A Conflict Between Forest Renewal and White-tailed Deer: A Silviculturist's Perspective on Values

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INTRODUCTION

This conference is focused on "The Impact of Deer on the Biodiversity and Economy of Pennsylvania." Each speaker on this panel has been asked to speak about the interaction between our values and the ecological impacts of white tailed deer from a specific perspective. My perspective is that of a silviculturist. Silvicuiturists study how trees and forests grow, so that we can help maintain and establish or reestablish forests that sustain the benefits that humans value. We can use silviculture to open a vista, to muffle distant noises, to create habitat for one or- more wildlife species, or to produce wood products, for example.

In Pennsylvania, for at least the last 30 years and perhaps as long as 60 years, the primary challenge for silviculturists has been forest renewal. This challenge reflects the fact that foresters in Pennsylvania rely primarily on **natural regeneration,** not planting, to establish new forests regardless of the benefits for which we are managing. Whether our strategy is "hands off' as in the management of an old growth preserve or "very hands-on" as in industrial management for high-value timber products, the future of the forest depends upon the establishment and growth of new generations of trees and companion vegetation. For me, forest renewal means the renewal of the whole forest community – trees, wildflowers, shrubs, and wildlife – and the associated biodiversity and ecological integrity. In too many places in Pennsylvania, for too long, deer have been allowed to exist at densities that interfere with this process.

In fact, the Forest Service ecology and management research team with which I work has been involved in some form of research about the impact of white-tailed deer on forest renewal for the last 5 or 6 decades, because the problem has been important for that long. I will share some of the evidence that we've gathered with you, but first, let me share some of the history of white-tailed deer abundance in Pennsylvania.

SOME HISTORY

How did we get to the point where deer have negative impacts on their own habitat? Ac the conference, Steve Fadden reminded us that humans have created this problem, and that is certainly the case in Pennsylvania. By the 1890s, we had eliminated the last of the non-human predators of white-tailed deer, the timber wolf (Kosack 1995), and market hunting of deer was widespread. Pennsylvania, like many other eastern states, established a Game Commission in part to save the white-tailed deer. By 1907, laws limiting the season of hunting and the sex of deer to be hunted were in place. Deer were imported from Virginia and Michigan.

In Pennsylvania, all these changes coincided with creation of nearly perfect deer habitat clear across the state. A wave of timber harvesting to support the industrial revolution swept across the state from about 1880-1930. From the Delaware River co Lake Erie, deer found mile after mile of tree seedlings growing in high sunlight. From 1907 to 1923, the Pennsylvania herd increased very rapidly, and in 1923, antlerless seasons were reinitiated to cope with local over-abundance (Leopold 1943; Marquis 1975; Kosack 1995; Redding 1995).

The graph in Figure 1 shows the changes in deer density in northwestern Pennsylvania over time (Redding 1995). But note that it has another implication. If we assume that most of Pennsylvania's current hunters have been hunting for fifty years or less, we can see that these hunters have never hunted in forests with deer densities at the goal densities chat the Game Commission has decided are right for these forests. In fact, at least in the northwestern part of the state, current densities are the lowest in fairly long memory - although they are still higher than the goal density!

THE IMPACTS OF DEER

It was probably during the early years of deer overabundance that deer had their most devastating impacts on wildflower and shrub communities. Trees can literally grow out of the reach of deer, but shrubs and wildflowers don't have that option. Susan Kalisz (personal communication), a botanist at Pitt who works with trillium, reports that they can literally "hide" underground for a few years of intensive

browsing pressure. But when browsing pressure lasts for decades or longer, we can only guess that this survival strategy will eventually fail.

Torn Rooney has done two studies on the Allegheny National Forest concerning impacts of white-tailed deer on wildflower communities (Rooney and Dress 1997; Rooney 1997). Additional research in Wisconsin, Illinois, and Ohio also shows that deer can have very important impacts on this part of the forest community (Anderson 1994; Augustine 1998). For example, Rooney (1997) showed that, on rocks too' high for deer to climb, communities of wild-lily of the valley *(Maianthemum canadense)* included larger plants with a higher proportion of reproducing plants than were found in comparable populations on low rocks exposed to deer browsing.

Ash Hough was one of the First Forest Service researchers in northwestern Pennsylvania. He was very active in convincing the Forest Service of the value of old-growth reserves like the Tionesta Scenic and Research Natural Areas. He described the gradual disappearance of the shrub hobbiebush (Viburnum *alnifoliurn)* from these old growth reserves through the thirties and forties (Hough 1965). Today, we find **one** remnant plant underneath a huge log within the 4000 acres of the Tionesta, a few more along some roadways where deer may be shy to browse, and a few in the Hearts Content Scenic Area. Another key shrub that's a species of concern in Pennsylvania is Canadian yew *(Taxus canadensis).* Studies in the Upper Lake States show that deer at high numbers devastate this species (Beals and others 1960; Balgooyen and Waller 1995). Another species that plays an important role in the shrub layer of northern forests is Eastern hemlock *(Tsuga canadensis).* This slow-growing species can spend many years in the shrub layer as a seedling/ sapling stem, and it provides important thermal protection to deer in winter. Several studies show that deer have important impacts on regeneration of hemlock (Anderson and Loucks 1979; Frelich and Lorimer 1985; Alverson and others 1988; Aiverson and Waller 1997, Whitney 1984). But in Pennsylvania, deer impacts on the shrub layer are more than just the sum of impacts on individual species. The next time you hike in Penn's Woods, ask yourself if there is a shrub layer where you're hiking—through much of the state, the whole layer has disappeared.

Deer also have devastating impacts on tree seedlings. As the forests created by turn of the century cutting in Pennsylvania began to reach the sizes associated with timber products in the late 1960s and early 1970s, foresters tried to manage those harvests as harvests were managed in other regions. Far too often, the forest was replaced by fields of ferns, grasses, and asters—plants of low preference to white-tailed deer. Foresters suspected that deer were the problem, so they built fences in several harvest areas. Earl[y] studies showed that regeneration failures occurred in 42 to 68% of the trials (Marquis 1975, 1981). In 87% of the problem areas, simply excluding deer made the difference between success and failure as Ear as tree seedlings were concerned (Marquis 1981). Comparisons of forests inside and outside fences showed that these deer impacts had important economic consequences. Forests inside fences were more valuable than chose outside, to the tune of $13/acre/year (Marquis 1981). A recent update of that estimate using current timber prices and costs of protective measures suggests that the forestry community in Pennsylvania is spending something like $75 million dollars a year on deer browse (Stout, testimony to Pennsylvania Game Commission Deer Management Working Group, November 4, 1998).

The studies described above occured in the dense forested landscape of northwestern Pennsylvania during the 60s and 70s, when deer densities were 40-60 per square mile. We wanted to know how many deer *were compatible* with our values of diverse and productive forests. During the late 1970s, my predecessors at the Forestry Sciences Laboratory teamed with many cooperators, including the Game Commission, the Bureau of Forestry, and the Society of American Foresters to design a study to answer that question. At four different sites in northwestern Pennsylvania, we erected fences around 160 acres of managed forest. Inside our fences, we created four pens—one 1/10th square mile pen and three 1/20th square mile pens. We managed the forests inside the pens in a typical intensive manner, to create deer food levels like those that would be found in a managed forest. We put clearcuts on 10% of the ground within each pen for high deer food production, and thinning on 30%, to produce moderate amounts of deer food. Then we put 1 deer in the 1/10th square mile pen and 1, 2, and 4 deer res[p]ectively in the 1/20th square mile pens. That simulated 10, 20, 40, and 80 deer per square mile. And we watched and measured as the forest grew under the impacts of these different deer densities.

In the high deer density pens, winter mortality was high. We also lost some deer through the course of the study to poaching, escapes, and predation. So the densities we actually achieved, averaged over the eleven years that deer were in the pens and the four different study areas, were 10, 20, 38, and 64 deer per square mile. The forests that developed were very different. There were important differences in seedling height. seedling species composition, and in the distribution of seedlings on the forest floor. Although the clearcuts offered the earliest and most vivid examples of the effects of deer on seedling heights, the effects were evident in the thinned and

uncut areas as well, as shown in Figure 2. There were also differences in the species composition of the forests that developed at high vs. low deer densities. By the fifth year of the study, for example. only two species - black cherry and striped maple—had grown tall enough to escape deer browsing in the highest deer density pens. The number of species reaching this height class in the lower deer density pens was six or seven, and these species included red and sugar maple, yellow and sweet birch, and white ash Many important tree species of Pennsylvania forests failed to grow to competitive heights at the highest deer densities (Tilghman 1989).

At ten deer per square mile, trees filled the growing space created by clearcutting, and deer survival and apparent health were good throughout the study period. At 64 deer per square mile, neither the deer nor the forests were healthy. In the clearcuts, patches of trees were interspersed with wide gaps, filled in with ferns or grasses and sedges. The deer in the 38- and 64-deer-per-square-mile enclosures died in late winter when their fat reserves were used up and woody growth was not available (Tilghman 1989). In thinnings and uncuts, much of the growing space in the high deer density pens was filled by ferns and grasses, which prevent the establishment of new seedlings even now. In many of the 64-deer-per-square mile pens a striking browse line developed. In the lower deer density pens, those with 10- and 20-deer-per-square-mile, the forest developed a more complex structure with more layers of foliage. This meant differences in wildlife habitat, and by the eleventh year of the study, these differences were reflected in the songbird populations of the different study areas. Figure 3 shows differences in species richness and abundance of songbirds in our study areas after eleven years (deCalesta 1994).

Our study confirmed another phenomenon. When deer eliminate tree seedlings, as they did in the high deer density enclosures, other plants often fill the growing space (Horsley 1995). Many of these plants, most importantly hay-scented and New York fern, become so entrenched that merely reducing deer numbers will not create conditions in which tree and wildflower seedlings can reestablish. In the case of fern, the barrier is dense shade at the forest floor level, but whatever the cause, it is a legacy that we will have to deal with in Pennsylvania for a long time.

The Hearts Content area on the Allegheny National Forest is another area in which deer impacts on forest renewal have been important and well documented. In 1929, Harold Lutz made a complete study of the vegetation in the interior twenty acres of this 120-acre old growth reserve. He divided the area into a hemlock-beech association and a hemlock consociation, and found a rich mixture of herbaceous and woody plants on the forest floor of both sections (Lutz 1930). Fifty years later, Gordon Whitney surveyed the woody vegetation on the same plots that Lutz used (Whitney 1984). In 1929, there were trees of seventeen species in the "small sapling" height class. In 1979, Whitney found only five species in that class - beech, mountain holly, black and yellow birch, and hemlock. While Lutz had found at least 5,300 hemlock per acre in this size class in 1929, Whitney found only ,20! In 1991, Tom Rooney and William Dress resampled the ground layer vegetation at Hearts Content to document the extent of changes in the herb and shrub community. They found that 33 species were missing from the hemlock-beech association and 16 species from the hemlock consociation (Rooney and Dress 1997).

AND WHAT ABOUT VALUES?

The evidence, in short, is overwhelming. In Pennsylvania, deer have affected tree regeneration and shrub and wildflower communities. In turn, these changes in plant communities have ripple effects on wildlife habitat and wildlife communities. Where the impact of deer browsing is severe and long-lasting, the vegetation that fills the growing space from which deer have removed seedlings and wildflowers may be species that have effects of their own, like the dense shade cast by hay-scented and New York fern. There are many places in Pennsylvania where deer impact has been severe for more than fifty years.

I value a full and complex forest community. White-tailed deer are absolutely part of the forest that I value. As a silviculturist, I enter the policy discussion to speak for healthy forests, forests that provide habitat for a diversity of tree and wild plant species, and for many animals. Surely the forest should be the home to white-tailed deer, but equally surely, the white-tailed deer must share their home with abundant and diverse tree seedlings, wildflowers, and other wildlife. Deer management-policies that result in heavy impacts on other parts of the forest are incompatible with my values.

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Figure 1. (From Redding 1995) Deer density in northwestern Pennsylvania over time, and Pennsylvania Game Commission goal densities for white-tailed deer.

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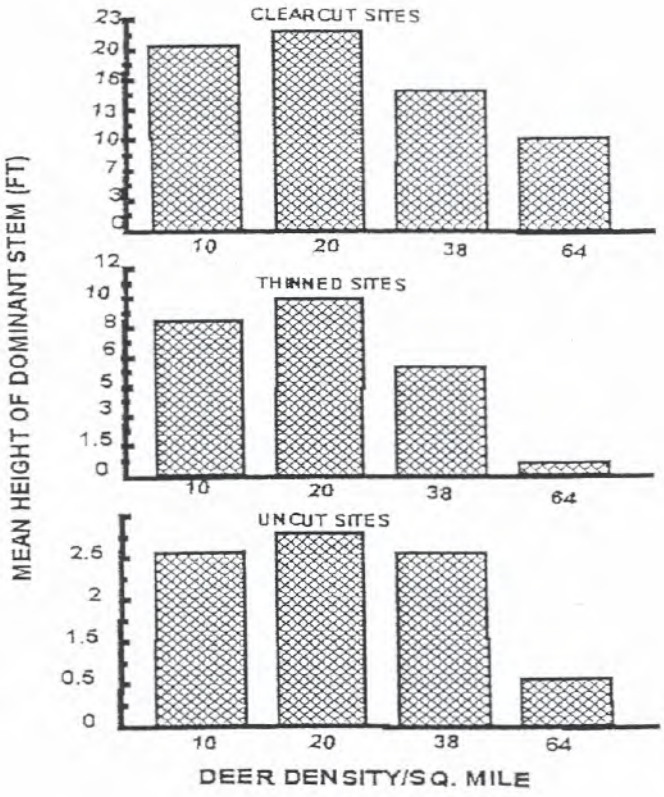

Figure 2. Heights of the tallest seedlings found on regeneration sample plots in clearcut, thinned, and uncut areas of pens maintained at different deer densities for 10 years.

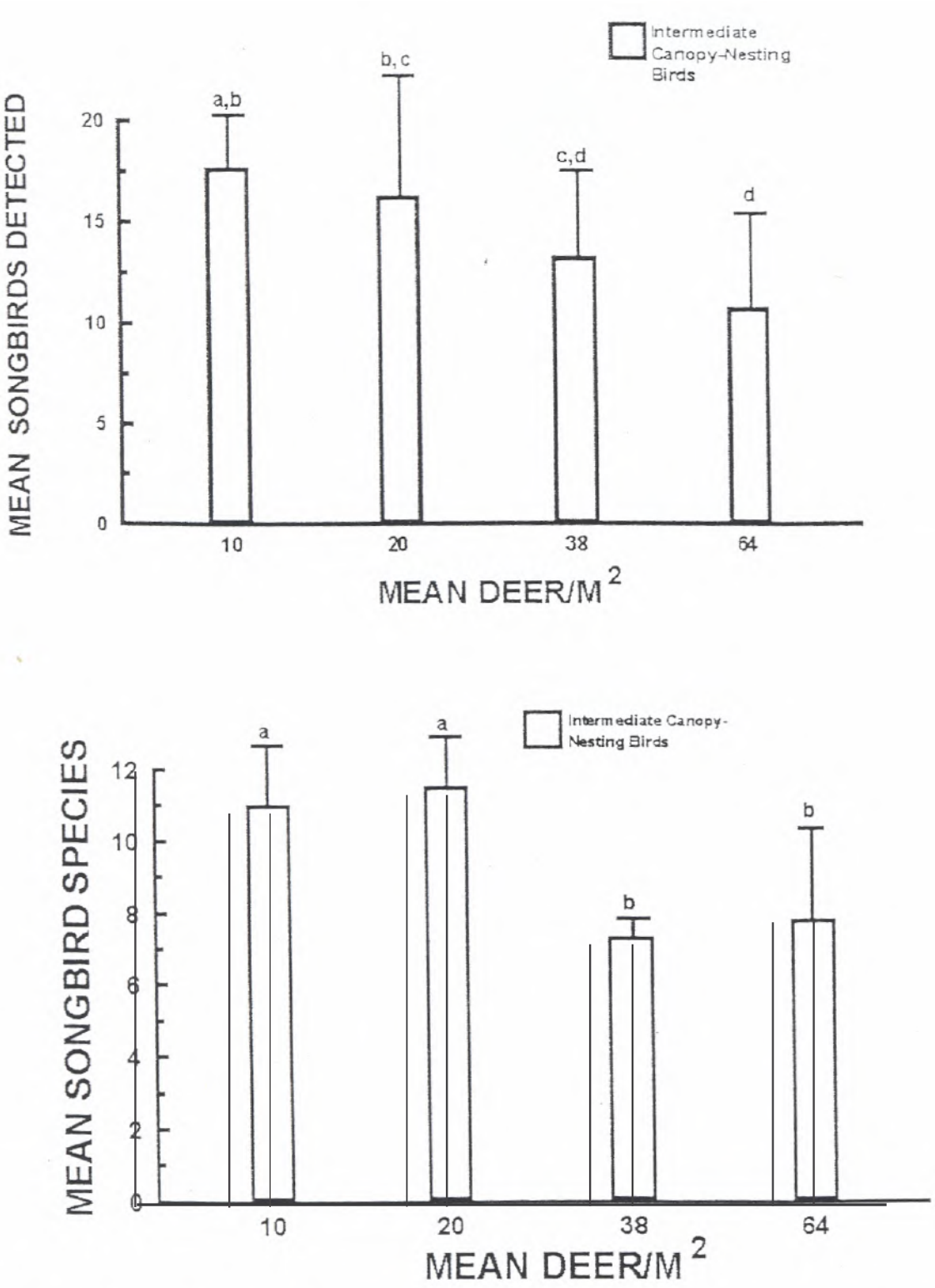

Figure 3. (from deCalesta 1984) a) Mean number of intermediate canopy-nesting songbirds on sites maintained for a decade at different deer densities. b) Mean number of *species* of intermediate canopy-nesting songbirds on those sites. In both figures, bars topped the same letter are not significantly different from one another.