data collection protocols only lack a few more measurements to complete the Boone and Crockett scoring method. Such measurements may help to illustrate easily comprehensible and universally recognized antler scores per district and would give the public a standardized metric to consider.

Maintaining frequent burn intervals (1–3 years) can help to improve, maintain, or maximize deer body weight and antler sizes. Our results further illustrate the ecological importance of prescribed burns in fire-evolved and fire-dependent landscapes. Maximizing deer body condition and quality can potentially improve hunter success and happiness, which carries its own set of economic incentives and implications for agencies, landowners, hunting leases, etc. Maintaining mosaics of frequent fire return intervals should aid in reducing potential impacts from wildfires, minimizing woody stem encroachment, promoting the propagation of native grasses, maintaining ecosystems components for other important game species such as quail and turkey, as well as benefit endangered species such as the red-cockaded woodpecker and Louisiana pine snake in East Texas woodlands.

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