

Deer browsing is just one of many factors shaping North American forests

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Seedlings that repeatedly are nipped off by browsing deer grow into shorter, stubbier saplings, according to the researchers, as this heavily browsed maple sapling clearly shows. Credit: Phillip Jones

In a new study, a Penn State-led research team discovered evidence that browsing by white-tailed deer had relatively little long-term impact on

two tree species in a northern forest.

The research took place in both fenced and unfenced plots in a one-square-mile area in the Flambeau River State Forest, Wisconsin, which had an estimated deer density of about 18–31 deer per square mile at the beginning of the study. With seven years of data, researchers examined survival and growth of [sugar maple](#) (*Acer saccharum*) and ash (*Fraxinus* spp.) [seedlings](#) and saplings with differing [light conditions](#) and levels of deer access.

Gaps of varying size—in which trees were removed to allow light to reach the [forest floor](#)—had been created in the study area by the Wisconsin Department of Natural Resources Division of Forestry to gauge how seedling growth rates responded. It turned out that survival of both species was greater in transition zones between gaps and full-canopy [forest](#).

The research is important because deer herbivory has a reputation for suppressing tree seedling development in northern hardwood forests, noted research team member Marc McDill, Penn State associate professor of forest management. For two decades his lab in the College of Agricultural Sciences has been studying forest management planning and economics, forest growth and yield modeling, and oak regeneration.

"In this study, deer had no discernible influence on height growth or survival of either sugar maple or ash seedlings," he said. "The truth is that seedlings in Northern hardwood forests respond to a complex of environmental factors in addition to deer herbivory, such as light availability, [soil quality](#) and competition from understory vegetation like blackberry."

The study was novel, according to Phillip Jones, postdoctoral researcher in Penn State's Department of Ecosystems Science and Management,

who spearheaded the research, because root-collar diameter of seedlings and saplings was used as a measure to gauge the impact of deer browsing. It is believed to be the first time the method has been used in such research in North America.

Greatly simplified, seedlings were evaluated based on the relationship of root-collar diameter and sapling height. The researchers used allometrics, which in this case describe how characteristics of trees change with size at different rates, specifically when the width of the sapling's trunk grows at a rate greater than its height. Seedlings that are repeatedly nipped off by browsing deer, Jones explained, grow into shorter, stubbier saplings (see video above).

"Our study showed that seedlings were more greatly influenced by light availability, size attained before gaps were created and soil nitrogen than deer browsing," Jones said. "Seedling growth was slow under even the best circumstances—as is typical in a northern forest—and gap capture was attained by saplings that responded more vigorously to gap creation."

In findings recently published in *Forest Ecology and Management*, the researchers noted that evidence of browsing was initially greater in unfenced treatments but declined through time, eliminating this difference. Seven-year survival of saplings of both species was correlated positively with larger initial root-collar diameter and was greater in transition zones between gaps and dense canopy.

Also, soils high in available nitrogen positively influenced height growth of sugar maple in transition zones but did not influence ash growth, the researchers reported. Although sugar maple height growth was correlated positively with initial root-collar diameter, greater initial height portended reduced growth rates in both species.

More research is needed to determine if root-collar diameter allometric measurements and equations are accurate enough to be used by forest managers to estimate deer-browsing impacts, Jones suggested.

"Direct correlation of browse damage with deer density is less important than the ability of an index to assess the degree to which such damage delays or imperils successful canopy replacement with desirable regeneration," he said. "But further investigation of the root-collar diameter/height relationship is needed across a range of both [deer](#) densities and forest management scenarios to accurately assess its potential for reliable assessment."

More information: Phillip D. Jones et al, Northern hardwoods seedlings respond to a complex of environmental factors when deer herbivory is limited, *Forest Ecology and Management* (2022). [DOI: 10.1016/j.foreco.2022.120600](#)

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