Assessing the carrying capacity of the white-tailed deer (*Odocoileus virginanus)* herd at Rider Park, Lycoming County

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Abstract

Deer density studies are of particular importance in protected nature preserves that often harbor overabundance of organisms otherwise controlled through human associations. This is the first year of a long-term deer damage study in Rider Park, just outside of Williamsport, Pa. This land had previously been open to recreational hunting, but all hunting has now been prohibited within the park boundaries for nine years. This study quantified damage to woody and herbaceous components of the park's ecosystem and used these numbers to create environmentally dependent carrying capacity numbers. A 950 square meter exclosure was erected on the property and inventory of herbaceous plants inside and outside the exclosure were taken and used to determine similarity of the two environments. A total of 5 tree and 12 herbaceous plant species were found at these sites, and there was an 81.7% similarity between the two sites with respect to trees and an 87.8% similarity between the two sites with respect to herbaceous materials. The most dominant vegetation in the area is hay-scented fern and the most dominant tree was sugar maple. Deer browse of woody vegetation was studied in November and January and used to determine the amount of available biomass. This biomass was then used to calculate habitat sensitive carrying capacity numbers for twelve sites in the park. Carrying capacity averaged 47 deer per square mile in November and decreased to 7 deer per square mile in January. Percent browsed remained constant from November (70%) to January (71%). These carrying capacity calculations were compared with deer drive and scat population survey numbers to determine the severity of deer overpopulation within the park boundary. The population estimate of 63 deer per square mile within the park greatly exceeds the carrying capacity calculated. The dominance of hay-scented fern and other non-palatable deer species in the area illustrate that deer damage is present in the park. This is, however, the first year in a long-term study, and management decisions cannot be properly made until more data is collected.

Introduction

White-tailed deer populations have been studied carefully in many parts of the northeastern United States for both their recreational and ecological importance (Diefenbach 1997A). It is the differences between these two categories that cause much of the controversy in forest management decisions, particularly Pennsylvania forests. The white-tailed deer is considered a keystone species in Pennsylvania. Keystone species largely alter community structures by affecting abundance and distribution of many other animal and plant species, modifies the abundance between competing species, and affects species abundance at multiple trophic levels (Waller 1996).

In Pennsylvania, 58% of land is classified as forestland, much of that 58% being categorized as commercial (Marquis 1981). Pennsylvania's forest structure differs per region, but the overall forest composition is shifting from seedling-sapling timber to older aged timber. This shift is causing decreases in the amount of deer that the forests can naturally support without sustaining severe damage (Diefenbach 1997A). However, natural predator elimination and Pennsylvania deer management history has yielded a large present day herd (deCalesta 1993). It is this large herd number that has caused much controversy in Pennsylvania's historical and present game management practices.

The history of white-tailed deer management is Pennsylvania has been a tumultuous one. Starting in the late 1800's, deer numbers were very low due to open hunting environments that were not regulated by the Game Commission. At the same time, much of Pennsylvania's forests were being clear-cut for their valuable timber.

Subsequent protection and stocking of deer by the Pennsylvania Game Commission and new forage availability in previously clear cut areas led to an explosion in the deer population. This explosion was so great that there were incidents of mass deer starvation in the mid to late 1920's. This situation prompted the game commission to institute several anterless deer seasons during the next fifteen years. The deer population decreased, but pressure to decrease deer numbers was lessened between 1950-1980, allowing the herd to increase again. In 1979, the Game Commission first instituted deer density goals calling for a herd reduction to an optimum state-wide level. Since then, anterless harvests have been insufficient to decrease deer numbers and the buck harvest has peaked in the 1980's and then declined. In 1988, the Game Commission instituted the statewide "bonus deer program" that permitted hunters to harvest more than the allotted one deer per season. In 1997, the Game Commission formally recognized the threat that the deer are posing to Pennsylvania's forests and instituted the Deer Management Outreach Committee to promote better deer management understanding of deer management. A Deer Management Section within the Research Division of the Bureau of Wildlife Management was created in 1999, and several new policies are expected in the 2001 hunting season (PA Game Commission 1999).

Deer are perceived as overabundant if they limit a resource's availability or interfere with a valued process, either ecological or social (Healy 1997). This overabundance has been proven to cause both social and natural problems in Pennsylvania. Most easily recognized are those problems that interfere with our social lives. There has been an estimated 40,000 collisions between deer and personal automobiles every year in Pennsylvania (Jones 1993). Damages to agricultural crops by deer in Pennsylvania averages around $80 million dollars per year (Jones 1993). Deer threaten the timber industry by consuming desirable tree seedlings and allowing less desirable ones to grow in its place (Marquis 1981). Personal property damage has also been an issue of many residents in high deer density areas.

Within Pennsylvania's forests, deer produce a detrimental effect. Deer overabundance has been linked to a decrease of plant and tree biodiversity within forests; biodiversity is defined as the sum of component densities of woody, herbaceous and wildlife communities (deCalesta 1993). The Pennsylvania Natural Diversity Inventory has 290 species of native vascular plants listed as extirpated, endangered or threatened (Rhoads 1992). Deer most likely play a key role in this standing. Deer have been shown to have impacts on both specific woody and herbaceous plant species as well as overall plant community structure (Waller 1997). The abundance as well as the percent ground covered by wildflowers decreased in response to increasing deer densities, some beginning at 10 deer/ sq. mi. (deCalesta 1992A, deCalesta 1993). Lily and orchids accounted for nearly 40% of all herbaceous plants damaged by deer (Rhoads 1992). In addition to decreasing wildflower amounts, the percent of ground cover composed of ferns and grasses increases as deer densities increase. This keeps the total percent ground cover steady (deCalesta 1993).

Tree species within a forest are also greatly impacted by increasing deer densities. In undisturbed, overpopulated stands, understory cover is sparse in cut areas and new seedlings are severely browsed in very high deer density areas (Marquis 1981). Species richness, density, and height of tree seedlings decreased as a result of an area's increasing deer numbers (deCalesta 1992A, deCalesta 1993, Marquis 1981).

Wildlife in an area are affected by decreases of plant material. Songbird numbers, for example, decrease with increased deer densities (deCalesta 1993). It has been speculated that overwinter deer carrying capacity numbers established by the Game Commission to allow for tree regeneration may not be adequate to protect endangered plant or other wildlife species such as reptiles, amphibians, insects and other invertebrates (Diefenbach 1997A, Rhoads 1992).

Rider Park is a private park in which hunting has not been permitted for nine years. Because it is a small area of protected land (860 acres) amidst areas on which hunting is permitted, deer impact in this area is a subject of great interest. Hunting is the primary deer management tool at use in the state, and only about 15% of Pennsylvania's land areas are open to recreational hunting (Diefenbach 1997A). The primary challenge for deer management in protected areas is to determine whether the deer population levels are acceptable for the area's objectives and if the impact they are having are affecting the area's integrity of the resources or impacting management goals and objectives (Coffey 1997). Overabundance in private areas will be ultimately defined based upon a value judgement (Healy 1997).

The goal of this project is to study the impact upon the vegetation in Rider Park. Through the use of several study methods, including exclosure work and browse surveys, data will be gathered that may help influence future management decisions within the park. Over the course of several years, cumulative data will help determine if the park's white-tail deer herd is damaging the park's natural assets and threatening its place as a nature preserve.

Methods

The study site was located at Rider Park, 1.3 miles north of Warrensville Road, Pennsylvania at a longitude of 41° 78', latitude of 76° 56' and an elevation of 1136 feet (Figure 1). It is approximately 900 acres and shares its borders with Tiadaghton State Forest, privately owned hunt clubs and Loyalsock Creek. The park's terrain is mainly gently sloping to very steep well drained soils on hills and ridges (USDA 1986). Previous studies have determined the park's continuum index value to be 1567, and the forest is mainly composed of birch, maple, oak and hemlock (Appendix I; Foran and Clayton 1997). The closer the continuum index value is to 3000, the closer the forest is to a mature climax community (James & Shugart 1970). It is a public access park that has several trails and is used in all seasons for recreation. No hunting has been permitted in the park since 1990.

Deer Drive

Deer drives have been carried out in the park for the last three years. Deer drive techniques included the driving of a 110 acre section , and extrapolating the number of deer seen exiting the area to yield total deer/square mile. A minimum of 60 students was used for each drive. Students were placed around the periphery of the drive areas and were also used to create a drive line through the area.

Exclosure Analysis

An 8 foot tall woven wire exclosure encompassing approximately 950 sq. meters was erected September 1999, located at 41° 20.99'N and 076° 55.84' W. Within the exclosure, fern densities were first determined. Using a random number table, 10 square meter plots were selected and marked with a wooden frame. Within this frame, all ferns with stems originating within the frame were counted. Fern density per square meter was then calculated. Using the same random selection method, 28 square meter plots were analyzed for total herbaceous plant content. Within each random square meter, all plants, regardless of their height were counted and catalogued. All trees within the exclosure were identified, recorded and diameter breast height measurements taken with a reach stick with a Biltmore scale. Temperature at the exclosure was recorded using a HOBO XT every two hours for 150 days between October 12, 1999 and March 10, 2000.

The tenth acre circle method was utilized to study the vegetation outside of the exclosure. Five circles located within sight distance of the exclosure were chosen to study the relationship between the exclosure and the surrounding forest. Tenth acre circle centers were randomly selected and a calibrated measure wire was used to determine the boundary of the circle. All trees within the circle were identified and classified by diameter breast height using a Biltmore reach stick. Shrub density was determined by making two transects at right angles across the circle and counting the number of woody stems less than 4 inches in diameter encountered by two outstretched arms. This number was multiplied by 10 to give an estimate of shrubs for the entire circle. Percent canopy and ground cover were determined by 20 random sightings through an ocular tube. Tree height of the tallest tree was determined by triangulation (James & Shughart 1970). Within each circle, four random square meter plots were chosen and all herbaceous growth contained within was identified and recorded.

Using the plant and tree data from the tenth acre circles and the exclosure, the species were tested for diversity using the Shannon Wiener Index for evenness and the Simpson Index for species richness. The Shannon Weiner formula is :

$$H'=-\sum_{i=1}^{s}(n_i/N)\log(n_i/N)$$

where n_i is the number of organisms collected to the ith species, N is the total number of individuals in the species, and s equals the total number of species in the sample. The Simpson formula is:

$$C=1-\sum_{i=1}^{s}(n_i/N)^2$$

where the symbols represent the same as the Shannon Weiner. A Jaccard Index number relating the similarity between two community structures were calculated using the equation:

$$SC_j=c/A=B-c$$

where c is the number of common species, A is the total number of species in stand A, and B is the total number of species in stand B. An index of percent similarity was also calculated for the two stands, using:

$$\text{percent presence}=\frac{\text{\# of individuals in a species}}{\text{total \# of individuals in a community}}$$

percent presence= number of individual of a species/total number of individuals in a community. The lowest percentage for each species is determined and used to calculate similarity by the following equation:

PS=F(lowest percentage for each species)

For the tree species inside and outside of the exclosure, relative density, relative dominance and relative frequency were calculated along with respective importance values. Formal presentations of all of these formulas are found in Lycoming College Biology 224 Ecology Lab Manual (Zimmerman 1993).

Browse Survey

Twelve sites were chosen for November and February browse studies. Their respective locations are located in a map in Figure 1. Coordinates of each site were taken using a Magellan GPS system (Table 1). Sites 1 and 5 were forested areas that were dominated by sugar maple and witch hazel, Sites 2, 8 and 10 were open field environments, Sites 7, 9, 12 were black birch stands, Sites 4 and 6 were areas dominated by shrubby vegetation, mostly mountain laurel, and site 11 was also shrubby vegetation, but mostly dominated with blueberry.

At each site, a 30 m transect was randomly placed along the ground. Seven sites located at 5m intervals on the transect were chosen for study using the following random method: to determine which side of the transect line to study, a coin was flipped, heads locating left and tails locating right. Facing the line on the side chosen, an object was thrown over the shoulder. Wherever the object landed would mark the center of a square meter plot. Within the plot, all woody browse material between 0 and 6 feet that fell within the plot was identified and recorded. The number of plants that showed browse damage was recorded. Of these plants, the numbers of browsed and unbrowsed twigs on each plant were also recorded. Ten samples of unbrowsed annual growth for each browsed species were collected. These samples were then dried at 80° C for a minimum of 48 hours. The weight of this material was taken and used to calculate total browse available per plant. This browse amount was used to calculate an optimum deer density, the total amount of deer that the area could support if all annual growth was consumed (Pennsylvania Game Commission). This number was then modified by dividing the available biomass by half to determine a sustainable carrying capacity that would not hinder the plant's regenerative ability. This modification was based estimate that plants can tolerate 50% browsing before their regenerative ability is sufficiently affected (Wallamo 1977).

Pellet Counts

Deer populations within the park were estimated by two methods, the previously mentioned deer drives and pellet counts. Pellet counts were performed by walking a one mile hourglass transect several days after a fresh snow. All pellets that were deposited on top of the snow within three feet of either side of the transect were counted. Pellet groups that included any part inside this six foot area were counted. This number was used in conjunction with the amount of time accumulated and the average defecation rate for white-tailed deer to determine population densities in that area (Benner 1993).

Results

Deer Drive

Deer counts were done the week before hunting season began and the Sunday between buck and doe season. The November drive estimated the deer population to be 79 deer per square mile, and the December drive had an estimate of 56 deer per square mile (Table 2). Data from the past three years average into a total park deer population of 63 deer per square mile.

Exclosure Analysis

The twenty trees found within the exclosure (0.23 acres) were composed of 5 different species (Figure 2, Table 3). Outside the exclosure (0.5 acres), 8 species total were identified, totaling 81 individual trees. The dominant species in both the exclosure and the tenth acre circle areas was *Acer saccharum* (sugar maple) composing approximately 72% of trees sampled with an importance value of 137.6 outside the exclosure and 195.4 inside the exclosure (Table 3, 4). *Hamamelis virginiana* (witch hazel) composed the second greatest number of trees (approximately 20%) and the second most important species (Table3, 4). Site physical data (DBH, %cover) can be found in Appendix II. The Simpson diversity of the exclosure was 0.505, the tenth acre circles was 0.668 and the overall value from Rider Park as determined in a previous study was 0.88 (Foran and Clayton 1997). Shannon Diversity for the exclosure was 1.149, for tenth acre circles was 2.124 and for the park overall was 3.35. The Jaccard coefficient between the exclosure and tenth acre circles was 0.625 and the percent similarity was 81.7 (Table 5).

There was an average of 54 fern stems per square meter within the exclosure area. These numbers subsequently decreased as winter approached and the ferns died. Within the exclosure, 12 species of herbaceous and woody seedling plants were counted and identified using a total of 28 square meter plots, totaling 1194 plants overall (Table 6). Outside the exclosure, a total number of 20-sq. meter plots were used in identifying 1108 plants, found in 11 species. Of these plants, *Dennstaedita punctilobula* (hayscented fern) was the most widespread, totaling 83% of all vegetation studied with a density of 47 and 34.64 plants per square meter outside and inside the exclosure respectively (Table 6). *Eupatoriun rugosum* (white snakeroot), *Rubus idaeus* (red raspberry) and assorted members of the violet species also composed a great deal of the material studied (Table 6). Plant numbers were used to calculate several diversity indices. The Simpson diversity of the exclosure was 0.333 and the tenth acre circles were 0.276. Shannon diversity numbers were 1.209 for the exclosure and 1.039 for the tenth acre surrounding area. The Jaccard Coefficient between the two areas was 0.916 and the percent similarity was shown to be 87.8 (Table 7). Temperature measurements at each site determined average temperature to be 2.86°C (Figure 3, Appendix IV).

Browse Survey

November browse surveys yielded estimated carrying capacity numbers for the 12 individual sites (Table 10, Appendix III). These capacities ranged from 0.33 to 169.79 deer per square mile based on habitat assessment. The average November carrying capacity value for the park overall is 47 deer per square mile. Preferred browse species were calculated based upon the November data (Table 8). The most preferred species were *Hamamelis virginiana* (Witch Hazel), *Vaccinium sp.* (Blueberry), and *Rosa multiflora* (multiflora rose). An average of all sites determined that 70% of all vegetation was browsed.

January-February browse surveys yielded estimated carrying capacity numbers ranging from 1.34 to 35.97 deer per square mile (Table 10, Appendix III). The average carrying capacity value for the overall park based on the January browse data is 7 deer per square mile. The most preferred browse species in January-February were *Lycium halimifolium* (matrimony vine), *Hamamelis virginiana* (witch hazel), and *Acer pennsylvanicum* (striped maple) (Table 9). January-February data determined that 71% of vegetation was browsed.

Pellet Counts

The first pellet count was taken January 29, 2000 four days after a snowfall. The snow depth averaged 4.5 inches. The count was taken on 2 hourglass shaped transects each one mile long (Figure 7). This lower pellet count calculated the deer to number 0.1 deer per square mile. The upper park pellet count was taken on February 22, 2000, four days after snowfall. The depth average of the snow was 4 inches. This count yielded no pellets, thus averaging 0 deer per square mile (Table 11).

Discussion

This study's main objective is not to conclude with a management decision for the park, but to accumulate data for the area. This data will improve the validity of any future suggestions based upon data from subsequent studies.

The deer drive data has maintained a mark of similarity throughout the past three years (Table 2). Because of this similarity, the drive is most likely a good deer density estimate for the area. There are constantly a large number of participants for the study, so human error is reduced to a minimum. However, because of the apparent diversity of habitat in the area, driving one area may not show the best representative of the park as a whole. A drive of the whole park, although difficult, would provide a better estimate. Data shows evidence that deer numbers have also not increased during hunting season (Table 2). This illustrates evidence that deer do not seem to be moving into the park to "escape" hunting pressures.

Eight tree species were found in the exclosure area (Table 3, 4 Figure 2). This is about 2/5 of 19 total tree species that have been found in the park overall (Appendix I; Foran & Clayton 1997). Such variability within the park illustrates the importance for subsequent studies to be preformed within a close area to accurately judge community changes. Based upon importance values Sugar maple (*Acer sacchrum)* is the most important tree species within the study site (Table 3,4) The apparent ages of these trees range when diameter breast heights are compared. For the sugar maple, the DBHs range from 5-24inches (Appendix II). Witch hazel (*Hamamelis virginiana*), the next most dominant species, seem to have a younger population with DBHs falling between 3-4.5 inches (Appendix II).

The study area falls in between the Hemlock-White Pines Northern Hardwoods Region and the Oak Chestnut Region (Braun 1967). Hemlock- White Pine region climax tree species are sugar maple, beech, basswood, yellow birch, hemlock and white pine with these species occurring in different combination in different areas. The Oak-Chestnut climax area is categorized by climax species of red oak, chestnut oak, and tulip tree. Based upon the tree data taken at the park, the park shows more characteristics of a Hemlock- White Pine Northern region climax community with many species of sugar maple, hemlock and white pine (Appendix I, Figure 2, Table 3, 4). The park also contains several species of red and chestnut oak, illustrating some characteristics of the Oak Chestnut Region. Oak and most maple species are commonly considered as preferred species for deer browsing (Marquis 1981). Because the park contains a high number of these species it illustrates that deer have not had a long history of severe park damage. If they had been continuously damaging the plants of the park, the larger forest community structure would differ with a dominance of non-palatable tree species dominating the community.

The Simpson and Shannon diversity indices show that there is moderate species diversity within the area but not a great amount due to the dominance of a few species including sugar maple and witch hazel. Diversity indices calculated using the entire park as a sample area show that there is more tree diversity in the park overall as compared to the exclosure and immediate vicinity (Table 6). Thus, it is very important that subsequent data be taken from the same area. Data taken too far from the exclosure could result in erroneous diversity and similarity numbers. The Jaccard coefficient and percent similarity values illustrate a high similarity between the tenth acre and exclosure sites with respect to tree species (Table 6). A high similarity is ideal to have between two sites during the first year of a exclosure study because over time, the percent similarity should decrease as the two sites become less similar.

Of the 12 herbaceous plant species found at the study site, the dominance of hay – scented fern species is the most important to note (Table 6). Deer overbrowsing within an area favors the growth of hay-scented fern in an area (Waller 1997). Because deer are preferred browsers, they select more desirable species and because of constant browsing of these species, it allows undesirable plants to become established in an area (deCalesta 1992B). Once established, it may become difficult to reverse the change in habitat. The rise in numbers of hay-scented fern is correlated with a decrease in wildflowers and other herbaceous material (McGuiness 1996). The site's relative abundance of raspberry gives some evidence of a lack in severe deer damage. *Rubus* species is known to be palatable to deer and at higher deer densities, the percent cover of *Rubus* should decrease. In correlation with this decrease, the percent cover of hay-scented fern should increase (Horsley 1992). It should be important in following years to note density changes between these two species in an effort to quantify deer damage. Due to the majority of hay-scented fern as opposed to *Rubus*, it seems most likely that the area has been very damaged by deer in the past (Table 6).

The Simpson and Shannon diversity values for the herbaceous data show that the biodiversity of the plants in the study area is less than the biodiversity of the trees in the same area (Table 7). This is mainly due to the overwhelming dominance of the hay-scented fern species in the area. The presence of sugar maple seedlings in the area seems contradictory to the idea of deer damage because they are thought to be a palatable species and a preferred browse for deer (Marquis 1981). However, no saplings of the same species were noted which leads to the belief that the deer consume the seedlings before they can become established as sapling trees. The Jaccard coefficient and percent similarity show even more similar environments that when evaluated with tree species. This high similarity is, again, ideal to begin a first year study.

The browse study attempted to evaluate pre- and mid-winter environments within the park. Assessing environments separately is important because excessive deer injury to plant material may be confined to a limited area while tree growth in surrounding areas may not show as great a degree of damage (Frontz 1930). The best way to understand and identify habitats is to map the elements available in the study area and determine how animal density and damage are correlated within an area (Riney 1982). Deer carrying capacities for both pre- and mid-winter values had very large ranges (0-170 deer per square mile) (Table 10). This large range of values could be associated with the aforementioned random damage pattern or could possibly be due to the randomness with which the area was sampled. Plots were sometimes devoid of all vegetation and were sometimes found in a thickly vegetated area. Subsequent browse studies would be beneficial to observe trends in the data.

Deer damage of woody browse buds and leaves may be fatal anytime during the life of a tree until they reach 6 feet and escape the physical range of deer (Frontz 1930). The species richness of this woody vegetation declines as deer density increases (deCalesta 1992A). The woody species found by the browse survey vary in palatability to deer. White pine, black birch and raspberry are known to be palatable while striped maple, multiflora rose, and golden rod and known as unpalatable (Frontz 1930, Horsley 1992, Natural 1993). Many other species found by the browse survey are thorny and exotic species that exhibit lower browse utilization rates than native species (Natural 1993).

Pre-winter carrying capacity value averages were greater (42) than mid-winter (7) (Table 10, Figures 4, 5, 6). This decrease is expected due to severe browse pressure exhibited by deer overwinter along with natural overwinter plant death. Taking the average of the two numbers to estimate an average carrying capacity for management purposes is insufficient to maintain proper deer numbers all year and promote regeneration of species. Also, numbers based upon habitat may not be sufficient to allow for regeneration of all plant species found in an area (Diefenbach 1997).

Another important point to be considered with the browse survey is each species' nutritional value of each representative species. As a deer population grows, deer are not able to have a diet of ideal species and must begin to browse on all available forage creating a less healthy diet (Brush 1991). Deer in the park have shown evidence of browsing on very unpalatable species such as sugar maple, mountain laurel and goldenrod (Appendix III). Meanwhile, the percent of browsed plants changed only from 70% to 71% between November and January (Tables 8,9). This data illustrates a very general browse menu, leading to the assumption that the deer in the park do not have an ideal, healthy diet. However, it is important to note how much of each species can be present in the white tailed deer diet without impairing digestion (Wallamo 1977). Subsequent studies may want to consider caloric contents of each species sampled to view a more specific plant material background.

The transect method may give inaccurate readings because it tends to overestimate actual browse utilization due to observer bias. The twigs most frequently sampled are terminal branches that are most easily attacked by deer (Natural 1993). Another possible error in this method could be in the methods by which carrying capacity was calculated based upon one source, regenerative ability of plants was assumed at an average of 50% of available biomass (Wallamo 1977). Other studies have used different percentages such as 25% (Natural 1993).

Pellet counts showed very sparse deer densities (0.01 and 0 deer per square mile) (Table 11). Other studies that have utilized these counts in snowfall have encountered a decline in estimated numbers as compared to estimates in non-snow ground cover (Walker 2000). Although the Game Commission is calling for this "post snow" count to become the new standard, the accuracy may need to be reevaluated, at least for this study area.

Based upon the population and browse data from this study, deer numbers within the park greatly exceed the carrying capacity of the park's natural environment (Figure 8). Diversity of plant species within the park seems to have been greatly affected by these large populations and will continue to be until management decisions are made.

Again, this is only a first year study and this material should not compose the background of a management decisions. More data is needed to formulate a solid data base.

Because Rider Park is small in area (860 acres) management decisions made within the park need to be made within a "landscape level perspective" (Rosenberry 1999). Several food plots do exist on the surrounding hunt club land, supplementing the deer's diet over winter. If management decisions are made and deer form the area are removed, it is likely that this low density will persist for a few years (McNulta 1997). Eventually dispersal by yearling males would exchange individuals across borders and eventually reestablish the population within the park (Rosenberry 1999). However, this is only the first year of a five year minimum project. Management decisions should not be made until more data can be collected on the area and trends are noticed.

Decreases in species richness, number and abundance have been observed with densities as small as 10 deer per square mile (deCalesta 1993, Warren 1997). Likewise, the composition of the state's forest land is changing from seedling-sapling timber to older aged timber, decreasing the amount of deer that can be supported by the forest (Diefenbach 1997A). These changes in forest structure, coupled with the height percentage of does in the deer population create unfavorable visions of deer herd populations. Deer overabundance is thought to be one of the greatest challenges facing wildlife professionals now and in the future. The problems are more complex that simple biological or ecological problems- they also encompass social, political, legal and economic aspects (Warren 1997). As with all management decisions, each of these areas must be considered to have a successful outcome.