Assessment of White-tailed Deer (*Odocoileus virginianus*) Impacts on the Woody Plant Community in the Vireo Ridge Restoration Area of the Jollyville Unit of the BCP FY2006



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INTRODUCTION

This report presents the results of a deer browse study conducted by Travis County Natural Resources field staff during September 2006 on the Vireo Ridge tract of the Jollyville Unit of the Balcones Canyonlands Preserve (BCP).

BACKGROUND

White-tailed deer (*Odocoileus virginianus*) have increased in abundance and expanded their geographic range in North America over the past century and currently exist at higher densities than they have in the past several hundred years (Rooney 2001). In particular, the Edwards Plateau of Central Texas has one of the largest populations of white-tailed deer in the United States (Richards 2000) with an estimate of 65 deer per 1,000 acres for 35 counties in the region. Higher populations occur in many areas, with numbers reaching one deer per three acres (Armstrong and Young 2000). Data collected by Texas Parks and Wildlife Department (TPWD) indicate that despite hunting efforts, deer populations continue to increase (Gore and Reagan 1984). With no significant limiting factors, deer have the potential to negatively impact native plant communities through structural and compositional changes. (Russell et al. 2001). Deer foraging habits can affect plant morphology, plant growth rates (Russell et al. 2001) and also cause a significant reduction in understory vegetation (Rooney 2001). Consequently, high deer densities may potentially become a critical problem on lands managed to protect endangered species. Research has shown that sites with high deer densities result in changes in size distributions within populations of preferred browse species due to lack of recruitment to sapling and small adult size classes (Tilghman 1989; Healy 1997) and thus, negatively affecting key habitat components for both the black-capped vireo (*Vireo atricapilla*) and the golden-cheeked warbler (*Dendroica chrysoparia*).

White-tailed deer feed on forbs (herbs, flowers), mast (seed, fruit, nuts etc), grasses, and browse (seedling trees and shrubs). Although deer prefer forbs, browse makes up approximately 65% of their diet, constituting a dependable food source throughout the year (Nelle 1994; Armstrong 2000;). Because browse is such an important part of the white-tailed deer diet, utilization of browse species can provide information on relative herd size and condition (Armstrong 1991; Nelle 1994). The presence or absence of certain browse species, the degree to which deer are utilizing these resources, and the extent of species regeneration, can all indicate whether deer numbers are too high relative to the carrying capacity of the local habitat.

Study Site

The Vireo Ridge tract comprises approximately 609 acres of the BCP Jollyville Unit. The vegetational community is characterized by oak-juniper (*Quercus sp.-Juniperus ashei)* woodlands (with ashe juniper density extremely high in some areas) with a shrubby understory component including a variety of sumacs (*Rhus spp.*), yaupon (*Ilex vomitoria*), mimosa (*Mimosa spp.*) and Texas persimmon (*Diospyros texana*).

From 2001 to 2006, approximately 100 acres of Vireo Ridge have been manipulated to create black-capped vireo habitat (Travis County Parks and Natural Resources 2005), characterized by successional, deciduous shrubland with woody cover from ground-level to 2 m (Grzybowski 1995). In these restoration areas, as identified in Figure 1, woody plants were cut, leaving islands of intact shrubs and understory species. Additionally, a deer-culling program was initiated on the Jollyville Unit in 2002.

The purpose of this study is to measure the impact of white-tailed deer on the vegetation in an area currently being restored to black-capped vireo habitat. Three plant community characteristics are of particular interest: 1) woody plant species composition, 2) the degree of woody plant use by deer, or degree of browsing, and 3) the size class distribution. Data is also collected on the density and frequency of woody plants and then compiled based on deer browse preferences.

METHODS

Circular plots were used to determine woody plant species composition, density, relative density and frequency. In 2002, seven plots with a radius of eight meters each, totaling 0.35 acres, were randomly established on the Vireo Ridge tract where black-capped vireo habitat restoration efforts have occurred (Travis County Parks and Natural Resources 2002). The center point of each plot was permanently marked with a t-post, and all post locations were recorded with a Geographic Positioning System (GPS) unit.

In 2003 and 2006, six of those plots were revisited, for a total of 0.30 acres. All woody vegetation within each plot was recorded. Because an exact count of live oak seedlings and root sprouts was immeasurable, the number for each of these was estimated.

Following TPWD (2001) guidelines for assessing browse intensity, each individual woody plant was classified as severely browsed, moderately browsed, or unbrowsed. To evaluate

woody plant recruitment, the size class of each individual plant was also recorded. Shrubs were classified as seedlings (0 – 50 cm tall) or mature plants (≥ 51 cm tall), while trees were classified as seedlings, young trees, or mature trees. Tree size class was based on plant height and diameter at breast height (dbh), with three categories: 1) seedlings and suppressed seedling-sized saplings: 0 – 50 cm tall; 2) young trees (including saplings): ≥ 51 cm tall and <15 cm dbh; and 3) mature trees: ≥15 cm dbh. This was a modification of the 2002 method of age class determination, where a plant was classified as mature if it was resprouting from an adult that had been cut down, regardless of height (Travis County Parks and Natural Resources 2002). Additionally, the method for classifying twisted-leaf yucca (*Yucca rupicola*) was modified in 2003; if there were two leaves or fewer, it was classified as a seedling; otherwise it was classified as mature.

Woody plant species were then placed in four categories according to deer preference, based on research by Armstrong (1991) and Nelle (1994): preferred, good, low quality, and other. For study purposes, the designations "low quality browse" and "little utilized browse" used by Armstrong (1991) were combined into one category. Additional species listed by Nelle (1994) as "low quality browse" were included in this category as well. Browse species that were not listed by either researcher were designated as "other species." Drought conditions did negatively affect some individuals, making it difficult to ascertain whether or not browsing had occurred. These individuals were recorded for density/frequency calculations alone and not recorded into a browsing category.

In an effort to monitor the effects of browsing compared to an area where no browsing has occurred, two exclosures, each 132 square feet in size, were established within the Vireo Ridge restoration area in 2006. Baseline data collected at the time of enclosure establishment will be used for future comparison and analysis.

RESULTS

A total of 1842 individual plants were encountered within the six study plots. Out of this total twenty-eight woody species were recorded. This number decreased from the 31 species found in 2003. Three of the 28 species recorded in 2006 were categorized as preferred browse, 11 were good browse, nine were low quality browse, and five were "other". These results are listed in Appendix 1 following this report.

Density values for good quality browse dropped from 2003 as shown in Figure 2. Density was highest for good browse and low quality browse species and density was lowest for preferred browse species (see Table 1). Of the total individuals sampled, 72% were categorized as good browse, 21% of the plants were low quality browse, 5% of the plants were "other, and the remaining 2% were categorized as preferred browse (see Table 2). For all individuals combined, 75% showed no signs of browse, 21% were moderately browsed, and 5% were severely browsed. These values are very similar to those obtained in 2003 as demonstrated in Figure 3.

Table 1. Density, relative density, and frequency of plants in the study plots at Vireo Ridge, Sept. 2006 based on browse preference by white-tailed deer, *Odocoileus virginianus* (Nelle 1994, Armstrong 1991)

	Density/acre[1]	***Relative Density[2]***	***Frequency[3]***
Preferred Browse	143	0.02	0.83
Good Browse	4393	0.72	1.00
Low Quality Browse	1296	0.21	1.00
Other	303	0.05	1.00

[1] density per acre = no. of individuals per acre

[2] relative density = no. individuals of species *i* / total individuals of all species

[3] frequency = no. of plots where species *i* occurs / total no. of plots

Table 2. Percentages of browse sampled at Vireo Ridge, September 2006 based on total number of individuals (N=1842) recorded from each white- tailed deer preference classes (Nelle 1994, Armstrong 1991).

N= 1842	***% of N***	***Browse Not Evident (%)***	***Moderate Browse (%)***	***Severe Browse (%)***
Preferred Browse (n=43)	0.02	0.70	0.19	0.11
Good Browse (n= 1318)	0.72	0.75	0.20	0.05
Low Quality Browse (n=389)	0.21	0.80	0.17	0.02
Other (n=91)	0.05	0.48	0.46	0.06

Of the 43 individuals recorded under the preferred browse category in 2006, 70% (n=30) showed no evidence of browsing and 11% (n=5) were recorded as severely browsed. Of the 1318 individuals recorded under the good browse category, 75% (n=996) showed no evidence of browsing and 5% (n=62) were severely browsed. These percentages are detailed in Table 2 above.

Table 3. Percentages of browse sampled at Vireo Ridge, September 2006 within each browse usage category (Nelle 1994, Armstrong 1991).

	% Browse Not Evident (N =1381)	*% Moderate Browse (N=378)*	*% Severe Browse (N=83)*
Preferred Browse	0.02	0.02	0.06
Good Browse	0.72	0.69	0.75
Low Quality Browse	0.22	0.18	0.13
Other	0.03	0.11	0.06

Table 3 displays the 2006 percentages of sampled browse for each usage category. Seventy percent of the severely browsed individuals came from the good browse category and 6% came from preferred browse. The seedlings age class represented 64% of all individuals sampled as shown in Table 4. However, this percentage was down from 2003 (see Figure 4). Nevertheless, as indicated in Figure 3 sapling and adult percentages increased. Sixty-seven percent of all severely browsed individuals came from the seedling age class, 10 % came from sapling age class and 23% were adults (Table 4).

Table 4. Percentages of utilized and un-utilized browse vegetation sampled at Vireo Ridge, September 2006 based on age class. Browse class percentages calculated using total number of individuals within each unique category.

	% of N (N=1842)	*Browse Not Evident (%) (N=1380)*	*Moderate Browse (%) (N=378)*	*Severe Browse (%) (N=83)*
Seedling (n=1174)	0.64	0.66	0.52	0.67
Sapling (n= 211)	0.11	0.09	0.21	0.10
Mature (n=456)	0.25	0.25	0.27	0.23

Overall the total number of individuals from 2003 was higher than 2006 with a value of N= 2798. However, a two-tailed T test showed no significant difference ($t = 1.67$, $p = 0.7$, $df = 58$) between the total numbers of individuals from the two samples over three years.

DISCUSSION

In summary, the results of the 2006 survey were very similar to the 2003 survey with the exception of age class recruitment, particularly for seedlings and saplings as evident in Figure 3 and Figure 4 respectively. For example a total of 46 Texas oak (*Quercus buckleyi*) seedlings and two saplings, categorized as a preferred species, were recorded in the 2003 survey. In the 2006 survey 16 individuals were recorded with only 12 seedlings and four saplings. Subsequently, only two of the 46 Texas oak seedlings from 2003 survived to the next age class. Also in the 2006 study, of the 83 individuals classified as severely browsed, almost 70% of these were seedlings (see Table 4). The species hardest hit of the seedlings in 2006 was shin oak (*Quercus sinuata*) with 36 individuals out of 56 showing signs of severe browse. However, 48 shin oak seedlings with no evidence of browsing were also recorded. Other variables that were not examined or taken into account in this study, such as temporal variation, previous weather conditions etc., may have influenced a lack of recruitment. Nontheless, seedlings seem the most negatively affected by browse and are therefore, not advancing to the sapling or mature age classes (see Table 4). This determination corresponds with findings by Russell et. al (2001).

Recent drought conditions did affect sampling. For some individuals it was impossible to determine whether or not they had been browsed or were simply showing the effects of extremely dry conditions. As previously mentioned, these individuals were counted only for density/frequency purposes.

Seventy-four percent of individuals sampled from Vireo Ridge fell within the preferred or good browse category as shown in Table 2. Of these, the majority was unbrowsed (see Table 3). This indicates a medium to high condition range (Nelle 1994). Additionally, censusing results in 2005 gave the Jollyville unit a value of 1-deer/7.2 acres. Culling efforts in 2005 removed 22 deer off the Jollyville unit and efforts continue in 2006. Nonetheless, based on TPWD deer density recommendations for endangered avian species habitat, management goals must ultimately acquire deer density values of one deer/15-20 acre.

Another important consideration is plants experiencing browse pressure, either moderate or severe, are important components of black-capped vireo habitat in the form of nest sites and/or cover. Species present on Vireo Ridge and frequently known to occur in preferred black-capped vireo habitat include shin oak, Texas oak, live oak, sumac species, and redbud (Grzybowski 1995). All of these species were showing signs of deer browse on Vireo Ridge in 2006, although to varying extents. Therefore, the woody plant composition on Vireo Ridge indicates low to moderate deer numbers. However, these deer are browsing plant species that are a crucial component of black-capped vireo habitat. Ultimately, this foraging preference could potentially have a negative impact on the recruitment of woody plants into the larger size classes, and thus affect restoration success. For these reasons, deer management and vegetation monitoring efforts will continue until a suitable carrying capacity for Vireo Ridge, with consideration to endangered species present, is obtained.

RECOMMENDATIONS

Deer censusing TPWD recommends that a deer census be completed each year on lands where deer are harvested. An annual census will allow managers to evaluate the effectiveness of management strategies, determine whether desired deer densities have been attained, and calculate future harvest recommendations.

Culling As long as the deer herd remains larger than the carrying capacity of the preserve, it is recommended that deer harvesting take place on the Jollyville Unit and other BCP properties demonstrating over browsing pressure.

Plant monitoring Annual plant monitoring programs, such as the current browse study, will allow staff to assess the effectiveness of deer management strategies on a yearly basis.

Exclosure studies Further study of plant community characteristics on the Vireo Ridge tract will facilitate a more clear understanding of the impact of white-tailed deer on native flora. Exclosures will allow staff to quantify plant community characteristics in the absence of browsing pressure.



Figure 1. Vireo Ridge restoration area on the BCP Jollyville unit showing browse plot locations.

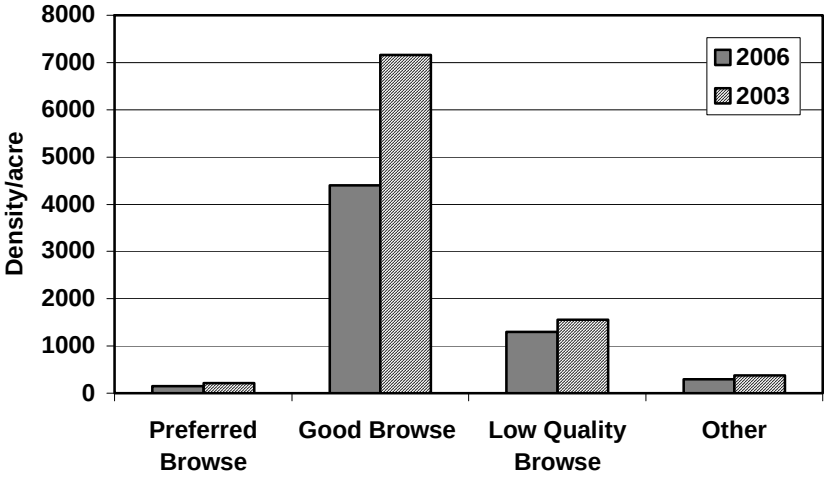

Figure 2. Comparison of density per acre values for each browse Category from both 2003 and 2006. Quality of browse is classified according to Armstrong (1991) and Nelle (1994).

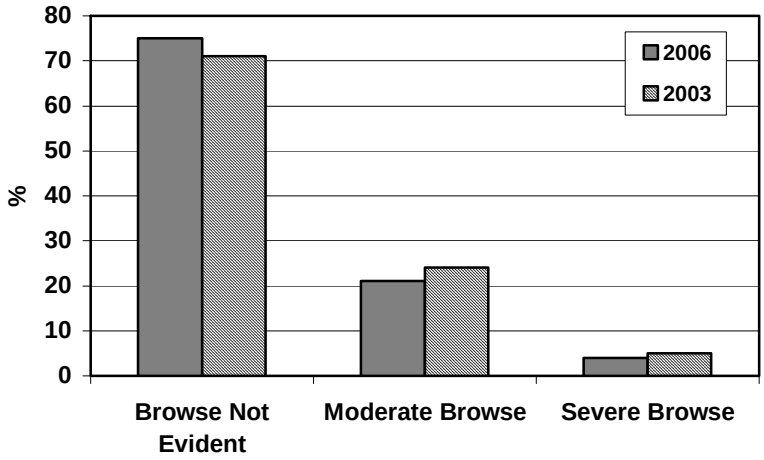

Figure 3 Comparison of percentages of woody vegetation from Vireo Ridge study plots based on browse class data from both 2003 and 2006. Browse pressure is classified according to TPWD (2001) guidelines.

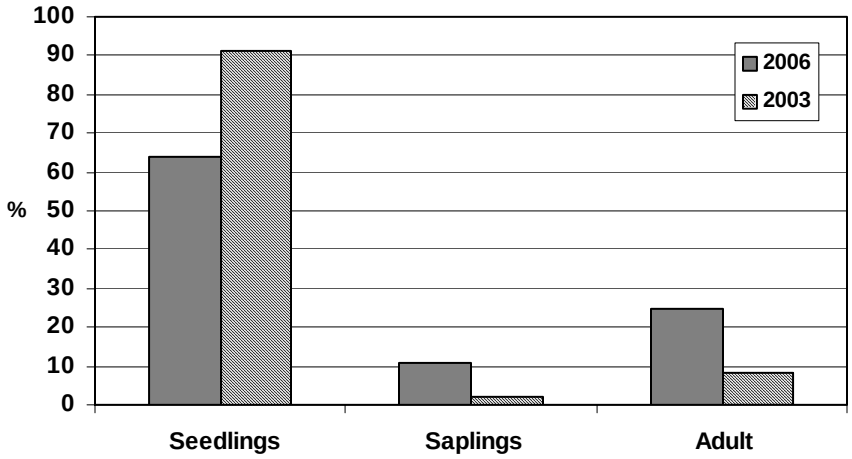

Figure 4 Comparison of percentages of woody vegetation from the Vireo Ridge study plots based on age class data from both 2003 and 2006. Age classes defined by TPWD (2001).

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Appendix 1. Number of individuals of woody plant species (*N=1841)* encountered in study plots at Vireo Ridge, September 2006. Species ranked by total number of individuals encountered and by browse preference (Nelle 1994, Armstrong 1991)

	Hackberry	1	good
	Cherry	3	good
	Bumelia	5	good
	Virgina Creeper	16	good
	Grape	22	good
	Possumhaw	44	good
	Greenbriar	46	good
	Redbud	71	good
	Flameleaf Sumac	81	good
	Shin Oak	205	good
	Poison Ivy	824	good
	Fragrant Sumac	6	low/poor
	Prickly Ash	6	low/poor
	Prickly Pear	6	low/poor
	Wafer Ash	23	low/poor
	Persimmon	26	low/poor
	Evergreen Sumac	41	low/poor
	Twisted-leaf Yucca	48	low/poor
	Live Oak	111	low/poor
	Juniper	122	low/poor
	Kidneywood	3	preferred
	Texas Oak	16	preferred
	Carolina Buckthorn	24	preferred
	Carolina snailseed	1	other
	Povertyweed	2	other
	Dewberry	9	other
	Texas Ash	31	other
	Yaupon	49	other