

DEER DENSITY EFFECTS ON A FOREST ECOSYSTEM:

A STUDY

ITS HISTORY-DESIGN-IMPLEMENTATION

Jim Redding, Forester

Today's second growth Cherry-Maple forests on the Allegheny Plateau have been heavily influenced by decades of overbrowsing by white-tailed deer. When these forests were established deer were nearly extinct in Pennsylvania. Laws to protect deer **and** vast amounts of forage created by the extensive cutting that took place from 1890 to 1930 combined to set the stage for a major eruption of the deer herd that lasted through the early '40s. A combination of severe winters and lack of forage caused by stands growing out of reach of the deer caused mass starvation and a sharp decline in populations from 1940 through the early 1950's. As the forests began to reach commercial size in the '50s cutting increased and modern deer herd management techniques were instituted. Deer herds increased although **not** as rapidly as earlier and began to level off or decline slightly in the 1980's to the present day. This paper will describe the history of forests and deer on the Plateau from pre-settlement time to the present.

As early as the late 1920's damage to forests and agricultural crops was apparent and studies were started that documented deer as the cause. Studies conducted on the Plateau from 1935 through 1975 are reviewed.

These early studies identified deer as a causal agent by excluding them from cuttings and comparing the results inside versus outside fences. The **big** weakness of these early studies was that these comparisons were being made against unknown population levels of deer outside the fences. In 1978 the Society of American Foresters Deer/Forest Management Committee agreed to establish a long term enclosure study where the development of regeneration was compared with known densities of deer. The result was a large cooperative 10-year study conducted **by** the Northeast Forest Experiment Station in cooperation with the Pennsylvania Game Commission, Pennsylvania Bureau of Forestry, Allegheny National Forest, and National Fuel Gas Company. Deer population levels tested were 10, 20, 38, and 64 deer/sq mi. Study objectives, design and implementation will be covered in this paper.

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IMPLICATIONS FOR DEER MANAGEMENT

David deCalesta

Forests in the eastern United States evolved with deer densities approximating 20 per square mile, and that is a probable density for forests in the Allegheny Plateau. Factors that interacted to maintain deer density near 20 included unremitting predation by predators we no longer have (mountain lion, wolf, American indian), cycles of catastrophic disturbance (wind and fire), and deer forage availability. We have lost the major predators, and historic timber cutting practices may have provided more forage than that produced by weather patterns and forest succession in the past. The result has been creation of a deer herd approximately 50% above normal deer density, a skewing of the forest composition to a monoculture of black cherry where regeneration succeeds, and a notable lack of a shrub component. Forest regeneration potential and diversity are less than that which occurs under "natural" deer density.

The only viable solution to the negative impact deer have on forest resources is to trim the herd down to the level recognized by our research and set as a goal by the Pennsylvania Game Commission: 20-21 deer per square mile. Fencing is being used to protect regenerating forest stands from excessive deer damage, but fencing is only a local solution to a problem of landscape dimensions. Fencing will enhance regeneration success on protected stands, but it will do nothing to address the impact deer have on diversity of natural resources across landscapes as large as and larger than the Allegheny National Forest. Increasing levels of cutting to overwhelm deer and at least provide regeneration has resulted in monoculture black cherry and impoverished diversity of forest resources.

Trimming the herd to the preferred density level will require more intensive management of the deer harvest. The fixed pool of current hunters, and shrinking pool of future hunters has not and will not control the deer herd without innovative approaches to enhance the effectiveness of hunting to reduce the deer herd. Allied problems are limited hunter access to areas requiring herd reduction and management of deer on biological units that will allow for control of deer herds on an ecological rather than a political basis.

IMPACT OF DEER ON INTERACTIONS AMONG PLANTS

Stephen B. Horsley, Plant Physiologist

The role of browsing by white-tailed deer is complex, effecting forest vegetation directly through plant removal and indirectly through plant-plant interactions that are set in motion by browsing. We studied changes in the herbaceous and woody vegetation at deer densities of 0, 10, 20, 38 and 64 deer/sq mi. At each of 4 sites, 10% of the area was clearcut, 30% was thinned and 60% remained uncut. Tallies of herbaceous and woody vegetation were made 0, 1, 3, 5 and 10 years after cutting. Only a few species seemed to be key players in browsing-generated plant-plant interactions: Rubus spp., hayscented and New York fern, grasses and sedges, pin cherry, black and yellow birch, and striped maple. A few species characteristics seemed to be important in determining whether interaction with deer density occurred and in which cutting treatment: palatability to deer, tolerance of repeated browsing, response to light, abundance of regeneration propagules and regeneration strategy.

In uncut stands, deer density affected abundance, height and species composition of woody seedlings that were able to grow into the 1-3 ft height class 10 years after cutting. At 0 deer/sq mi, there were more than 3 times as many seedlings of all species as at 64 deer/sq mi. Seedling height decreased as deer density increased. At densities less than 20 deer/sq mi, woody vegetation was dominated by birches, striped maple and black cherry, although other species also were abundant. At higher densities, there was a near-monoculture of small black cherry seedlings.

In thinned stands there also were important deer density-dependent plant-plant interactions. First, there was a strong relationship between the % ground cover by Rubus, a palatable species, and deer density; the higher the deer density, the lower the % ground cover by Rubus. Rubus in turn influenced the % ground cover by hayscented and New York fern, species not palatable to deer which strongly interfere with survival and growth of black cherry and other Allegheny hardwood species. Where % ground cover by Rubus was high, % ground cover by ferns remained low, but where deer removed Rubus, fern cover increased. Second, deer density determined which tree species dominated thinned stands. At 2 sites, black cherry and birch were the dominant species. Birch, which is more palatable to deer and more tolerant of shade than black cherry, outgrew black cherry and was the dominant stem 10 years after thinning at densities less than 38 deer/sq mi. However, at 64 animals/sq mi deer consumed most of the birch, resulting in dominance of 90% of the regeneration sample plots by black cherry. At the other 2 sites, striped maple, a browse resistant, very shade tolerant species dominated 65-80% of the regeneration sample plots at the beginning of the study. This dominance was maintained through 10 years. Other species were suppressed beneath striped maple.

Deer density had a strong effect on species composition and site productivity of clearcut stands. Where fern and grass were present as a result of Rubus removal by deer, there usually was little tree regeneration. After 10 years, 15-37% of each clearcut remained treeless at 64 deer/sq mi. Deer density also determined which tree species dominated clearcuts. At densities of 20 deer/sq mi or less, pin cherry was the dominant species on 50-75% of the sample plots after 10 years. Other species were found beneath pin cherry, although mortality was high where pin cherry was dense. At 38 and 64 deer/sq mi, black cherry dominated 50-80% of the sample plots. Other species were not key players.

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IMPACT OF DEER ON FOREST REGENERATION

David decalesta

Deer impact forest regeneration by affecting the quality and quantity of small seedlings on the forest floor. These seedlings determine the composition of the trees in the stand that will develop following final harvest. Excessive feeding damage by deer can: 1) eliminate commercial species; 2) reduce height growth, extending the time for seedlings to grow to harvestable size; and 3) reduce stocking rate, which is a predictor of area occupancy by the mature stand. This paper relates how density of deer affects these three regeneration factors.

Forest management history and deer densities influenced the composition of advance regeneration when the study started: black cherry seedlings made up the majority of advance regeneration, followed distantly by red maple, striped maple, beech, white ash, and sugar maple. Starting conditions imposed by the study resulted in about twice as much forage as was created by typical cutting rates at that time, which diluted the overall impact of deer on all regeneration factors.

The impact of deer on regeneration was still obvious and significant, beginning at three years after treatment and extending throughout the ten years of the study. As deer density increased from 10 to 64 deer per square mile all three regeneration factors - number of species, height growth, and stocking rate - declined significantly. At the highest deer density, number of species and height growth were cut by more than half. Highly palatable species disappeared, leaving species of low palatability at greatly reduced height. Stocking rates on all but the lowest deer density were below the acceptable level on clearcut sites. Competing vegetation (ferns and striped maple) combined with deer density to negatively affect height growth and stocking rate, but not number of species.

The large amount of forage produced by the study, when combined with deer densities at or below 20 deer per square mile, resulted in clearcut sites dominated by pin cherry. Because pin cherry was so abundant, and so much taller than other commercial hardwood species on sites with lower deer density, we recommend use of shelterwood cutting inside fences or in regions of low deer impact when advance regeneration is small.

Results suggest that managing for 20 deer per square mile will be most beneficial for forest regeneration.

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IMPACT OF DEER ON DIVERSITY OF PLANTS, SONGBIRDS, AND SMALL MAMMALS

David deCalesta

Increasing interest is being focussed on factors that affect the diversity of forest resources, including woody and herbaceous vegetation, and wildlife. Additional data were collected during the 10th and last year of the deer density study that provide insight into the impact of deer on diversity of forest resources.

Woody vegetation, herbaceous vegetation including wildflowers, songbirds, and small mammals were sampled across all deer densities. The songbird community was partitioned into three groups according to where they nest: on the ground, in the intermediate canopy, or in the overstory canopy. For all of the diversity components species richness, abundance of all species, and a diversity index (Margalef) were computed. Impact of deer density on these measures of diversity was evaluated.

Species richness of woody vegetation and songbirds nesting in the intermediate canopy declined significantly as deer density increased. At the highest deer density about a quarter of the woody species were lost and 3 of 18 songbird species were not found. Abundance of woody vegetation, wildflowers, and intermediate canopy songbirds declined significantly with increases in deer density. The Margalef index of diversity declined with increases in deer density for woody vegetation and intermediate canopy songbirds. Threshold for negative impact by deer on woody vegetation and wildflowers was between 10 and 20 deer per square mile, for songbirds it was between 20 and 38 deer per square mile.

Birds nesting in the overstory canopy and on the ground, and small mammals were not affected by deer density. Deer did not affect structure of vegetation in the upper canopy during this study, so lack of impact on birds nesting there is expected. Small mammals (excepting flying squirrels) and ground-nesting birds were not affected because their habitat was apparently unaffected. Amount of ground cover did not differ among deer densities: as the wildflower component declined with increases in deer density, the fern and grass component increased: overall there was no change.

Threshold for negative impact on songbirds affected by deer appears to be about 20 deer per square mile. Although results suggest that threshold for impact of deer on woody vegetation is between 10 and 20 deer per square mile, the potential negative impact of pin cherry at deer densities below 20 per square mile on clearcuts dictates caution, especially where forest management provides large amounts of deer forage. Threshold for negative impact on wildflowers appears to be below 20 deer per square mile.

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SUMMARY

Susan L. Stout

Overbrowsing has been important in Pennsylvania's forests for at least 60 years. The effects of this overbrowsing can be seen in the plant community, the animal community, and in the effects of forest practices. The results of a 10-year study of the effects of deer density on forest ecosystems shows that deer impact, rather than deer density, must be assessed and controlled to ensure ecosystem recovery. Intensified cutting within the effective home range of a local deer herd, as was done in the study areas, can reduce the deer impact associated with a given deer density.

As deer impact increases, the Plant community becomes impoverished. Diversity of woody species and abundance of woody and herbaceous species is reduced. Height growth is slowed at higher deer impacts. *Rubus* species, which play an important role in forest recovery from disturbance, are rare at high deer impact. Black cherry dominates almost 60% of the regeneration sample plots in the 64 deer/sq mi clearcuts. Palatability of browsing varies systematically with species, and those species with low palatability or **high** tolerance for browsing dominate overbrowsed forests: black cherry, striped maple, and American beech.

At lower deer impacts, birch and pin cherry become more important in plant competitive relationships than they are in the current forest. Silvicultural guidelines will be required for the changed conditions of the forest if deer impacts are systematically reduced.

In the impoverished plant community that develops at high deer impact, habitat for intermediate canopy birds is virtually non-existent, and the diversity of this subset of the bird community is reduced. Wildflower abundance is also reduced at high deer impact.

Hunting is the most effective tool for reducing deer impacts regionally. With hunter populations on the wane, creative and ecological management of hunting allocations will be required to achieve target deer densities in managed forests.