

Management of white-tailed deer (*Odocoileus virginianus*) at Greenwoods Conservancy, Burlington, NY

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INTRODUCTION

Greenwoods Nature Conservancy is located in the town of Burlington, New York. It is a 1200+ acre nature preserve, under conservation easement, having a variety of ecosystems and wildlife. *Odocoileus virginianus* (white-tailed deer) is common in New York State, and Greenwoods offers them an ideal habitat. There is adequate shelter, corridors of cover between areas of shelter, limited hunting, and no main roads through the property. These benefits have allowed the deer population to thrive.

The Marcy-Volney powerline runs through Greenwoods Nature Conservancy. The Right-of-way under the powerline is regularly maintained and cleared of tall growing trees, allowing increased growth of smaller, shrubby species. This provides a source of winter browse for white-tailed deer on the property. Rights-of-way result in less protection through a loss of cover, but provide an important source of winter browse for deer populations (Doucet 1987). According to Doucet (1987), the exposed right-of-way may be less utilized during mild winters when adequate browse is available in less exposed areas, but during particularly severe winters, these open ROWs may become important to deer herd survival.

Greenwoods property is managed in accordance with its conservation easement, which incorporates the New York State Tax Law Management Plan. The Forest Stewardship Management Plan provides tax incentives to property owners who follow the management plans outlined by a professional forester. The land is then used for activities that protect the environment. The plan provides a schedule of activities and accomplishments to aid in providing good management practices for the forest and the wildlife. Some sections of the property which are ineligible for the management program (ponds, bogs and open fields) are managed for wildlife. A survey was conducted which divides the property by dominant tree type and size (Jones 2002). Dominant tree types for each zone are listed in Figure 1. Tree sizes were split up into three categories for the survey: Seedling sapling (ss), defined as less than 1 inch (2.5 cm) in diameter at breast height (dbh); pole timber (pt), between 1 inch (2.5 cm) and 5 inches (13 cm) dbh; and saw timber (st), which is at least 5 inches (12.7 cm) dbh for hardwoods and 9 inches (23 cm) dbh for softwoods (Southern Forest Resource Assessment undated). For the purpose of this project the saw timber and pole timber categories were combined into one category.

White-tailed deer are abundant throughout the eastern United States, including central New York. The purpose of this study is to determine the carrying capacity for a

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sustainable white-tailed deer population at Greenwoods Conservancy, using winter food supply as the limiting factor. This information may aid in future management of a self-sustaining population.

Natural History of Deer

Close to extirpation in the mid to late 1800s, white-tailed deer have successfully repopulated the northeast (Rue 1978). There is little data concerning the population of pre-colonial deer in the United States, creating difficulty in accurately determining whether or not they are overpopulated today (McShea et al. 1997). Predator control programs, in order to boost deer abundance, have led to increased deer populations. These increases have led to changes in plant biodiversity within deer habitats, including extirpation of plant species and slowing of succession (Schmitz 1997). Deer habitat has improved as farmland was abandoned during the twentieth century, and edge communities increased. Post-clearing succession provides another source of browse. New York State has approximately 209 million acres of abandoned farm land (Dunn 1999). Many estimates state that sustainable deer populations are approximately 10 deer/mi², and ecosystems begin to be impaired at 15-20/mi² (Rue 1978), though these figures do not distinguish between region or ecosystem. Problems, such as parasites, disease and malnutrition increase as herds become overcrowded (Rue 1978). During summer months vegetation is abundant, but becomes limiting during the winter when only woody browse is available. Winter becomes a critical time for deer; not only is food less abundant, but both protein levels and digestibility of nutrients within the browse decreases (25-40% and 12% respectively) (Rue 1978). Deer feed selectively on high protein foods, ignoring those with lower protein content. When these high protein foods run out, “stuffer”, or starvation foods, are their only option. It is not uncommon to find deer who have died of starvation while full of “stuffer” foods (Rue 1978).

Once snow cover reaches >30 cm deer tend to winter within yards. Yards are usually found at lower elevation coniferous stands, on south facing slopes. Yarding is an excellent form of energy conservation because snow depth is less, communal trails are used, there are lower wind and temperature ranges and higher temperature and humidity. Restricted movement is observed in deer starting around 25-30 cm of snow; they are completely confined to the yard at 50 cm. Snow forces a shift in diet as herbaceous vegetation is no longer available. Thermoregulation becomes an important factor for the deer as energy intake is reduced. Deer tend to avoid the younger, less covered stands, preferring mixed wood stands at all snow depths (Sabine 2001). During the deep snows, deer will remain within the yards, facing starvation rather than risk exposure. The less energy they expend during this time, the less they need to replace with food. Deer in good condition typically lose an average of 12-15% of their body weight during the winter; 33% body weight loss usually results in death (Rue 1978).

Preferred browse size varies from 4.17 mm diameter for red maple to 1.26 mm diameter for gray birch. During times of starvation, deer will eat larger twigs, as the younger, smaller and more nutritious browse is removed. The highest nutrient and protein

levels are found in the bark, making larger browse much less efficient, because the larger diameter twigs have less bark per volume. During winter months, twigs must be defrosted during digestion, requiring more energy expenditure for little more nutrition, which can also lead to starvation. Dehydration can be fatal when deer become secluded within yards and are forced to eat snow for water. During starvation times, deer will stand on their hind legs to reach higher browse. Fawns can reach up to 1.5 m, and larger bucks up to 2 m. Higher browse lines are a sign of starvation (Rue 1978).

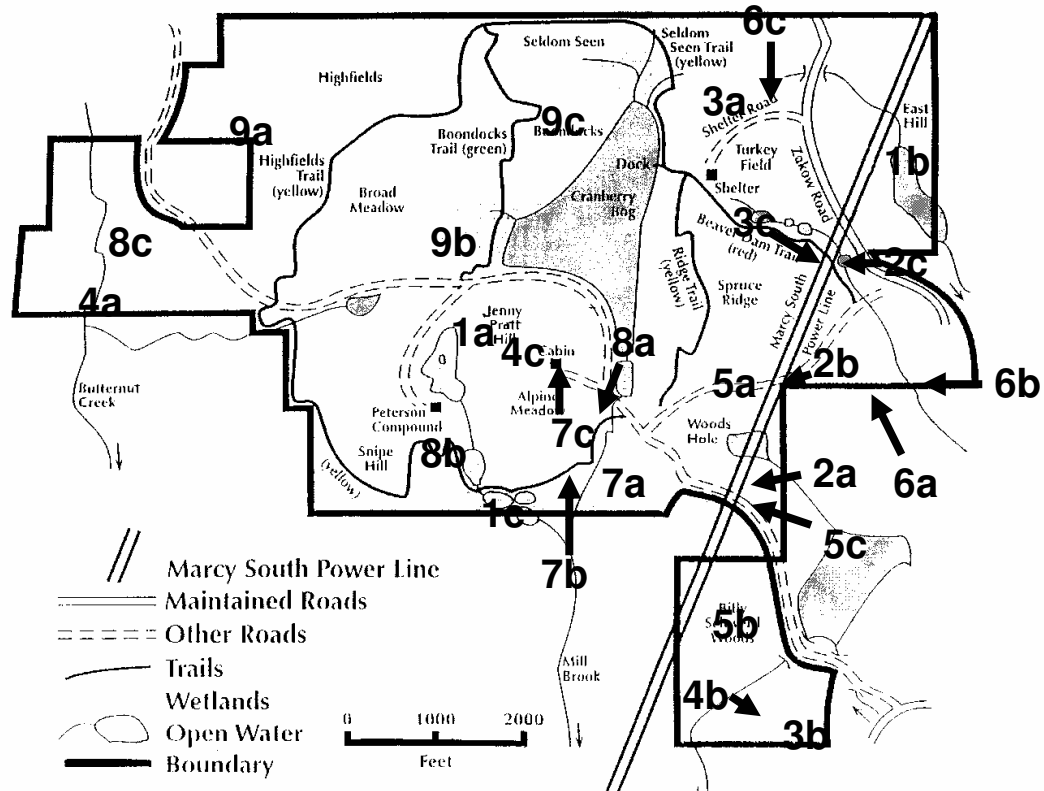
Deer feed selectively on easily digestible, high nutrition browse. Browse can be split up into categories of preferred browse, second choice browse (readily eaten) and starvation browse. Preferred browse includes white cedar (*Thuja occidentalis*), striped maple (*Acer pennsylvanicum*), red maple (*Acer rubrum*), dogwoods (*Cornus* spp.) and blueberry (*Vaccinium*); second choice consists of hemlock (*Tsuga canadensis*), nannyberry (*Viburnum*), cranberry (*Vaccinium macrocarpon*), white ash (*Fraxinus americana*), sugar maple (*Acer saccharum*) and northern arrowwood (*Viburnum recognitum*). Starvation foods include aspens (*Populus*), blackberry and raspberry (*Rubus* spp.), pine (*Pinus*) and spruce (*Picea*) (Doig 1968). Several conditions must be met for deer population to remain healthy during the winter, including adequate cover, food supply and a water source.

METHODS

Using forest survey data for Greenwoods under the New York State Tax Law Management Plan (Jones 2002), forest types were mapped out for the property. Greenwoods property is managed for saw timber and wood products, wildlife habitat, research and education. Forest types within Greenwoods were mapped in order to determine which silviculture methods should be implemented (Jones 2002). Three sections for each of the 9 forest types were chosen at random; within each section a plot was randomly chosen. This created 27 random plots, three for each forest type. Figure 1 shows location of the plots at Greenwoods and briefly describes the forest types. The portion of the property not characterized ("Un-surveyed") had total area measured by the survey, but no distinctions between forest and open field. Using aerial photos, comparisons were made between open field and forested land within the section. By photocopying aerial photos onto graph paper, the fields and forests were both cut out and weighed. These measurements were then used to determine total area (Table 1).

Plot sites were given a label with a number representing the forest type, and a letter designating which of the three plots for that forest type was assigned. At each site a 1 by 10 meter plot was laid out. All woody vegetation within the plot was counted by species and size was recorded. Size data were categorized as <1m, 1-2m, 2-5m and 5+m. Also noted was whether or not there was new growth available to be clipped. Clipped twigs were ultimately used to estimate available browse. Twigs were not clipped above 1.5 m because those above that are not available as browse (Rue 1978). New growth was clipped to the first bud scar, as that portion is considered as adequate browse (Higgins et al. 1996). Twig diameter was taken into account because deer prefer specific twig sizes

for maximum nutrition with least energy expended; smaller diameter browse provides more nutrition per unit volume since most nutrition is associated with bark material. Using measurements given by Rue (1978), twigs of preferable browse size were selected. Table 2 provides the maximum twig size collected for each plant species (according to Rue 1978). Samples were refrigerated until processed in the lab. Table 3 gives the volume of browse required per day by deer of various sizes (Dasmann 1981).



Forest Types:

1. Northern hardwood seedling/sapling
2. Right-of-way
3. Northern hardwood saw timber/pole timber
4. Hemlock-northern hardwood
5. Norway spruce saw timber/pole timber
6. Pioneer hardwood
7. Norway spruce seedling/sapling
8. Red pine/scotch pine
9. Un-surveyed property

Figure 1: Map of Greenwoods showing plot sites and list of forest types found in Greenwoods.

	Percent of total	Acres	Square meters
Total area	100	271	1,096,170
Forest	72.4	196	793,630
Field	27.6	75	302,540

Table 1. Determination of forest area vs. open field area in un-surveyed land, using percentage comparisons.

Vegetation	Maximum diameter(mm)
Hickory	2.0
Red Maple	3.5
Black Cherry	2.0
Chokecherry	2.0
Striped Maple	3.0
White ash	3.0
Arrowwood	3.0
Y. Birch	1.5
Nannyberry	3.0

Table 2. Maximum twig sizes that were included in the sample measurement; based on Rue (1978).

Deer weight (lb/kg)	Air-dried forage need per day (lb/kg)
100 (45)	2.80 (1.27)
150 (68)	3.88 (1.76)
200 (91)	4.78 (2.17)
250 (113)	5.63 (2.55)
300 (136)	6.43 (2.91)

Table 3. Food requirements of white-tailed deer by live weight (Dasmann, 1981).

When clipping was complete, leaves were removed and the twigs were oven-dried overnight at 100 C°. Samples were weighed and mean biomass was determined for each species, within each plot (according to Higgins et. al. 1996). After the samples were weighed, the data were separated by forest type and species and recorded. With data on average deer browse consumption from Dasmann (1981), an estimate was made as to the sustainable population of white-tailed deer on Greenwoods Conservancy.

RESULTS AND DISCUSSION

Using the data collected, each forest type was analyzed based on the total number of plants of each species and the mean weight of available browse. Figures 2a-i summarize the number of plants of each potential browse species present in each plot, the number of those plants having available browse and the weight (g) of browse actually available (i.e., twigs within 1.5 m of the ground). Using data collected from the plots, the total number of browse vegetation was extrapolated out to each corresponding forest type. It became clear that white ash is the most common species, followed by northern arrowwood, sugar maple, red maple and meadowsweet. Available browse by weight allows recognition of those species with the most available growth. This shows that although white ash is the most common “browse” species, it has much less available growth than does northern arrowwood.

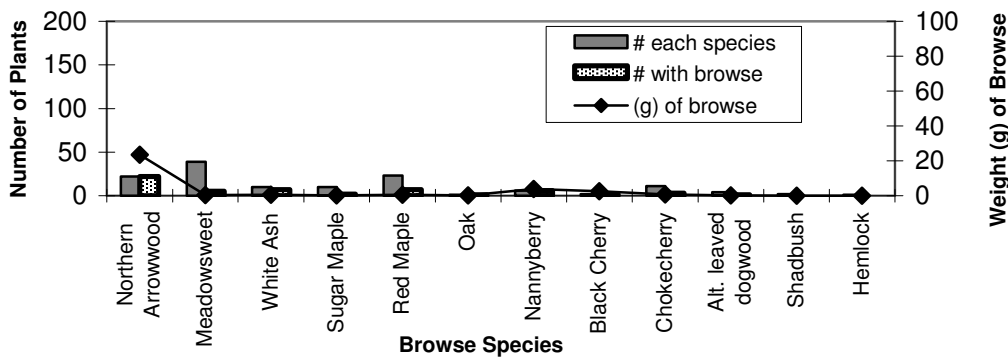


Figure 2a. Northern Hardwood seedling/sapling forest (type 1; see Figure 1). Moderate woody plant density, but relatively low browse availability, with the exception of northern arrowwood.

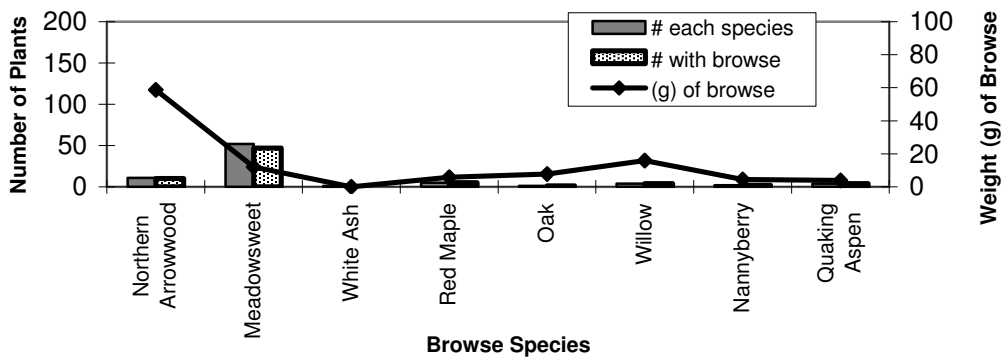


Figure 2b. Right-of-way (type 2; see Figure 1). Moderate-high available browse, but low woody plant diversity and density.

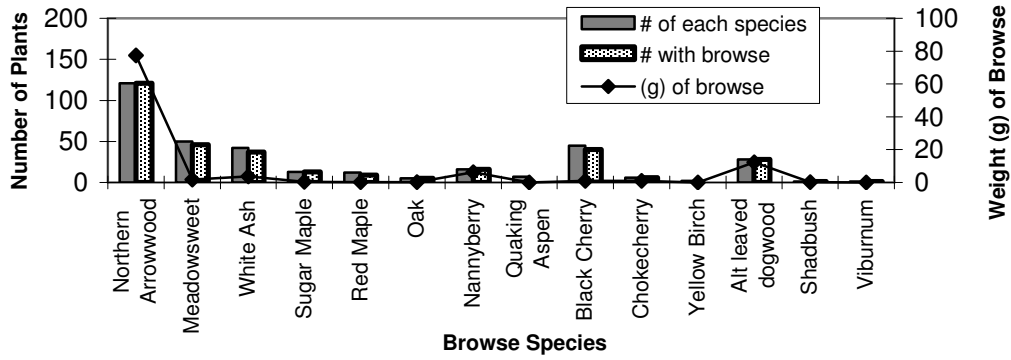


Figure 2c. Northern Hardwood saw timber/pole timber (type 3; see Figure 1). Moderate-high diversity with a moderate density, relatively high amount of browse, especially northern arrowwood.

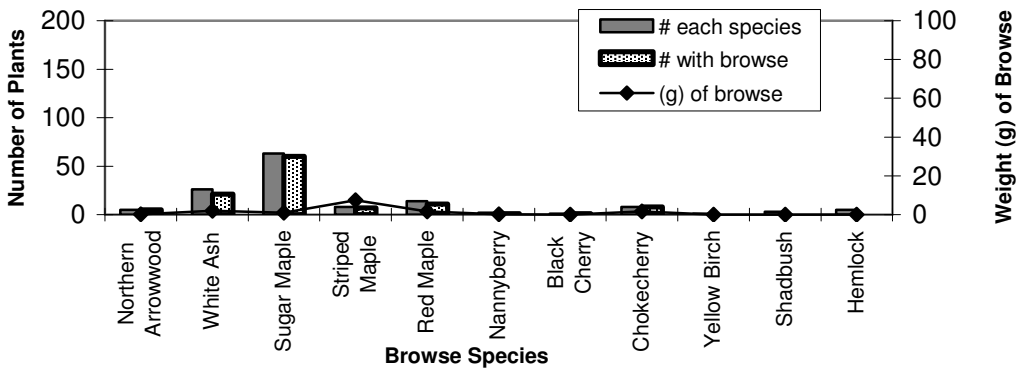


Figure 2d. Hemlock-Northern Hardwood Forest (type 4; see Figure 1). Low browse quantity but high number of species with browse, suggesting they are not producing a significant amount, or the browse is out of reach.

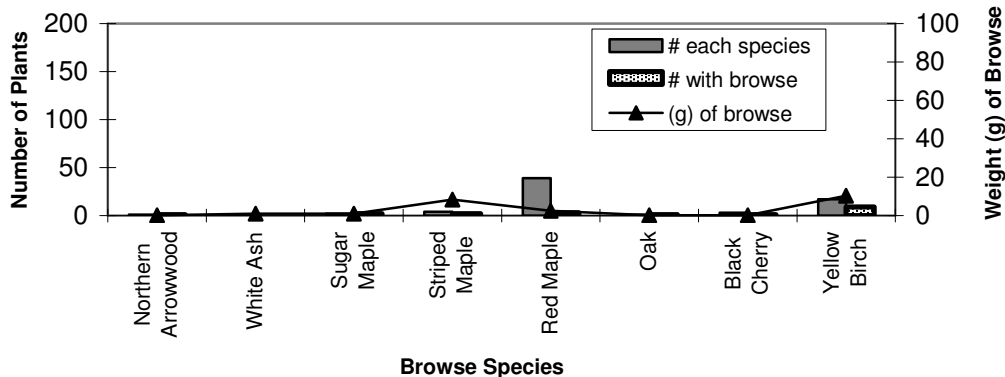


Figure 2e. Norway Spruce saw timber/pole timber Forest (type 5; see Figure 1). Low browse quantities and woody vegetation density.

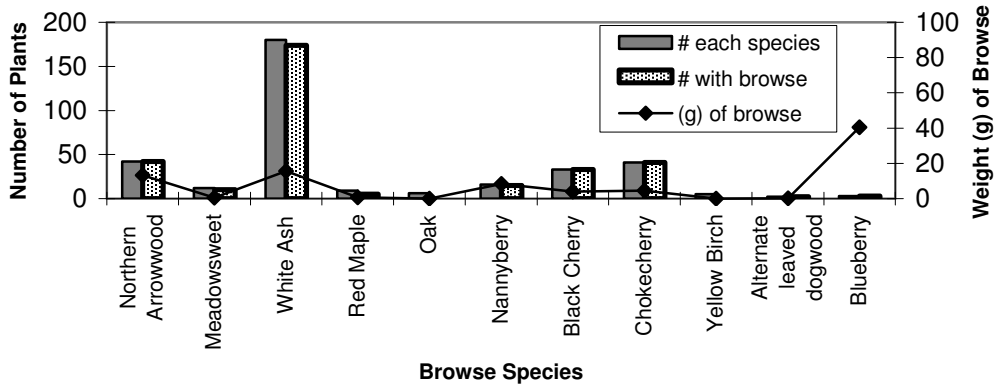


Figure 2f. Pioneer Hardwood Forest (type 6; see Figure 1). Moderate to high woody vegetation population; moderate to low available browse.



Figure 2g. Norway Spruce seedling/sapling Forest (type 7; see Figure 1). Extremely low browse quantity, diversity and density.

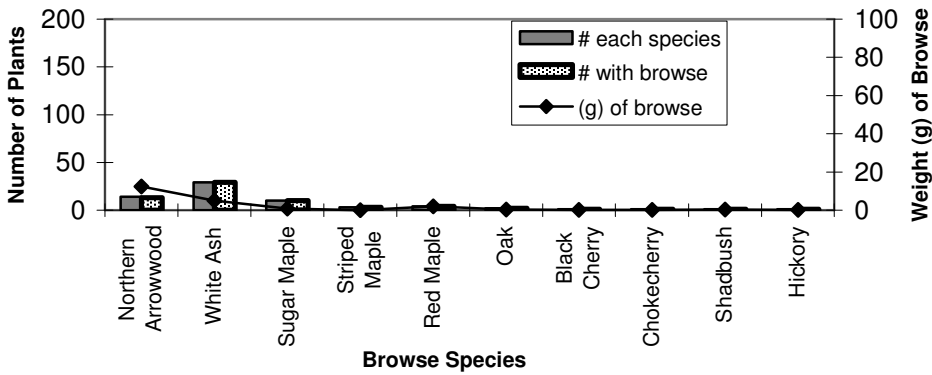


Figure 2h. Red Pine-Scotch Pine Forest (type 8; see Figure 1). Low browse availability.

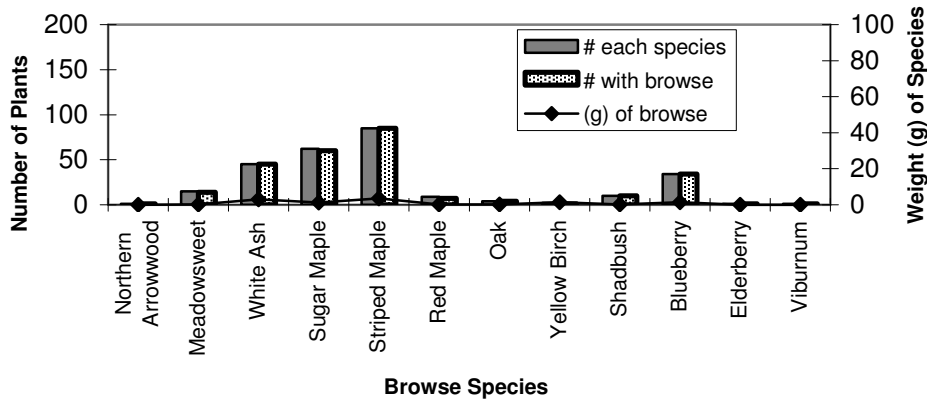


Figure 2i. Un-surveyed Land (type 9; see Figure 1). High numbers of browse plants and moderate diversity, but low browse availability.

Figure 3, an extrapolation the aforementioned data, summarizes the number of each plant species considered and estimates the amount of browse available by those species for all of Greenwoods Conservancy. These two parameters are not necessarily correlated. For example, whereas white ash and maples are quite numerous, they provide minimal browse. Conversely, northern arrowwood provides a much higher volume of browse per plant. Figure 4 provides the same data (number of browse species and volume of browse available) based upon forest type. This information provides insight as to where the most substantial food sources are located. This chart suggests that although Northern Hardwood seedling/sapling stands have less vegetation overall, they contain a high amount of available browse; the Un-surveyed land has a high vegetation population, with very little available browse.

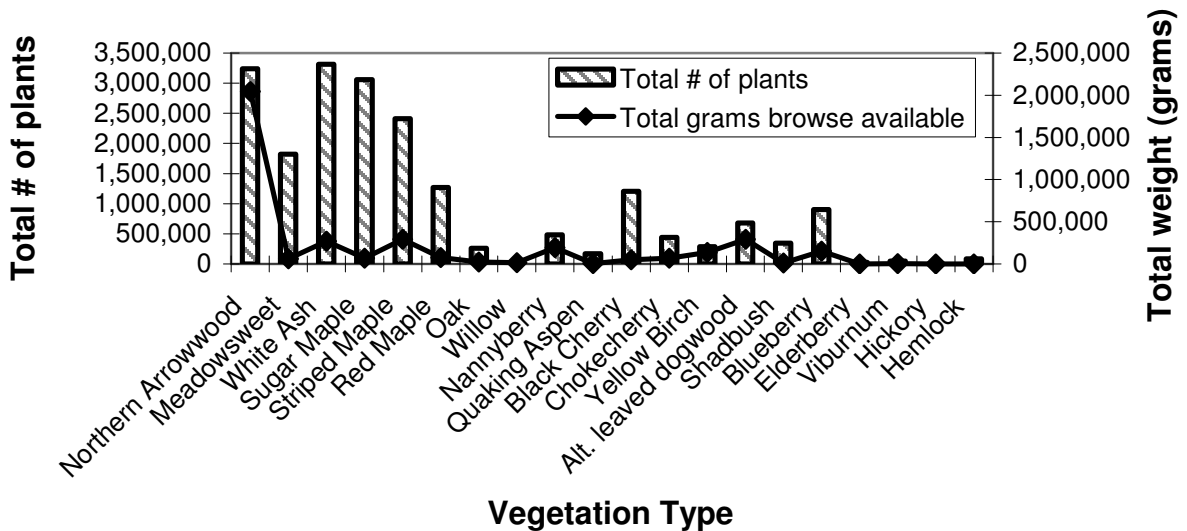


Figure 3. Total number of browse species present and total grams of browse available per species available at Greenwoods Conservancy.

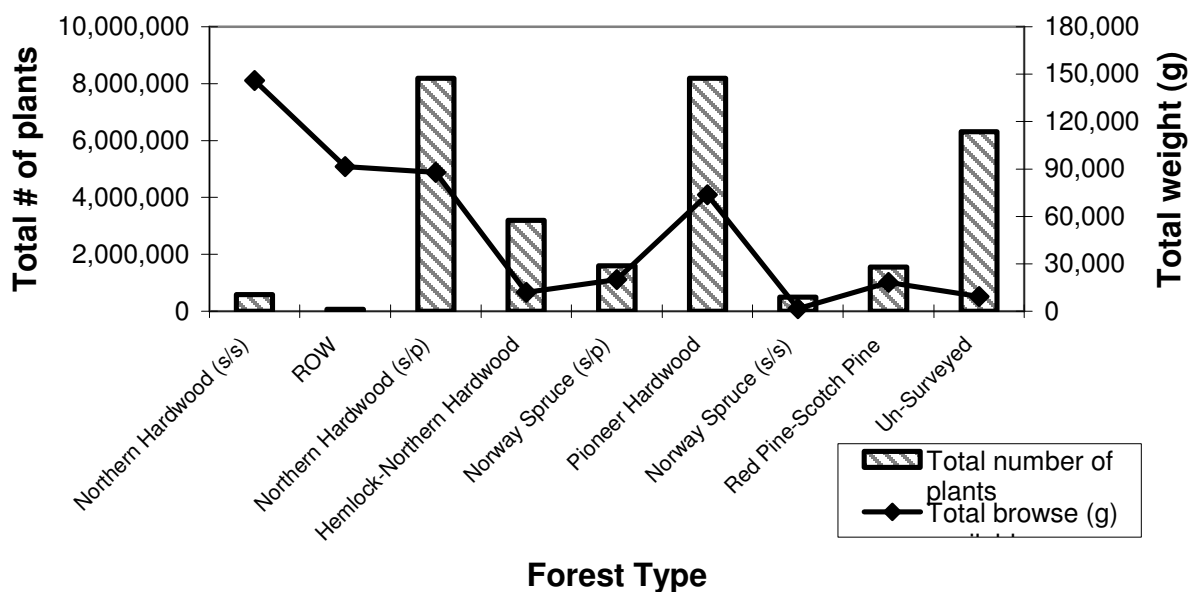


Figure 4. Number of browse plants and total volume of available browse (g) by forest type throughout Greenwoods Conservancy (see Figure 1 for forest type explanations).

Using these data, preliminary assumptions can be made about the deer habitat provided on the property. Some notable problems which arose during this study should be considered in future research. Browse samples should be taken later in the year, preferably around the first snowfall, to account for the entire browse resource available for the winter. Also, edge communities and bogs were not surveyed, both of which provide food to wintering deer. Few considerations were made concerning the vicinity of yarding areas to food and water sources.

CONCLUSIONS

- (1) In order to determine a *sustainable* carrying capacity, the amount of browse that specific plants can withstand without suffering permanent damage should be considered. Because of the early sampling (before the completion of new growth), estimates provided here are likely low. The initial results do not take anything into account other than the amount of new growth compared to what deer must eat daily to survive. For the purpose of estimating a sustainable herd size, some assumptions were made. First, that winter ranges from December 21 to March 20, or 120 days. Second, that the average live weight is 150 lbs. (68 kg), in order to account for doe, bucks and fawns. A 150 lb (68 kg) deer must eat around 3.88 lbs. per day (see Table 3), so one deer requires approximately 465.6 lbs (211 kg) of browse per 120 day winter. Therefore, given the amount of browse available (estimated to be 4,220 kg, or 9,300 lbs), the estimated carrying capacity for white-

tailed deer at Greenwoods Conservancy is 20 deer. This number seems reasonable as the average sustainable number of deer per mile² according to Rue (1978) is 10. Greenwoods covers approximately 1,100 acres (1.7 miles²), giving a population density of 12 deer per mile².

- (2) What are the most/least available browse species at Greenwoods? This can be considered from two perspectives, the number of browse species and the total weight of new growth. While white ash and maples were the most common browse species encountered, the clipped weight data indicate that northern arrowwood has the most available browse in terms of new growth (see Figure 3).
- (3) Which forest types have the most/least sources of browse (see Figure 4)? Northern Hardwood seedling/sapling stands contain the most significant amount of available browse in new growth, with much lesser species abundance (<1 million individual plants and over 8 million grams of browse). Northern Hardwood saw timber/pole timber and Pioneer Hardwood stands have similar abundances (approximately 8 million individual plants) and available browse (4-5 million grams).
- (4) How does the Right-of-way affect deer and deer browse during the winter? According to Doucet, et al. (1987), deer became less mobile when snow depths approach 50 cm. During the winter deer require cover and the deep snow restricts them to areas in close proximity to the yards, which can lead to starvation as adjacent food sources are overbrowsed, leaving other food sources untouched. Although the ROW reduces cover it increases available browse. Deer activity was lower in the ROW than in the adjacent cover, though there was considerable feeding within the ROW. Doucet's (1987) research concluded that deer will leave areas of cover in order to obtain browse within the ROW. Even so, during mild or moderate winters, the ROW may be under utilized for browse in areas that are less exposed (Doucet et al. 1987). The Right-of-way at Greenwoods contains relatively few browse species, but has the second highest amount of available browse for the property. This shows that the Right-of-Way improves the deer habitat in terms of food availability.
- (5) Can Greenwoods property support its deer population? In several areas of Greenwoods signs of overbrowsing were observed. This included browse on spruce trees, yellow birch twigs greater than 10 mm in diameter, and a lack of understory in certain areas. However, these areas of increased browse generally occurred adjacent to areas of suitable winter yards. It is expected, after last winter's severe weather, that food shortages and seclusion to yards would have occurred more than usual. Therefore it was not surprising to find such evidence of starvation in a normally very suitable habitat.

This project merely touched on one aspect of the deer population at Greenwoods Nature Conservancy. There are several other aspects which can and should be evaluated in order to truly determine the health and sustainability of the habitat. Other possible projects include browse survey, habitat survey and a study of the ROW effect on the deer population.

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