Tree Seedling and Understory Plant Presence in Deer Exclosures on the Matthews State Forest

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Introduction

White-tailed deer (*Odocoileus virginianus*) can impact the growth and survival rate of both tree seedlings and herbaceous plants via browsing (i.e., consumption of plants). Declines in tree seedling densities and diversity are often correlated with increases in white-tailed deer populations (Patton et al. 2021). Preferential browsing by deer on certain species can be so severe as to result in the elimination of sensitive tree species (Walters et al. 2016).

Oak species (*Quercus* spp.) are particularly vulnerable to browsing. In addition to possessing a slow juvenile growth rate, oak species are highly preferred by white-tailed deer (Apsley et al. 2004). Oak is a valuable hardwood species for its economic importance, and desirable habitat for wildlife and herbivory by white-tailed deer could limit their chances of growth and survival.

Deer exclosures can be used to demonstrate the level of deer herbivory in a specific location. Exclosures provide a physical barrier that prevents browsing of any vegetation in an enclosed area. In this case study, two undergraduate students from Virginia Tech evaluated two sites located at Matthews State Forest in Grayson County, Virginia. One site underwent a controlled burn in early April 2021 (two months prior to data collection) and the other in 2017. The purpose of this case study was to determine the impact of deer on the composition of the herbaceous and regeneration layer in two stands in the Matthews State Forest.

Methods

The forest cover type was upland hardwood at both sites. The 2017-Burn site was a 60- to 70-year-old upland hardwood stand that resulted from natural succession following what was likely pastureland abandonment in the early twentieth century. The 2021-Burn site was a 90- to 100-year-old second-growth upland hardwood stand that was also likely cleared for agriculture over 100 years ago. The 2021-Burn site was also burned in 2008 and 2014.

Each site had two plots consisting of a fenced exclosure and unfenced control plot; all four plots were measured at 32 x 32 ft (1,024 ft^2). One exclosure and control plot underwent a controlled burn two months prior to data collection (36.6277ºN, 80.9550ºW), while the other plot was burned once in 2017 (36.6412ºN, 80.9641ºW). The control plots were located immediately adjacent to the study plots, and had very similar canopy cover (Figures 1 and 2).

Figure 1. Unfenced control plot on 2021-Burn site.

Figure 2. Unfenced control plot on 2017-Burn site.

Slope, elevation, coordinates, aspect, and canopy cover were recorded for each plot. A clinometer was used to measure the slope of each site. Bad Elf GPS© was used to measure the elevation and coordinates. A compass was used to measure the aspect of each site and a spherical densiometer was used to determine canopy cover.

The tree seedling composition within the entirety of the plots was measured. To facilitate data collection, each plot was divided into eight equidistant transects using stakes and a pink string. Height was measured for each tree seedling using a yardstick and categorized in size classes represented by the letters A (germinant), B (small seedling), C (seedling), and D (large seedling) (Table 1).

Table 1. Height categories used for grouping tree seedlings.

Height Category	Height Range (in)
A (Germinant)	< 6
B (Small Seedling)	6.1-12
C (Seedling)	12.1-24
D (Large Seedling)	> 24.1

Understory herbaceous plants were also identified and tallied for each plot at both sites. For the unburned site, every plant was identified and tallied. Due to the abundant herbaceous growth stimulated by the April burn, the burned site was sampled using four randomly located 2.25-ft fixed-radius plots. The plants were later categorized into smaller subgroups in order to observe the diversity of each plot.

Results and Discussion

The 2021-Burn site had a slope of 28.4%, an elevation of 2,515 ft, and a northwestern aspect. The canopy cover inside the deer exclosure was 82%, and it was 73% in the control. The 2017-Burn site had a slope of 18%, an elevation of 2,520 ft, and a northwestern aspect. The canopy cover inside the exclosure was 85%, and it was 78% in the control.

The 2021-Burn site had more species and a greater number of tree seedlings present (Table 2). There were more tree seedlings measured in the A range (< 6 in) outside the exclosures at both sites (Figure 3). Both sites had an average of 3,734 seedlings per acre in the C and D ranges (> 12.1 in) inside the exclosures and 131 seedlings per acre outside the exclosures. This would indicate that the deer exclosures enabled seedlings to survive and grow into the taller height categories by preventing deer browse. The recruitment of oak species from the regeneration layer into the overstory is often low. One hypothesis for this low recruitment is the preferential browse pressure by deer. This case study provides evidence that deer pressure may be partially responsible for this low recruitment at Matthews State Forest.

Table 2. Tree seedlings per acre for exclosures and control areas. “Rel. Den.” is the relative density, or the percent component, of each species inside or outside of an exclosure for a given site, respectively.

	2021-Burn				2017-Burn			
	Inside Count	Rel. Den. (%)	Outside Count	Rel. Den. (%)	Inside Count	Rel. Den. (%)	Outside Count	Rel. Den. (%)
Blackgum, *Nyssa sylvatica*	3,404	6.4	3,915	5.4	0	0.0	0	0.0
Yellow poplar, *Liriodendron tulipifera*	1,574	2.9	2,085	2.9	255	2.3	85	1.0
Red maple, *Acer rubrum*	3,277	6.1	9,574	13.1	7,617	69.7	4,851	57.3
Red oak spp., *Erythrobalanus* spp.	1,617	3.0	596	0.8	1,957	17.9	1,872	22.1
Black cherry, *Prunus serotina*	85	0.2	298	0.4	340	3.1	1,574	18.6
Sassafras, *Sassafras albidum*	298	0.6	383	0.5	681	6.2	43	0.5
White oak spp., *Leucobalanus* spp.	128	0.2	0	0.0	0	0.0	0	0.0
Hickory, *Carya*	170	0.3	0	0.0	0	0.0	0	0.0
Birch, *Betula lenta*	42,681	79.7	55,872	76.7	85	0.8	0	0.0
White pine, *Pinus strobus*	0	0.0	43	0.1	0	0.0	0	0.0
Cucumber, *Magnolia acuminata*	0	0.0	0	0.0	0	0.0	43	0.5
Total	53,532		72,851		10,935		8,468	

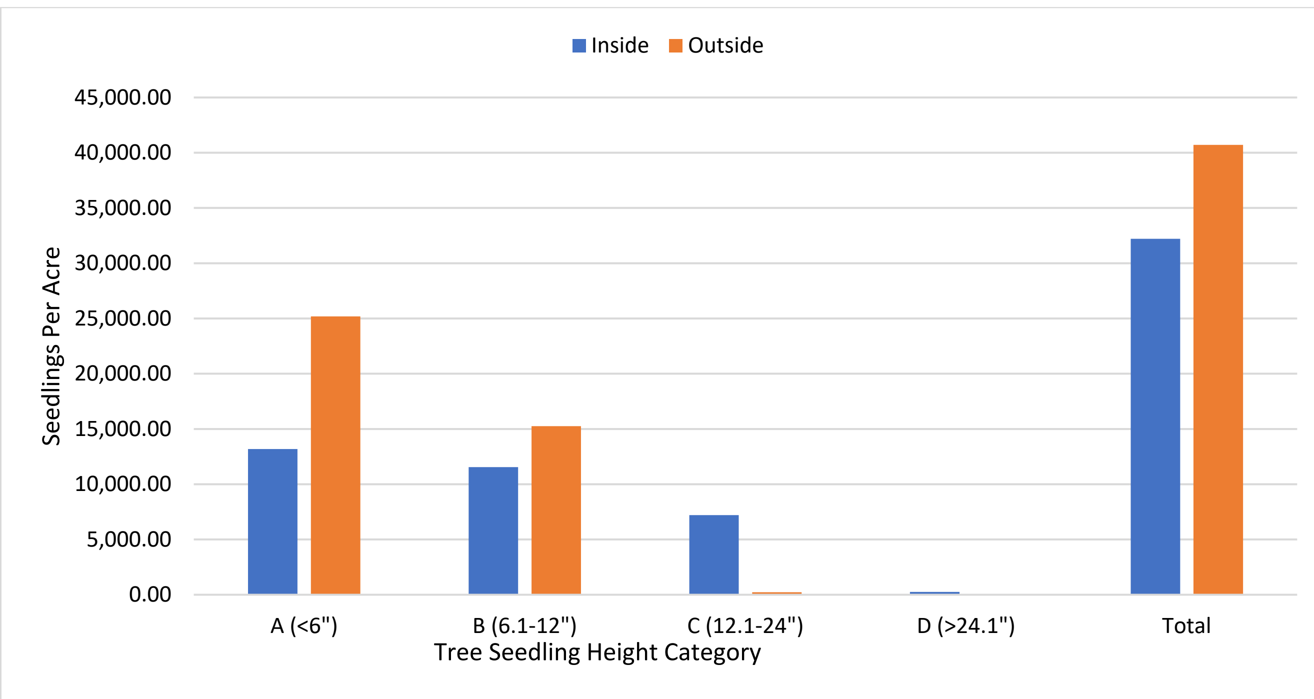

Figure 3. Tree seedlings per acre by height category.

Oak seedlings appeared to have a better chance of growth and survival inside the exclosure for both sites (Figure 4). Overall, there were more oaks inside the exclosure in comparison to outside of it (Table 3). However, in the shorter height categories on the 2017-Burn site, the abundance of seedlings was very similar inside and outside of the exclosure. Outside the exclosure actually had more oak seedlings; however, there were more in the taller height categories inside the exclosures. This could indicate that there are similar numbers of seedling germination both inside and outside, but because of browsing, seedlings are less likely to survive outside and make it into the taller height categories.

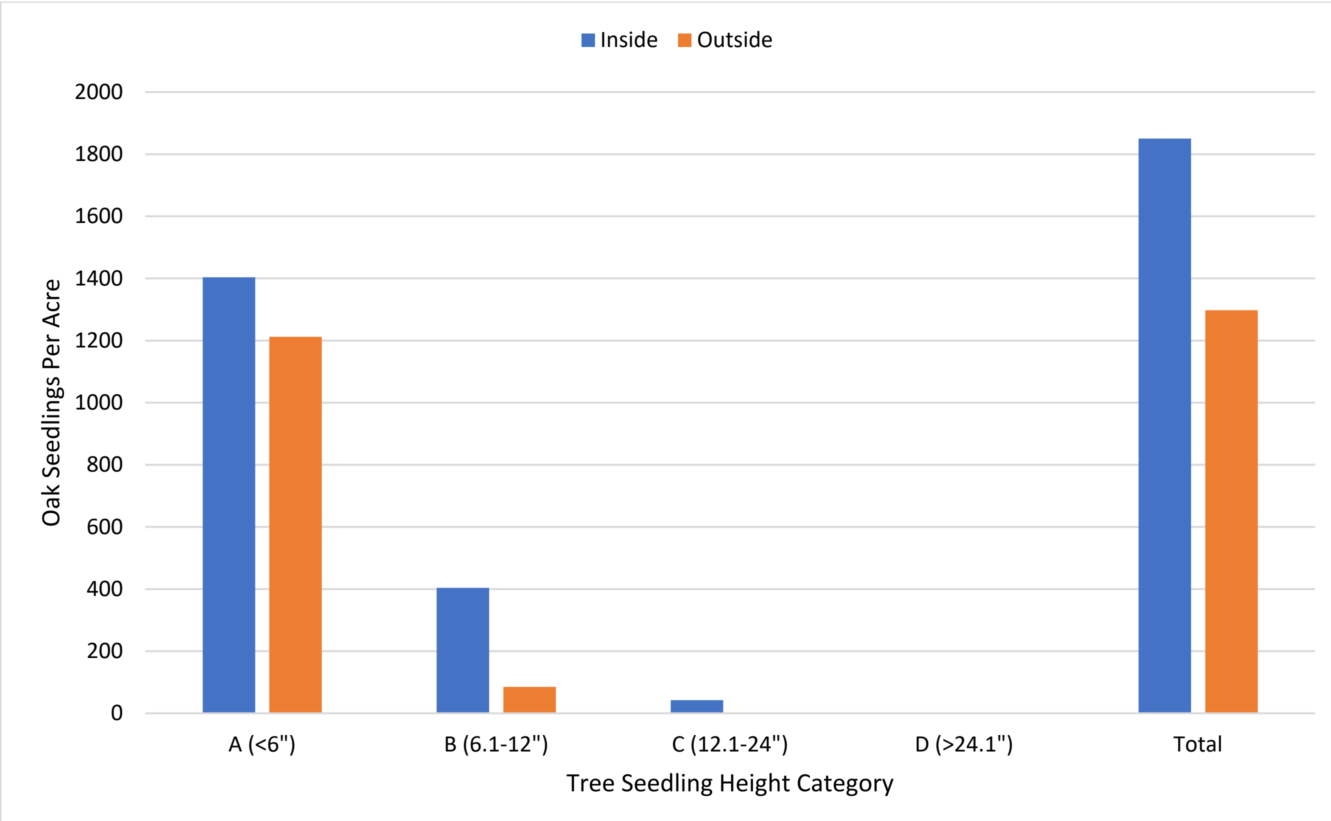

Figure 4. Oak (*Quercus* spp.) seedlings per acre by height category.

Table 3. Oak (*Quercus* spp.) seedlings by height category for exclosures and control area (1,024 ft^2).

	2021-Burn		2017-Burn	
Oak Trees	Inside	Outside	Inside	Outside
A (<6")	26	14	40	43
B (6.1-12")	13	3	6	1
C (12.1-24")	2	0	0	0
D (>24")	0	0	0	0

In addition to tree seedlings, deer herbivory can also have an impact on understory layer species. We noticed substantial differences in the herbaceous species composition between the 2017-Burn site (Figure 5) and the 2021-Burn site (Figure 6). With the exception of woody shrubs, there were substantially more growth forms across all other categories at the burned site (Table 4). However, the recently burned site also had a drastically higher amount of invasive species (bittersweet, multiflora rose, Japanese honeysuckle, and Japanese stilt grass) compared to the unburned site (Figure 6). Thus, fire not only has some advantages for favoring oak and other understory plant species, but it can also favor invasive species. Fire could increase the vegetative cover, which would help restore native, fire-dependent plant communities; however, it may also invite more invasive species that may outcompete native species.

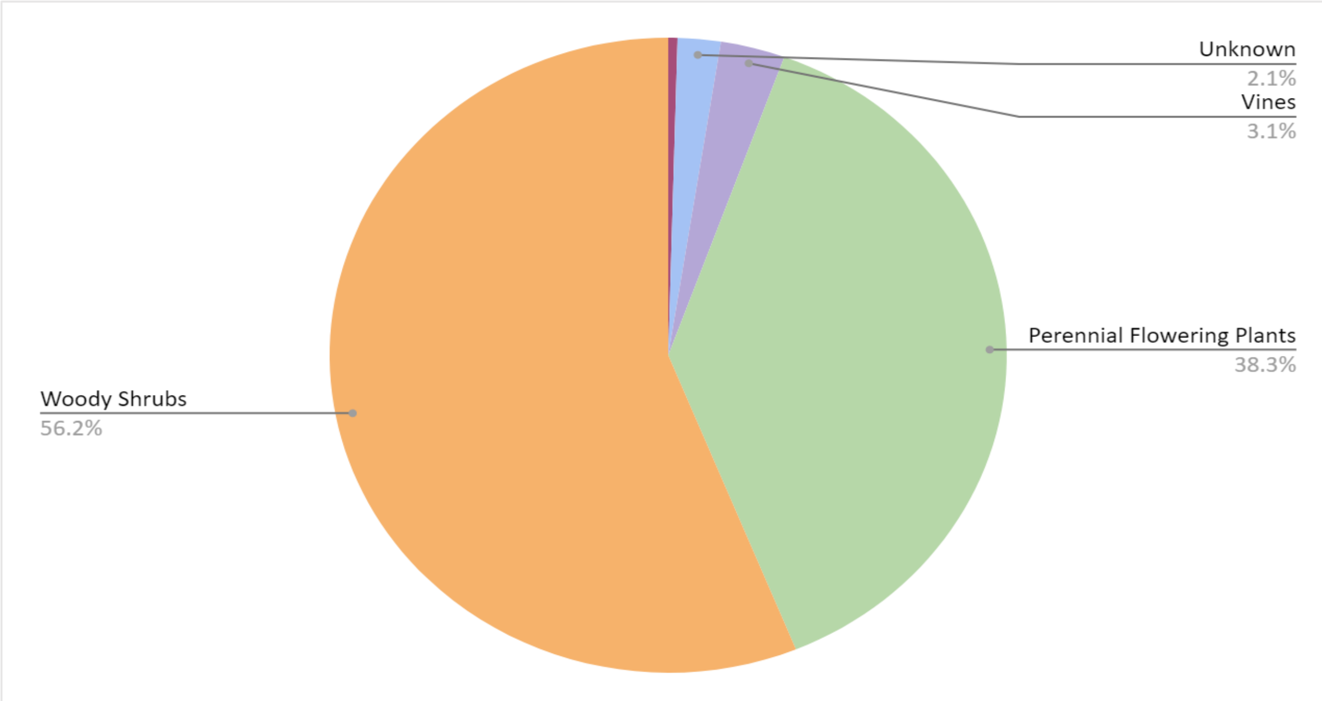

Figure 5. Total understory vegetation at the 2017-Burn site.

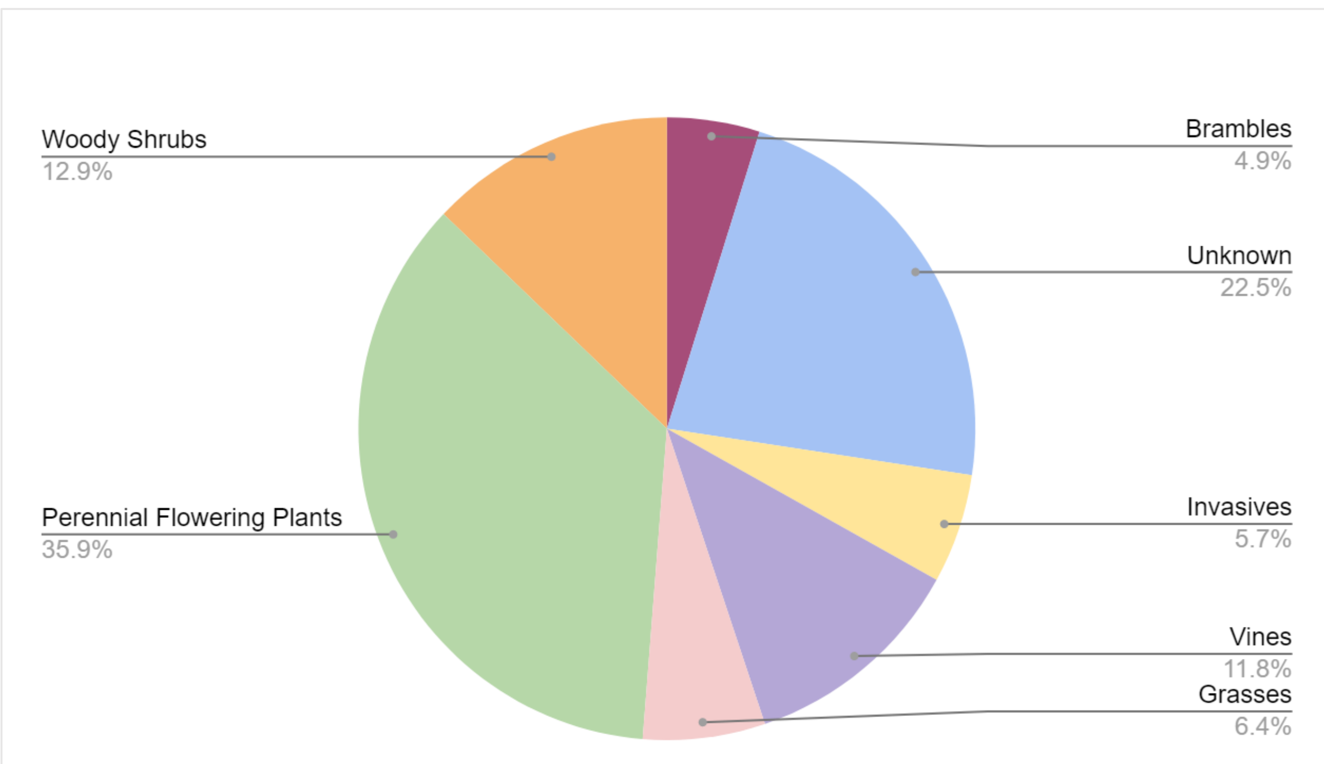

Figure 6. Total understory vegetation at the 2021-Burn site.

Table 4. Understory vegetation by category for exclosures and control area.

	2021-Burn			2017-Burn		
	Inside	Outside	Total	Inside	Outside	Total
Brambles	28	160	188	1	2	3
Unknown	656	216	872	0	14	14
Invasives	24	196	220	0	0	0
Vines	28	428	456	21	0	21
Grasses	0	248	248	0	0	0
Perennial Flowering Plants	700	688	1,388	76	185	261
Woody Shrubs	374	125	499	196	187	383

Conclusion

The deer exclosures appeared to have a positive effect on the overall survival and recruitment of the tree seedlings at both sites. The abundance of seedlings as a whole was larger outside of the exclosure. However, the individual seedlings inside the exclosures were generally taller at both sites. Furthermore, the data would concur that deer have preferences when it comes to browsing behavior. For instance, white oaks were only seen inside the 2021-Burned exclosure. Moreover, the overall abundance of red oaks was larger inside the exclosure at both sites. Thus, the deer exclosures appeared to have a positive impact on the growth and survival of tree species, particularly among oak species.

While this case study was conducted during the summertime, when food sources for deer are not limited, it provided valuable information on overall browsing behavior. Had the case study been conducted in the fall, the data could have been different. The data did show that oaks tended to be more abundant and more likely to reach a taller height category inside the exclosure. There was also a stark difference in the overall abundance of understory vegetation between the two sites.

Further research could be done on the effects of fire on regeneration by evaluating the growth, survival, and diversity of the understory of a forest floor before and after a prescribed burn. Utilizing prescribed fire can offer many benefits for both forest and wildlife management. However, this study also highlights the importance of monitoring for invasive species and taking appropriate management actions to control invasive species where possible.

This case study demonstrated that deer herbivory likely impacts forest regeneration in this area of the Matthews State Forest and can have potential implications on the composition of future forest stands. As deer populations increase within a given region, it would be expected that the impacts on regeneration of oaks and other species could be impacted more. However, it is not financially practical to construct deer exclosures from man-made materials around large areas of forest land. There are other case studies that would suggest using “slash walls” can be an effective means to create a barrier from browsing. Slash walls use logging residue rather than metal posts and wiring to make the barriers, which could be more cost-efficient (Smallidge et al. 2021). These exclosures demonstrate that there are, in fact, impacts to forest regeneration as a result of deer browsing. Landowners may want to consider deer population management as a component of their overall forest management plan. Depending on a landowner’s overall forest management goals, in areas with high deer populations, efforts to manage deer populations may be helpful in achieving their forest management objectives.

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