

Northern Research Station

Rooted in Research

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Private Lands Hold the Key to Oak Sustainability in Eastern U.S. Forests

In the eastern United States, oak ecosystems historically dominated eastern hardwood forests and provided significant ecological, economic, and aesthetic benefits. However, shifts in forest composition—attributed to factors including fire suppression, climate change, land use changes, and management practices—have led to a rise in shade-tolerant, mesophytic species like maples. These shifts have implications for biodiversity and ecosystem function as oaks are gradually replaced by species that have different ecological roles.

A recent publication by scientists Lauren Pile Knapp and Jacob Fraser (U.S. Department of Agriculture, Forest Service, Northern Research Station), Shengwu Duan and Hong S. He (University of Missouri), and Thomas W. Bonnot (U.S. Fish and Wildlife Service) examines the long-term sustainability of oak populations on managed public and private lands in the eastern United States. Using the LANDIS PRO forest landscape model, the researchers analyzed how current and alternative management practices on public and private land can influence the balance of oak and maple species over a 150-year period in southeastern Ohio.



A contractor felling a tree next to a set of white oak trees on the Wayne National Forest in Ohio. USDA Forest Service photo by Kyle Brooks.

Simulating the Forests of the Future

The researchers used LANDIS PRO to simulate forest composition changes over a 150-year period under two management scenarios:

- Business-as-usual (BAU)—current, relatively limited management interventions
- Alternative management (AltMgt)—more intensive timber management practices aimed at promoting oaks and decreasing maples

The simulations explored four scenarios to disentangle the effects of management strategies on private and public land:

- Scenario 1—BAU on both private and public land
- Scenario 2—AltMgt on both private and public land
- Scenario 3—BAU on private land and AltMgt on public land
- Scenario 4—AltMgt on private land and BAU on public land

KEY MANAGEMENT IMPLICATIONS

- Approximately 57 percent of forest land in the eastern United States is privately owned. Private lands play an important role in oak sustainability.
- Under current forest management practices, oak populations will continue to decline, and mesophytic species, such as maples, will become more dominant on the landscape.
- Alternative management strategies, including increasing the use of shelterwood harvests and thinning, can foster a more diverse range of oak size classes and reduce maple competition. These methods support oak regeneration and also control maple expansion.
- LANDIS PRO is a forest landscape model that can help researchers and land managers evaluate how different management actions can affect forests into the future.

The study area comprised about 2.1 million hectares north of the southern unglaciated Allegheny Plateau in Ohio. More than 87 percent of this land is privately owned. Public lands in the study area had strict fire suppression before the 1970s, leading to more red maple in the understory. Current forest management on public land aims to sustain oak-dominated forests, ensure a variety of tree ages and sizes, and promote plant species that are valuable for wildlife. Private owners vary considerably in their management objectives and practices. For example, some landowners may prioritize short-term profits, leading to selective harvesting practices that often reduce oak populations and increase in maple dominance. Other landowners do not actively manage their land.

Model Results

Under the BAU management approach, the model showed a fivefold increase in total maple basal area over a 150-year period and a doubling of maple-dominated forest types on both public and private lands. By 2160, maples accounted for more than 50 percent of the total forest dominance, compared to between 22 percent and 26 percent for oaks. This result confirms the competitive advantage of shade-tolerant maples in current forest conditions, where fire suppression and limited active management have allowed maples to outcompete oaks.

In contrast, model results over the same period indicated that the AltMgmt approach significantly improved oak sustainability by fostering diverse size classes and suppressing maple dominance. Alternative management strategies, such as guided harvesting with professional foresters on private lands, indicated an increase in oak basal area. Other alternative strategies, such as shelterwood harvests and multiple targeted thinnings, also created more favorable conditions for oak regeneration.

The Importance of Private Land Management

The model projected that private lands will play a crucial role in the dynamics between maple and oak over the next 150 years. In scenarios where only private lands were managed intensively, oak populations stabilized regionally. In contrast, in scenarios where only public lands were managed intensively, the impact on oak populations at the landscape scale was limited. This finding emphasizes the significant role that private land and private landowners' management actions can have in shaping forest composition and the sustainability of oak forests into the future.

In addition, the model suggested that interactions between public and private lands are important. For example, the spatial arrangement and connectivity of these lands affected seed dispersal and management outcomes. Public forests managed to promote oaks can act as seed sources, supporting oak regeneration on nearby private lands.

Pile Knapp summed up the findings this way, saying, "Active forest management can help shape the composition of forests into the future. Without that, successional processes may transition forests in ways we might not want for a variety of reasons. Active forest management is needed to favor light-demanding species like oaks in the long run."

FURTHER READING

Duan, Shengwu; He, Hong S.; Knapp, Lauren S. Pile; Bonnot, Thomas W.; Fraser, Jacob S. 2023. [Current management in national and state forests has important but limited impacts on sustaining oaks in temperate forests of the eastern U.S.](#) In: Forest Ecology and Management. 546(5): 121331. <https://doi.org/10.1016/j.foreco.2023.121331>.

Duan, Shengwu; He, Hong S.; Pile Knapp, Lauren S.; Bonnot, Thomas W.; Fraser, Jacob S. 2024. [Private land management is more important than public land in sustaining oaks in temperate forests in the eastern U.S.](#) Journal of Environmental Management. 35217–25 3: 120013. <https://doi.org/10.1016/j.jenvman.2023.120013>.

PROJECT LEADS

[Lauren Pile Knapp](#) is a research ecologist with the Northern Research Station in Columbia, Missouri. Her work emphasizes four aspects of forest management: invasive plant ecology, climate adaptation and disturbance, new approaches to vegetation management, and supporting bees and other pollinators.

[Jacob Fraser](#) is a research ecologist with the Northern Research Station in Columbia, Missouri. He uses ecological models to estimate the effects of climate, disturbance, and management on trees and forests. He is also interested in using nationwide inventory data in forest landscape models to help answer land management questions.

[Cherie Fisher](#) is the author of this Rooted in Research science brief.

[Forest Service Research and Development](#) works with partners to deliver the knowledge and tools that land managers need to sustain the health, diversity, and productivity of our Nation's forests and grasslands for present and future generations. The Northern Research Station (NRS), one of seven FS R&D units, is rooted in the geography of the Northeast and Midwest. NRS science supports a sustainable future.

For questions on Rooted in Research, please contact [Andrea Brandon-Hennig](#). Technical editing by [Carol Hollar-Zwick](#). Design and layout by [Jeremy Siegrist](#).

