FOREST SCIENCE Review

ISSUE NUMBER 1
WINTER 2004

NORTHEASTERN RESEARCH STATION
USDA FOREST SERVICE

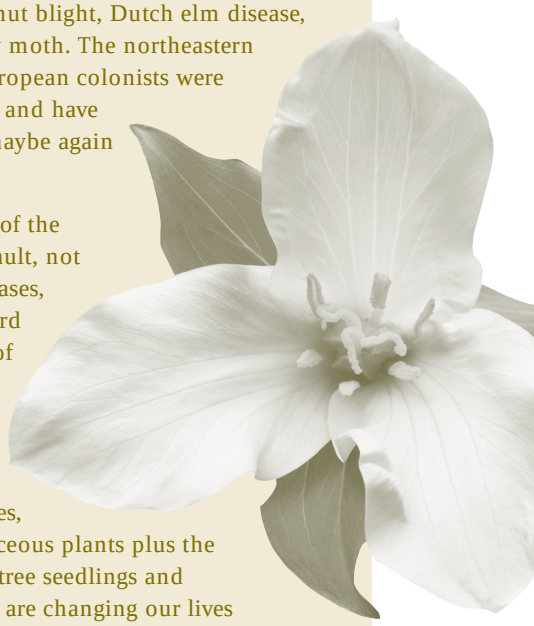
ENVIRONMENTAL RESEARCH, TECHNOLOGY & LEADERSHIP

"We think we know our forests. But in Pennsylvania and many other parts of the Northeast, deer overabundance has changed our forests so much and for so long that we truly don't know how our forests would look without too many deer. I walk inside a fence that's been up for three or four years in the springtime, and I am amazed at the wildflowers and seedlings I find."

DR. SUSAN STOUT
Forest Service Research Silviculturist, 2003

The Forest Nobody Knows

The non-urban residents of the Northeast, who live in or close to the forests and woodlands, and the urban residents who live within several hours' drive of the mountains and spend recreation time there would be surprised by Dr. Stout's words. We think we know what a forest should look like. But according to her, very few people have ever seen examples of what our forests really could look like. We like to use terms such as "old-growth," "virgin," or "primeval" forest to describe our wilder forests, but most of us truly do not know what such forests were. Most of the forests we see now are not old-growth (that is, never cut). The few scattered remnants of old-growth forest remaining have all been touched by chestnut blight, Dutch elm disease, butternut canker, and the gypsy moth. The northeastern forests reported by the early European colonists were cleared for agriculture long ago and have grown back at least once and maybe again after timber harvest.



But more than that, the forests of the Northeast have been under assault, not from humans or insects or diseases, but from the ever-increasing herd of deer. The ecological history of the Allegheny Plateau (see "Canary in the Coal Mine") tells the story of the deer and the forests of northwestern Pennsylvania. Deer are ungulates, like cows — they can eat herbaceous plants plus the leaves and twigs of shrubs and tree seedlings and saplings. And eat they do. They are changing our lives and our forests. Our lives? If you are a gardener, or the friend or relative of a gardener, you know of the garden favorites (hostas, roses, daylilies, rhododendrons, etc.) eaten by deer. Farmers relate stories of crops (especially corn) eaten by deer,

Continued

or cows mistaken for deer during hunting season. Motorists meet deer on the road, and none of the participants come out well (about 40,000 deer are killed annually on the highways of Pennsylvania, for example) Children playing in the backyard can be bitten by deer ticks and develop Lyme disease and/or babesiosis. The newly appearing problem of chronic wasting disease, a spongiform encephalopathy of deer and elk that is related to mad cow disease and Creutzfeld-Jakob disease of humans, is moving eastward and has reached Wisconsin. It begins to sound grim.

The problem is that there are too many deer here in the Northeast. These white-tailed deer are beautiful, graceful, and a natural part of forest-edge and clearing ecology. Unfortunately, a combination of historical and ecological occurrences has allowed deer populations in the Northeast to rise to levels that could result in more than just the human-centered problems listed above. Dr. Stephen Horsley, a scientist with the USDA Forest Service's Northeastern Research Station puts it thusly: "in the long term, deer have the capability of changing forest ecology, by changing the direction of forest vegetation development." Such changes could result not only in damage to the forest's ecological integrity but also to the humans who depend on it economically — for water quality, lumber, hunting, birding, etc. — and for recreation of all kinds.

In many parts of Pennsylvania, they have already changed the forests. Drs.Horsley and Stout work in a Forest Service laboratory in northwestern Pennsylvania, in the heart of the "deer belt"—the vast Allegheny Plateau,the north central and western part of the commonwealth that has little agriculture and an economy that depends heavily on deer hunting and logging. What they and other NE scientists have found is that, at the deer population levels occurring there, deer are producing long-term effects on both the amount and the kinds of vegetation growing in the forests. In many places there is very little undergrowth left except plants that deer don't like. Wild flowers and the middle level of shrubs such as viburnums and small trees, which are home to many native songbirds, are no longer present and fewer of these birds are to be seen. There are no saplings of sugar maple, white ash, and pin cherry. (In Wisconsin, cedars, hemlocks, and yews are scarce and there are no seedlings.) In many places on the Allegheny Plateau, vast swaths of hay-scented and New York fern and

Continued

In the left picture, taken in the 5th year of the 10-year study of deer effects on forests, research wildlife biologist Nancy Herbert is almost hidden by several species of young trees in a forest managed with 10 deer per square mile. On the right, she towers over a nearly pure stand of black cherry seedlings in a patch of the same forest, with the same history — but with 64 deer per square mile.

"The current density is producing devastating and long-term effect on forests. Foraging deer "vacuum up" the seedlings of highly preferred species, reducing plant diversity and in the extreme, creating near mono-cultures. It could take decades or even hundreds of years to restore forests."

DR. STEPHEN HORSLEY, Forest Service Plant Physiologist

"Since game management boiled down to its essentials is the control of game population density, it becomes apparent that an understanding of density limits is essential to successful practice."

ALDO LEOPOLD, an important advocate of nature and conservation, and the "father of game management" came to the Allegheny Plateau to observe the deer herds in the 1930s.

Continued

striped maple dominate in so-called fern parks; in other places, black cherry dominates. Many areas that were clearcut in the 1960s did not regenerate into a forest as they did in years before but rather became grassy meadows — unless they were fenced to exclude deer, in which case a forest grew again.

We do know something of what northeastern forests could look like from exclusion studies, where deer were fenced out, and from natural areas where deer are excluded. Botanist Tom Rooney, now at the University of Wisconsin, discovered small natural "gardens" on top of large boulders in the Allegheny National Forest. When he examined these gardens, he found that the plants growing on boulders tall enough to be out of reach of the deer grew three times more densely than those on the lower boulders, which were browsed by deer. Many of the threatened and endangered plants of the Northeast, including such beauties as lilies, trilliums, and orchids, are browsed by deer and are much reduced in size and abundance in many of their habitats.

Dealing with and even resolving the problem of too many deer is complicated and highly polarized. Stakeholders include hunters, animals rights groups, silviculturists, foresters, farmers, naturalists, wild flower advocates, gardeners, and park managers. Policymakers and land managers can make better decisions and members of the public can receive more accurate information if they have scientific studies of how deer affect ecosystems over time. Most scientific studies have used fencing to exclude deer from study plots. In such studies, however, the number of deer outside the plots is uncontrolled and their eating habits can be affected by outside factors.

Scientists at the USDA Forest Service's Northeastern Research Station's laboratory in Warren, Pennsylvania, recently published the results of research that actually studied the effects of several controlled population densities of deer on various forest treatments. The researchers at this location have a long-term commitment to studying the effects of deer on forests. The Forest Service group's first publication on deer, in 1965, was based on research that was begun in 1942 and still continues today.

The most recent paper, published by Dr. Stephen Horsley, Dr. Susan Stout, and Dr. David S. deCalesta (now retired) in the peer-reviewed journal *Ecological Applications* (2003: 13(1): 98-118), is carefully designed to test the effects of various levels of deer populations on the forest. The 160-acre plots were fenced to exclude local deer populations, then populated with deer at four specific levels: 10, 20, 38, and 64 per square mile. Each plot had 10% clearcut, 30% thinned, and 60% untreated forest. The scientists measured and analyzed the vegetation and found that deer affected the abundance and density of all plants; the horizontal and vertical structure of the forest; species abundance of wild flowers, shrubs, and birds; species composition and biodiversity of the forest understory and resilient versus deer-preferred foods. The deer densities studied represent the range that has been found in these forests from pre-European settlement days in the early to mid-1800s through the peak densities of the 1960s and 70s in the region. The average density of deer per forested square mile in Pennsylvania was 35 in 2001, according to the Pennsylvania Game Commission, and in some forested areas deer population can be much higher. ■

Forest Science Review is dedicated to providing its readers with clear concise descriptions of the scientific findings (and their implications) that have been recently discovered and published by the scientists of the USDA Forest Service's Northeastern Forest Research Station, which serves New England, New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, and Ohio, the most densely populated and most densely forested part of the United States.

We hope that land managers, policymakers, extension specialists, science communicators, environmental advocates, and educators, as well as conservationists and all others interested in the health and productivity of forests in the Northeast, will find that our quarterly newsletter offers important insights and information for them.

The NE Research Station is part of the USDA Forest Service's Research and Development national network. NE scientists work at sites in 11 states Hamden/Ansonia, CT; Newark, DE; Amherst, MA; Baltimore, MD; Bradley, ME; Durham, NH; Syracuse, NY; Delaware, OH; Warren and Newtown Square, PA; Burlington, VT; and Morgantown, Parsons, and Princeton, WV.

NERS scientists work in a wide range of laboratories and field sites all over (and even outside) the Northeast. They conduct research in 8 experimental forests, including several with long-term data sets that are unique to science, and in 6 research natural areas, sited on National Forest System lands. Two important research localities are the Forest Service's only primary quarantine laboratory on the continental U.S. (Hamden/Ansonia, CT), a facility certified for biological control research on exotic forest pests and their natural enemies, and the Baltimore (MD) Long-Term Ecological Research Site, where NE scientists and other cooperators study the ecology of an urban forest.

Contact the USDA Forest Service's Northeastern Research Station:

11 Campus Boulevard #200
Newtown Square, PA 19073-3200
www.fs.fed.us/NE

Michael T. Rains
Station Director
610-557-4017
mrains@fs.fed.us

Lynn Campbell Wingert
Communications Director
610-557-4253
lwingert@fs.fed.us

Rebecca G. Nisley
Newsletter Writer & Editor
rnisley@fs.fed.us

Canary in the Coal Mine—A Short History of Northern Pennsylvania Forests and Their Deer Herd

The results that we discuss in the text of this issue are important to most northeastern states. But why focus on northwestern Pennsylvania forests, you ask? What is happening there that is important to the rest of the Northeast? In the following short history of the forests of northwestern Pennsylvania, we will discuss what very high deer populations can do to a forest ecosystem. The unique ecological and human history of the Allegheny Plateau in northwestern Pennsylvania have created a situation that could be considered an indicator of the possible future for the rest of the Northeast, if deer populations are not controlled — a kind of "canary in the coal mine." (See Jim Redding's paper, *"History of Deer Population Trends and Forest Cutting on the Allegheny National Forest"* for a more complete history.)

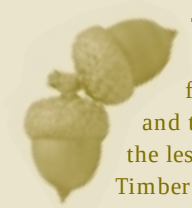
The forests of this region were mostly hemlock–beech when Native Americans were the sole inhabitants. Their communities relied heavily on deer for food, clothing, and shelter; their hunting pressure, in combination with that of many native wild predators, held deer populations to an estimated density of 8 to 15 per square mile. As European settlers entered the region, the associated land clearing and edge creation for agriculture and timbering may have boosted deer populations temporarily, an effect exacerbated by the elimination of native predators by hunting and trapping.

As timber harvesting in the region accelerated in the second half of the nineteenth century, venison was the meat of choice — for logging camps, growing settlements, and urban markets. Hides were also highly valued. Deer were hunted year-round, using every imaginable tool. By the late 1800s, deer were nearly extirpated from Pennsylvania. Public reaction to this realization was an important reason for the creation of the Pennsylvania Game Commission (PGC) in 1895.

The PGC quickly limited harvest of deer by imposing hunting seasons and, for a time, outlawing the harvest of does. They also reintroduced 700 whitetails from other states. These protections and reintroductions coincided with the peak of a wave of heavy timber harvesting that created almost ideal habitat for white-tails across the state, and deer numbers doubled every 2 years from 1907 to 1923.

By 1923, farmers were lobbying for doe seasons to reduce damage to farm crops, and by the late 1920s, foresters were making similar demands. Despite the establishment of doe season, the effects of deer browsing began to be seen in northwestern

Pennsylvania forests. The virtual disappearance of shrubs such as hobblebush was noticed first, but impact on species composition of tree seedlings on the forest floor was also apparent. Hunting mortality did not keep pace with population growth. By the early 1940s, two severe winters in a row, combined with the poor habitat in turn-of-the-century harvest areas where saplings had grown out of reach of the deer, resulted in high winter mortality and a population crash.



The forests in the northwest portion of Pennsylvania continued to grow, and with them, the deer herd. Natural forest development led to more openings in the canopy and the reinitiation of understory growth. However, only the less preferred and browse-resilient species increased. Timber harvesting was also renewed as the forests matured, also contributing to increased forage and deer herd growth. During the late 1960s through the early 1980s, deer herds in northwestern Pennsylvania reached levels of 40 to 60 deer per square mile, and regeneration failures after timber harvest were common. Hunting and deer–car collisions were the major causes of deer mortality.

In the late 1970s, the PGC developed a habitat-based approach to deer management. They assigned a carrying capacity for deer to three different age classes of forest — young, high-forage-producing forests, slightly older forests in which trees had grown out of the reach of deer but were still too dense to permit understory growth, and mature forests in which understory growth was possible. Based on these carrying capacities, the PGC set goal densities across the state — in northwestern Pennsylvania, the goal densities were 18 to 21 deer per square mile. Even with new seasons and hunting opportunities to kill antlerless deer, densities stabilized around 30 deer per square mile, about 50% or more above PGC goals.

Although the late 1990s saw promising new initiatives that would allow hunters to reduce deer populations and their impacts across Pennsylvania, many forests have developed serious problems after 70+ years of deer overabundance. Understories are crowded with species less preferred by deer or resilient to their browsing pressure, such as hay-scented and New York fern. When understories become dominated by such species, simple reductions in deer density may not always be sufficient to restore healthier patterns of understory growth and development. One survey in 1989 suggested that as much as 30% of Pennsylvania's forest understories had troubling densities of ferns.

The USDA Forest Service research described here has helped foresters, hunters, and policy-makers understand the sequence of events that are set in motion by deer overabundance. The patterns documented in northwestern Pennsylvania identify specific species that increase with deer abundance, and other species that are reduced by deer overabundance. But nothing in this research suggests that other forests would be immune to these effects — northwestern Pennsylvania could truly be "the canary in the coal mine." ■

"Deer have the capability of changing forest ecology, by changing the direction of forest vegetation development. It doesn't matter what forest values you want to preserve or enhance — whether deer hunting, animal rights, timber, recreation, or ecological integrity — deer are having dramatic, negative effects on all the values everyone holds dear."

DR. STEPHEN B. HORSLEY, Forest Service plant physiologist, 2003

Sources and Further Reading

Audubon Society of Pennsylvania. 1999. Proceedings, Conference on the Impact of Deer on the Biodiversity & Economy of the State of Pennsylvania; 1999 September 24-25; Harrisburg, PA [on the web at www.audubon.org/chapter/pa/pa/DCP.htm].

Horsley SB, Stout SL, deCalesta DS. 2003. White-tailed deer impact on the vegetation dynamics of a northern hardwood forest. Ecological Applications 13(1): 98-118.

McWilliams WH, Stout SL, McCormick LH. 1995. Adequacy of advance tree-seedling regeneration in Pennsylvania's forests. Northern Journal of Applied Forestry 12(4): 187-191.

Ness E. 2003. Oh, deer: exploding populations of white-tailed deer are stripping our forests of life. Discover Magazine 24 (3; March 2003): [on the web at www.discover.com/mar_03/featdeer.html].

Redding J. 1995. History of deer populations trends and forest cutting on the Allegheny National Forest. In: Proceedings, 10th Central Hardwoods Conference. GTR-NE-197. Radnor, PA: USDA Forest Service, Northeastern Forest Experiment Station.

Stout SL. 1998. Deer and forest health. Pennsylvania Forests Spring 1998: 14-16. [www.audubon.org/chapter/pa/pa/Dunn.htm]

Northeastern Research Station
USDA Forest Service

11 Campus Boulevard, Suite 200
Newtown Square, PA 19073

In a recent paper published in *Ecological Applications*, Drs. Stephen Horsley and Susan Stout of the USDA Forest Service's Northeastern Research Station reported that as the deer density increased:

- **The number of woody species decreased as species preferred by deer were browsed selectively.**
- **The percentage of the forest floor covered by ferns, grasses, and sedges, which interfere with the establishment and growth of tree regeneration, increased.**
- **The height growth of many species was reduced.**
- **The percentage of the forest floor covered by blackberry species, which are preferred by deer, decreased.**

Dr. Stephen B. Horsley received a B.S. in Forestry from Pennsylvania State University in 1965. In 1968 and 1970, respectively, he received an M.S. in Forest Ecology and a Ph.D. in Plant Physiology from the Department of Forestry and Wildlife Management at the University of Massachusetts. Since 1972, Horsley has worked as a Plant Physiologist at the USDA Forest Service Northeastern Research Station. He has been located at the Forestry Sciences Laboratory in Warren, PA, since 1973.

During his career, Dr. Horsley has worked extensively on problems of forest regeneration, including plant-plant and deer-plant interference relationships, and methods of vegetation management. Recently, he and his collaborators have studied the factors contributing to sugar maple decline in Pennsylvania. Dr. Horsley is an active participant in workshops and training sessions designed to help forest and resource managers use the results of his research to improve the sustainability of their management practices.

Dr. Horsley serves as an Associate Editor of the *Canadian Journal of Forest Research*.

Dr. Susan L. Stout was educated at Radcliffe College of Harvard University (A.B. 1972), the State University of New York (M.S. Silviculture 1983), and Yale University (D.F. 1994). Since 1981, she has been employed as a research forester with the United States Forest Service Research Project located in Warren, PA. In 1991, she was named leader of the research team at that location.

Her research interests include measuring crowding and diversity in forests, deer impact on forests, silvicultural systems, and translating results from ecosystem research into practical management guidelines for Pennsylvania's forests and beyond. Currently, she is collaborating with the Sand County Foundation and several landowners in a demonstration project called the Kinzua Quality Deer Cooperative. Landowners, land managers, hunters, and scientists are working together to improve both hunting and habitat on a 74,000 acre landscape in northwestern Pennsylvania. She is an active participant in the annual workshops in sustainable forestry offered by the Warren Forestry Sciences Laboratory team, at which techniques for recognizing and managing deer impacts are an important subject.

Drs. Horsley and Stout's address is: USDA Forest Service, Northeastern Research Station,
PO Box 267, Irvine, PA 16329; Tel: 814-563-1040; Email at shorsley@fs.fed.us and sstout@fs.fed.us.