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Forage Yields in Turkey Hill Wilderness in East Texas for White-tailed Deer

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ABSTRACT

Wilderness areas are often considered quality areas where natural processes occur without human activity. It is often assumed that these unmanaged areas will provide and support quality wildlife habitat. The objective of this study was to evaluate the forage production and stocking potential of an unmanaged wilderness area in east Texas. Four different community types were evaluated for forage yield, forage availability, and browse utilization for white-tailed deer. Results show that although a wide range of forage yields were measured in the spring, summer forage yield did not differ among the various communities. Availability also differed between community types, but utilization within each community appears to be lower than what could be supported.

KEY WORDS: Browse, forage preference, utilization, stocking

INTRODUCTION

Historically, forests in the southeastern United States developed with and were impacted or modified by fire and other natural processes such as herbivory from white-tailed deer (*Odecoileus virginianus*) and woodland bison (*Bison bison* var. *athabascae*)

(Walker 1991). Many natural landscape processes, including fire, have diminished due to forest fragmentation and human population expansion (Harris 1984) and are limited on the relatively small-scale landscapes that are occupied by wilderness areas in the eastern U.S. The area currently designated Turkey Hill Wilderness, located within the Angelina National Forest in east Texas, was purchased in 1935 from private landowners and established in 1984 according to Public Law 98-574 (Texas Wilderness Act) in compliance with Public Law 88-577 (Federal Wilderness Act of 1965). Southern forests generally develop into dense stands in the absence of management or disturbance, which shade out forage and browse, reducing or preventing forage and/or biomass production.

There have been numerous studies on diets and preferred foods of white-tailed deer, with dietary preferences varying seasonally and geographically, dependent upon available forage species (Pogge 1967, Halls 1973, Korschgen 1980, Kroll 1991, Hill 1995). White-tailed deer are classified as concentrate browsers (Veteto and Hart 1971, Veteto and Hart 1974, Kroll 1991), and although herbaceous plant species and succulent new growth of a variety of plants are preferred, availability is limited seasonally. Browse, leaves and twigs are the mainstay of deer diets (Halls 1973, Kroll 1991), possibly providing greater than 89% of the year-round diet, although Dillard et al. (2006) recorded less than 50% browse in the cross-timber region of Texas. Hard and soft mast comprise more than 1% of deer diets and as much as ten percent of their fall diet. Deer tend to shift browsing species for several reasons. As deer mature, they shift from succulent forms to browse. They also change to browse with seasonal change in late summer and early fall, due to a decrease of nutritional value of forages.

Estimating carrying capacity for white-tailed deer may involve determining forage quantity divided by the yearlong dietary need of the animal (French et al. 1956, Blair 1960, Byrd 1980, Halls and Boyd 1982), although utilizing nutritional quality models are also often used (Fulbright and Ortega 2013). Deer respond to habitat quality or, as Dasmann (1964) defined, “tolerance density.” A high quality habitat leads to high deer reproductivity, often characterized by twin or even triplet fawns (Halls 1984); a poor quality habitat will often result in a decreased fawn crop (Kroll 1991).

The objective of this study was to evaluate forage species composition, forage yield and deer preference within Turkey Hill Wilderness area and to determine which of the sampled community types may best provide forage for deer.

MATERIAL AND METHODS

Study Area. This study was conducted in the Turkey Hill Wilderness, located within the Angelina National Forest in East Texas) in 2001. Following LeGrande (1998), plots were classified within four community groups: mixed hardwood (mixed hardwood, southern scrub oak. *Quercus alba, Q. alba-Q. pagoda, Q. michauxii-Q. pagoda),* pine-hardwood (*Pinus echinata-Q.* spp., *P. taeda*-mixed hardwood, *P. taeda-Liquidambar styraciflua),* pine *(P. echinata, P. palustris-P. taeda, P. taeda, P. taeda-P. echinata)* or no overstory. Separation into mixed pine-hardwood and hardwood stands were based on topographic features. Sixty-nine randomly located 0.04 ha plots were established following Zhang et al. (1999) (Fig. 1). Plot corners were marked with steel rebar and tagged for identification.

Between June and September within each plot, all trees (single woody stems greater than 4.5 m total height) were identified to species and measured for total height (m), diameter at breast height (dbh in cm), height to live crown (m), crown class and crown width (m, from drip line to drip line perpendicular directions). Also, a 0.01 ha subplot was nested in one corner of each plot, and all midstory shrubs and saplings were identified to species and measured for height and diameter (Bonham 1989).

In addition, two, 1 m^2 plots were established in two corners in each plot. All plants rooted within the square were identified to species, utilization estimated by ocular examination, new growth clipped and placed in a paper bag, oven-dried (60^{o}C until constant weight, about 24 h), and weighed to the nearest 0.01g. Same species in each plot were added together and plot data for all species were expanded for total production per ha (Hill 1995).

Within the 0.01 ha subplot, all vegetation with stems measurable at dbh (midstory shrubs and saplings, vines, and overstory tree limbs), and having current vegetative growth within 2 m of the ground, were sampled using a .025 m^2 frame (Hill 1995). The frame was placed on the plant side first approached. All new growth within the frame was clipped, oven-dried and weighed. One corner was sampled in spring/early summer and the other sampled in late summer/fall. Forage availability and production per species were calculated on a per hectare basis (Hill 1995). Following Lay (1967) and Thill (1983), plant species were identified and preference levels were assigned. Plant and animal common and scientific names were verified using Honacki et al. (1982) and USDA Forest Service (1999).

Deer Stocking Estimation. One plot from each community type was selected and four browse survey transects were laid out in the cardinal directions. Five subplots (0.0004 ha) were established along each transect and utilization of current or past season browse growth was classified as 0, 5, 30, or 70 percent. This represents approximate midpoints of four utilization percentage classes: none, trace-10, 10-50, and 50+ (Lay 1967). A winter browse survey, following Lay (1967), was conducted in late January through mid-February. The method included browse inventory (species identification) and estimated (ocular) degree of utilization, palatability classification (1^{st}, 2^{nd} or 3^{rd} choice browse, and calculation and interpretation of utilization indices. A utilization mean was calculated for each plant species occurring on 20 percent or more of the plots. Utilization percentages were calculated by totaling the utilization percentages (by percent classes) of each species, then dividing by the number of times the species occurs. Common utilization means, for each of the three choice classifications, were combined into a mean index. This produced a ratio for browse utilization, which was used to determine the existing deer stocking rate following Lay (1967).

Statistical Analyses. Importance values (Estrada-Bustillo and Fountain 1995, LeGrande 1998) were calculated for individual plant species as:

$$IV = NP \times AP \qquad [Eq. 1]$$

Where IV = Importance Value

NP = Number of plants of a species

AP = Animal preference (Lay 1967b, Thill 1983)

Total forage production (kg ha^{-1}) was calculated for spring and summer. Using importance values, communities were evaluated for potential usage for spring and summer. Potential forage within and among communities was determined by expanding plot estimates to per ha estimates. ANOVA and Duncan's multiple range test, using SAS® were used to test for significance of total forage production, preferred animal forage production and importance values among communities. T-tests were used to test for significance between seasons.

Deer forage was subdivided into 3 preference levels (Lay 1967) for known forages and a fourth class (other) for forages that were either unknown or had no references to deer utilization. Numbers of plants and deer utilization for each preference level were calculated per community. ANOVA and Duncan's then were used to test for significance of number of plants and utilization for spring and summer for each preference level among communities. Significance level for all analyses was set at the 0.1 *a*-level.

RESULTS

Spring mean forage yield for the four different community groups ranged from 31.7 to 214.1 kg ha^{-1}, and summer mean forage ranged from 39.2 kg ha^{-1} in pine communities to 211.1 kg ha^{-1} in no overstory stands. Mean forage production for both spring and summer were highly variable among vegetative community groups, but significant differences were not found between community groups for the summer (Table 1).

TABLE 1 ABOUT HERE

Significant differences in plant density for second, third and other preference levels were however found between community groups in the spring (Table 2). Second choice plant densities ranged from 11,000 stems ha^{-1} in no overstory to 153,885 stems ha^{-1} in the mixed hardwoods. Low spring season utilization of first choice plants occurred only in the no overstory community group at four percent. The greatest utilization occurred in the mixed hardwood community where third choice and other plants were utilized at eight and six percent, respectively, of available forage.

First, third and other forage preference classes significantly decreased statistically in number of plants per ha from spring to summer. However, for two community groups (pine-hardwood and no overstory), second choice plant numbers significantly increased (Table 3). TABLE 2 AND 3 ABOUT HERE.

Based on browse utilization, deer stocking across Turkey Hill Wilderness was classified as light. However, stocking rates among the community groups varied from light to moderate. Two community groups were light to moderately stocked; the others were lightly stocked (Table 4). TABLE 4 ABOUT HERE.

CONCLUSIONS AND DISCUSSION

There were significant differences in forage biomass for deer preferred forage in spring among community types. Overall biomass production generally follows Thill's (1984) results, with greatest forage production occurring in open communities and less production under forest canopies. There were no deer habitat preference differences among community types.

Forage Production. ANOVA analyses of forage availability, production and preferences proved significant for some variables, including total forage production in spring, importance values in spring, and preferred forage production in spring. Though Duncan's MRT failed to separate significant means in most cases, greatest total spring forage yield occurred in no overstory followed by mixed hardwoods. The no overstory community group had the greatest spring and summer preferred forage yield. The mixed hardwood and no overstory community groups generally had higher total forage production. These sites had open canopies, thus increasing forage production. Furthermore, the forest floor of pine communities generally was heavily covered in litter, effectively reducing herbaceous plant production. The classic assumption is pine stands cannot support deer, which may be the case in some pine plantations, although Jones et al. (2009) reported adequate deer numbers in intensively managed loblolly pine plantations in Mississippi. Our results indicate the mixed hardwood community is equal to or superior to open stands in terms of producing preferred deer forage in spring.

Mixed hardwoods had the greatest deer importance values for spring and this may be reflected by utilization levels. However, the high importance values may be supported by density of second choice browse species. This is followed by similarities between the no overstory and pine community groups. The mixed hardwood community group maintained the highest importance value for summer, followed by the pine and mixed pine-hardwood communities. The mixed hardwood stands often are more open and have less litter on the forest floor, leading to greater capability of producing herbaceous forage for deer.

Recurring droughts in the last few decades in Texas may have reduced herbaceous diversity, specifically annual herbs. Thus, summer deer importance values and preferred forage production became similar for each community. Furthermore, the entire Wilderness Area has experienced little disturbance since 1984, except beetle outbreaks in some areas. Successional trends expressed when limited disturbances occur can produce similar understories in each community, again resulting in a fairly uniform vegetative composition (Smalley 1986, Hinkle 1989, Franklin et al. 1993, McNab 1996).

Deer Stocking. Stocking at the research location generally was light, based on browse survey data. Numerous browse species in all three preference classifications were available and generally were under-utilized (<50% browsed), indicating deer stocking levels could be increased. Only 6 deer were observed (3 does, 2 fawns and 1 unknown), throughout the entire sampling periods. Also, there was very little visible utilization of first-choice species such as green briar (*Smilax* spp.). Alabama supplejack (*Berchemia scandens*), also a first-choice species, never appeared to be utilized within the forest, however, it was heavily browsed where found along an abandoned, improved-rock and caliche road within the area. It may have been made more palatable from the increased pH by calcium leaching from road materials (Heady 1964).

Deer numbers may have been low due to the highly accessible nature of this forested area. Hunters can enter the forest from roads bordering three sides. It is relatively small in size and it is heavily hunted during legal deer season and anecdotally may be subject to poaching. Two of the communities having light to moderate stocking are near the wilderness center, while the other light to moderate and the moderately stocked community are near the wilderness area's exterior. However, this side is adjacent to and separated from part of the Angelina National Forest by a Forest Service road. The other communities are scattered throughout the wilderness near boundaries with the National Forest, bordered by woods roads and Texas State Hwy 147 (south and west boundaries), with private property bordering the entire northern wilderness boundary and FM 705 bordering the eastern wilderness boundary.

Although adequate forage is available within this unmanaged forested area, stocking rates were much lower than anticipated or what could be supported. It is possible that the lack of disturbance processes, such as fire, may be resulting in reduced habitat diversity across the various community types found within the Turkey Hill Wilderness Area, thus negatively influencing white-tailed deer populations within Turkey Hill. Since there is little evidence that the area is unable to support more white-tailed deer, other possible reasons for the low population density should be investigated.

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Table 1. White-tailed Deer Forage Yield (kg ha^{-1}) per community group. Variables with same letter in a column are not significantly different.

Communities	Spring Forage Yield	Summer Forage Yield
Mixed Hardwood	211.8A	143.9
Pine-Hardwood	31.6B	43.4
Pine	52.18B	39.2
No Overstory	214.11A	211.1
P-value	**0.0042**	0.3090

Table 2. Availability[1] of white-tailed deer preferred spring and summer forage (stems ha^{-1}) using Lay's (1967) 3 choice levels in number of plants per hectare. Variables with same letter in a column are not significantly different. SE= Standard Error.

	1st Choice		2nd Choice		3rd Choice		Other Choice	
Community	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Spring[2]								
Mixed-Hardwood	29085	1676	153885A	7790	32830	2174	219570A	15241
Pine-Hardwood	23155	2581	38309B	3789	7872	1083	84890A	12420
Pine	24620	1478	87510AB	5683	11060	1119	47025A	1786
No Overstory	52200	18562	11000B	88	37400	15502	86966A	18489
Summer[3]								
Mixed-Hardwood	27020	1424	89735	5007	7355	513	59730B	2481
Pine-Hardwood	19600	2675	58009	8343	3109	431	43072B	2830
Pine	16960	1170	51525	2340	5370	595	25075B	1922
No Overstory	57100	19108	24200	1798	10400	5745	103466A	22241

[1]Usable, obtainable and accessible by the animal (Morrison et al. (1992).
[2] Spring P-values: 1st choice 0.5451, 2nd choice 0.0433, 3rd choice 0.0775, other 0.0553.
[3] Summer P-values: 1st choice 0.1432, 2nd choice 0.3473, 3rd choice 0.6254, other 0.0123.

Table 3. P-values for t-test differences between spring and summer number of plants per preference level.

	Browse Preference Level			
Community	1st Choice	2nd Choice	3rd Choice	Other
Mixed Hardwood	0.8114	0.1170	**0.0250**	**0.0350**
Pine-Hardwood	0.7856	**0.0547**	0.2770	0.3240
Pine	**0.0347**	0.2097	0.2604	0.0727
No Overstory	0.9200	0.0481	0.2412	0.7403

Table 4. Browse utilization ratios (from Lay 1967) for 4 community types in Turkey Hill Wilderness.

	Preference Classification					
Community	1st Choice Browse	2nd Choice Browse	3rd Choice Browse	Grass	Pine	Stocking Rate
	Lay (1967) Standard for White-tailed Deer					
East Texas	35	10	1	0	0	Light
	55	30	5	Trace	0	Moderate
	60	40	15	Trace	3	Heavy
	Turkey Hill Wilderness					
Mixed Hardwood	3.7	11.9	4.5	10.8	0.8	Light
Pine-Hardwood	5.7	15.9	3.5	5.4	1.7	Light-Moderate
Pine	3.6	6.1	5.2	6.2	1.6	Light
No Overstory	2.9	17.4	5.4	5.4	1.0	Light-Moderate
Mean	4.0	12.8	5.1	7.0	1.3	Light