Journal of Ecological Research, **6**, 35-40 (2004)

EFFECTS OF WHITE-TAILED DEER (*Odocoileus virginianus)* BROWSING ON NORTHERN HARDWOOD FOREST REGENERATION

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ABSTRACT

There is an overpopulation of deer in the state of Pennsylvania. Currently, there are many different forest and deer management practices under employment. One of these is exclosure fencing. Our study examines the effectiveness of this practice on regeneration in hardwood forests. We collected data inside and outside of exclosures found in the area surrounding Raystown Lake. Our results suggest that exclosure fencing allows more successful understory regrowth.

Keywords: exclosure, Odocoileus virginianus, *regeneration, white-tailed deer*

INTRODUCTION

Since the early 1900s when the white-tailed deer population was at its lowest point due to unregulated hunting (Bowser 2003), there has been a huge explosion in the number of deer inhabiting Pennsylvania. Presently in the state, the white-tailed deer population approaches 1.4 million. Factors attributed to this enormous increase in the population include stricter hunting regulations (Stromayer 1997), conversion of agricultural land to new forest, and the abundant browse that was available to the deer from clearcuts (Bowser 2003).

There is concern that there may be too many deer in Pennsylvania. The forests adjoining Raystown Lake in Huntingdon County are no exception. The Pennsylvania State Game Commission recommends a maximum forest density of 21 deer per square mile; according to a 2003 study, an average of 48 deer per square mile inhabit the forests surrounding Raystown Lake (Bowser 2003). Of the eighteen areas where deer populations were observed, over half had more than double the recommended number, the highest recorded at 71 deer per square mile.

Such severe overpopulation can have a devastating impact on a forest. At high population densities, "deer browsing has been shown to have profound effects on establishment of regeneration, species composition, and density of hardwood seedlings" (Stromayer 1997). This is understandable, given that to survive a single whitetail must ingest about 8 pounds of browse- terminal buds of seedlings and young shrubs- daily throughout the winter (Krause 2004). A 10-year study by Boerner and Brinkmand led to the conclusion that "'deer browsing was more important than environmental gradients or climate factor in determining seedling longevity and mortality'" (quoted in Waller 1997).

Once the deer eliminate available browse from an area, if the density of deer remains high, there is little opportunity for new growth to occur. As time elapses the seed bank dwindles, other species take root, regeneration fails to take place, and reestablishment of hardwood seedlings becomes more difficult. Grasses and, more especially, ferns are unfavorable to hardwood seedling growth and success. When these and other new species are allowed to survive as a result of preferential browsing by the deer, the forest may achieve an alternate stable state. An alternate stable state is defined as "a stable condition in an ecological community at a different stage than that which would be predicted, based on the prevailing ecological and successional conditions" (Stromayer 1997). In Pennsylvania, severely overbrowsed forest locations are easily characterized by their conspicuous lack of understory (Waller 1997; Krause 2004).

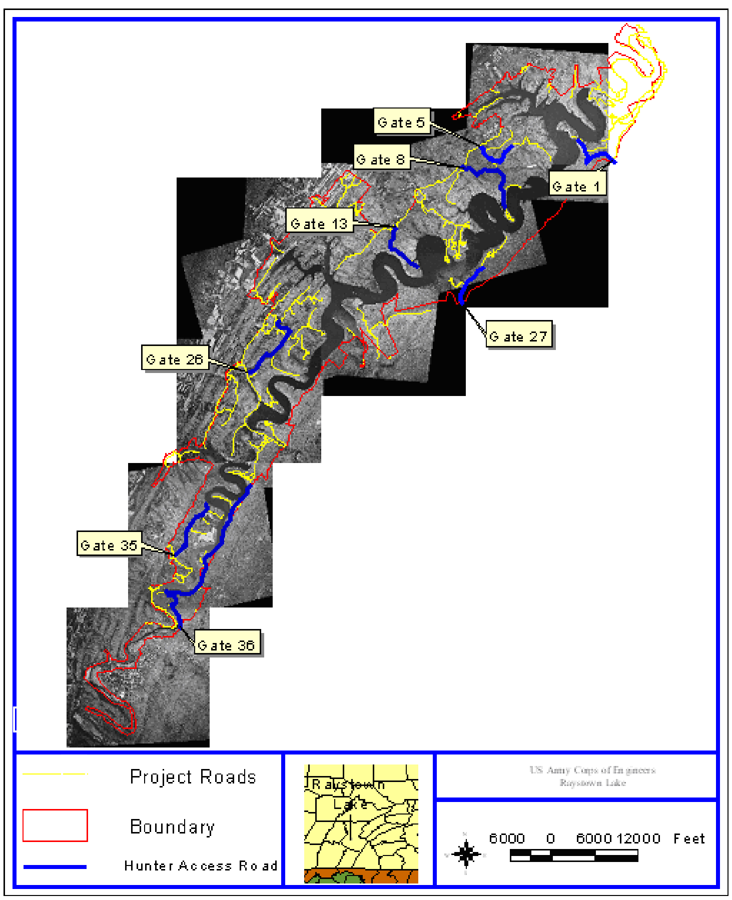
"As many woodlands suffer from excessive browsing, tree seedlings are unlikely to establish without protection unless deer numbers are controlled" (Harmer 2000). The United States Army Corp of Engineers, on their property bordering Raystown Lake, has attempted to control the rampant deer population through hunting as well as habitat management (Krause 2004). For example, clear-cutting has been done to increase the amount of browse available, and exclosure fencing has been erected around some of the cut areas to allow some of the seedlings a chance to survive. Our study examines the effectiveness of such fences in allowing the non-clearcut old growth forest to produce more browse. A significant increase in browse production will point to exclosure fencing as an appropriate and effective forest/deer management strategy.

METHODS AND MATERIALS

Field Site

This study was conducted in the forested mountains surrounding Raystown Lake, on land owned by the US Army Corps of Engineers in central Huntingdon County, Pennsylvania (see Figure 1).

Figure 1. Special Needs Access Gates and Roads at Raystown Lake.



The 22,000 acre forest surrounding the lake is generally considered to be a mature northern hardwood forest, primarily consisting of trees such as maple, birch, hemlock, beech, ash, oak, cherry, and pine (Bowser 2003). In some cases, it is described as an oak-hickory forest. In the areas we studied, the main species of trees evaluated were maple, oak, ash, beech, cherry, hickory, and flowering dogwood.

In 2000, as part of their Deer Management Project, the Army Corps installed 8ft high wire fences to make deer exclosures. Only on rare occasions would a deer be able to get past the fencing. Our study was conducted in and around one of these exclosures past Gate 35 on the western side of Raystown Lake (Figure 1). This exclosure was approximately 300ft by 600ft. One half had been clear cut and the other half remained old growth. We took samples only from the old growth portion, a 300ft by 300ft area called plot A (Figure 2 at end of paper). Samples were also taken from the area outside the fence surrounding plot A, named plot B (Figure 2). In the area surrounding these plots, the density of white-tailed deer is 38 deer per mi^2.

Data and samples collected from plots beyond Gate 36 on the eastern side of the lake were found within two smaller deer exclosures. Plot C enclosed approximately 20ft by 20ft. and plot D approximately 14ft by 14ft. Samples were taken from the area surrounding these exclosures; this was called plot E. On this side of the lake, the density of deer in the immediate area was 25 deer per mi^2.

Deer Browse

We collected data in early April, 2004, before the buds began to open. Twelve sites were chosen in both plots A and B. We used a grid and a random number chart to select the sites. Sites were shifted slightly when necessary to avoid streams and/or bulldozer tracks, as these sites would have been a misrepresentation of the plot.

To determine the extent of deer damage, the available browse for each of 5 species was analyzed within a 6ft radius of site center. The 5 species groups were classified based on known deer feeding preference (Krause 2004). Oak and maple are high preference; cherry, poplar/ash, are medium; birch/other species are of low preference. [“Other” included hickory, sassafras, dogwood and all other tree species]. Each sapling was counted and deer damage recorded. Multiple stems from a single plant counted as one sapling. Deer browse damage, obvious as a rough-edged removal of the terminal bud was distinguished from the clean cuts made by rabbits.

According to the protocol outlined by the Pennsylvania Game Commission, we evaluated the saplings for the level of browse damage exhibited: light, moderate, or heavy. Light browse was constituted by less than 50% of the terminal buds removed by deer. If more than 50% of the terminal buds on the sapling were removed, but the plant was not hedged, the sapling was considered moderately browsed. When more than 50% of the sapling’s terminal buds were removed and severe hedging was evident, the sapling was considered to be heavily browsed. Hedging occurs when the terminal bud is removed and, instead of being replaced by another single branch, it is replaced by multiple shoots. Consequently, the sapling resembles a bush instead of a tree.

In Plot C two random sites were chosen, in plot D one random site, and in plot E three random sites were chosen. The protocol used for plots A and B was followed in each of these three plots.

Browse Collection

In order to create an estimate of the amount of browse produced by an acre of fenced versus unfenced old growth habitat, we collected all available browse within three random sites in both the fenced plot A and in unfenced plot B. Browse was collected by clipping off the terminal bud and an equal amount of branch. This simulated the amount of damage a deer would cause to the plant. Browse was only collected from saplings less than five feet tall, as this is roughly the maximum height to which deer browse. After collection, the browse was stored in plastic bags in a freezer until it was able to be weighed. The three samples from each plot were averaged.

Statistical Analysis

Chi-square analyses were performed comparing the total number of saplings, preference levels of saplings, within and between all plots, the percentage of saplings belonging to each level of preference, and the browse production per acre in plots A and B.

RESULTS

Plot A had a significantly greater total sampling count than plot B. Plots C and D had a significantly greater number of saplings than plot E. Plot A had a significantly greater number of saplings than plots C and D. And plot B had a significantly higher count than plot E., as well.

In comparing browse mass produced by the fenced versus unfenced plot areas, Plot A yielded 1036 grams of browse per acre. Plot B produced only 322g/acre. Statistical tests showed that there was a highly significant difference between the two plots.

Percentage composition of plots A and B was compared at each preference level. To determine the percentage of saplings of a certain preference, the total number of saplings at each preference level was divided by the total number of saplings overall. At each level of preference, no significant difference was found.

Table 1. Data analyses using chi-square statistical test

Comparison	**Degree of Freedom**	**X^2**	**Significance***
Total sapling count in			
Plots A vs. B	1	12.56	P<0.01
Plots C & D vs. E	1	15.00	P<0.01
Plots C & D vs. A	1	430.8	P<0.01
Plot E vs. B	1	371.0	P<0.01
Browse Mass			
Plot A vs. B	1	362.2	P<0.01
Browse percentages in plot A vs. B:	1		
High preference	1	0.0502	NS
Medium preference	1	0.0152	NS
Low preference	1	0.0199	NS

*Chi-square values greater than the standard chi-squared at the 0.01 significance level were considered highly significant.

DISCUSSION

In Pennsylvania in general and in the Raystown Lake area in particular, the overpopulation of deer has reached a level of severity that requires some kind of management action. In the absence of some method of human intervention, there is little hope of forest understory regrowth. Without protection, forest habitats will quickly lose their capacity to support a viable deer population. Exclosure fencing, when installed in high deer-density areas of hardwood forest, is an effective approach to forest/deer management, allowing a significantly greater mass of browse than in areas that the deer are free to eat.

We found that the fenced plot A had both a greater number of saplings and produced more browse per acre than the adjacent plot B. This difference was statistically significant, indicating that exclosure fencing allows forests to produce more browse. The same results were found on the other side of Raystown Lake, fenced plots C and D supporting a significantly greater number of saplings than plot E.

When comparing unfenced areas, it was found that plot E had fewer saplings than plot B. This difference was highly significant, and visually obvious, as plot E was totally barren of saplings. Fenced areas compared across the lake (A vs. C and D) showed a highly significant difference as well. One explanation for these results is the discrepancy in deer density in the two areas. Surrounding plots A and B, the deer density is higher than around C, D, and E (Bowser 2003). With a higher browse production, it makes sense that that this area would support a greater deer density. The depletion on the eastern side of the lake could be attributed to a more sustained/severe overpopulation in the past. Once the land's ability to produce browse was impacted to a sufficient extent, the lack of food would cause the deer population to crash. A great enough overpopulation for a long length of time would also influence the land's ability to rebound.

Although there is a difference in the number of saplings in plots A and B, the composition of the plots in terms of preference is not statistically significant. Even though these areas produce the same plant species in comparable amounts, we believe it likely that, in the absence of deer management, the final forest make-up would be different. The high-preference saplings would be consumed at a greater rate and would therefore be eliminated, allowing low-preference species to dominate.

Our study supports deer exclosure fencing as a viable method of forest management that allows for successful regeneration of old growth forests.

The duration of this study did not allow us to address all angles of this research question or any of the closely related questions that stem from this one. The next obvious direction of inquiry would be to examine clear-cut areas by Gate 35, which were both fenced and unfenced. We would have thus been provided with data to compare the browse productivity and species composition of clear-cuts to non-clear-cut hardwood forest exclosures. Comparisons could have also been made between fenced and unfenced clear-cut areas could have been made in order to assess the benefits of exclosure fencing for promoting successful regrowth.

ACKNOWLEDGMENTS

We would like to express our gratitude to Chuck Yohn, who directed us to this project, and Jeff Krause, who not only donated a great deal of time but also provided us with the basic protocol and a wealth of valuable information. Thanks are also due to Chris, who gave us his internship paper as a source of necessary facts, and Chris, who gave us his time and a clear demonstration of the finer details of data collection.

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Figure 2. Diagram representing plots A and B.