USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northern Research Station

Rooted in Research

ISSUE 52 | SEPTEMBER 2025

Restoring Natural Red Pine Woodlands

In Michigan, Wisconsin, and Minnesota, 76 percent of the more than 800,000 hectares of red pine (*Pinus resinosa*) forests are plantations. Plantations of commercial timber species have increased over the last several decades due to the global demand for wood. In the western Great Lakes region, many of these plantations are on sites where red pine occurred naturally and were sometimes established on abandoned farmland that was unproductive for agriculture.

Although red pine is often the only species in the overstory of plantations, red pine historically grew alongside eastern white pine (*Pinus strobus*), jack pine (*Pinus banksiana*), and other tree species. Natural red pine ecosystems are characterized as woodlands, ranging from open barrens on the most xeric sites (dry, infertile sites with acidic soils) to closed canopy woodlands on dry-mesic sites (dry-mesic soils with a moderate supply of moisture).

Restoring red pine plantations to the native tree and plant species that grew on these sites and supported wildlife and plant diversity is the basis of a 15-year study conducted by Brian Palik and Douglas Kastendick, scientists with the U.S. Department of Agriculture, Forest Service, Northern Research Station. Palik and Kastendick studied the effects of silvicultural restoration on post-agricultural pine plantations in the Red Lake Wildlife Management Area (RLWMA) in northwestern Minnesota. Their study results were published in the journal Forest Ecology and Management.

Study Site and Methods

The RLWMA encompasses 130,000 hectares of mixed subboreal upland and lowland forest types and is where red pine plantations were planted on abandoned agricultural land by the Civilian Conservation Corps and the Resettlement Administration in the 1930s and 1940s. Seeking to restore plantations to native plant communities at the RLWMA, the Minnesota Department of Natural Resources partnered with researchers to compare changes in composition and structure of red pine woodlands over a 15-year period in response to two contrasting silvicultural approaches aimed at restoration: irregular shelterwood with either dispersed or aggregated tree retention.

STUDY OBJECTIVE

This long-term research examined how two silvicultural approaches—irregular shelterwood with dispersed or aggregated retention, which involved different spatial patterns of thinning and regeneration harvesting—influenced the development of woody plant communities in red pine plantations that were established on abandoned agricultural lands.

The silvicultural approach used combinations of direct seeding of tree species, silvicultural thinning, and regeneration harvests to move structurally simple plantations toward spatially variable structure and species-rich composition of native pine woodlands. They varied the spatial pattern of residual trees, from uniform thinning and regeneration harvesting with dispersed retention (dispersed treatment) to gap-focused cutting with aggregate retention that approximated an expanding gap irregular shelterwood (aggregated treatment).

An opening in the aggregated retention treatment showing diverse tree species regenerating. USDA Forest Service photo by Brian Palik.

Results and Management Considerations

The researchers reported that both treatments produced increased understory woody species abundance, including sapling, large regeneration, and small regeneration layers; changes in the understory composition; and conditions reflecting native red pine woodlands, including mixed species composition and variably open canopy cover. They also found that the aggregated treatment produced increased importance of several native tree species in the sapling layer, resulted in greater spatial variability of structure and greater importance of shade-intolerant tree species, and moved the plantations closer to native woodlands faster than the dispersed treatment. This treatment likely resulted in more diverse habitat conditions for native wildlife species.

An important management consideration for the silvicultural approaches studied is that low intensity surface fire, which would have occurred historically in these woodlands, was not reintroduced. With reintroduction of prescribed fire that emulates a natural fire regime, the compositional and structural responses may be accelerated and longer lasting.

The researchers note that these approaches could be applied to restoration efforts in other types of conifer plantations.

KEY FINDINGS

- Researchers compared two silvicultural treatments based on an irregular shelterwood with either dispersed or aggregated tree retention to transition red pine plantations in the western Great Lakes region to an overstory structure and woody plant community more representative of natural open-canopy woodlands formerly on the sites.
- Combinations of direct seeding of tree species, silvicultural thinning, and regeneration harvests can move structurally simple plantations toward spatially variable structure and species-rich composition of native pine woodlands.
- The study's silvicultural approach did not include low intensity surface fire, which historically was integral to the structure and function of red pine dominated woodlands. The addition of prescribed fire may accelerate the transition to woodland conditions.
- The findings have applications to broader conifer plantation restoration.

ECONOMIC VALUE

Both silvicultural practices led to similar harvest volumes of red pine sawtimber and pulpwood and supported restoration and sustainability of wildlife habitat and plant species diversity.

Natural regeneration of red pine following thinning and regeneration harvest in the dispersed retention treatment. USDA Forest Service photo by Douglas Kastendick.

PROJECT LEADS

Brian Palik is a retired senior scientist in applied forest ecology with the USDA Forest Service, Northern Research Station.

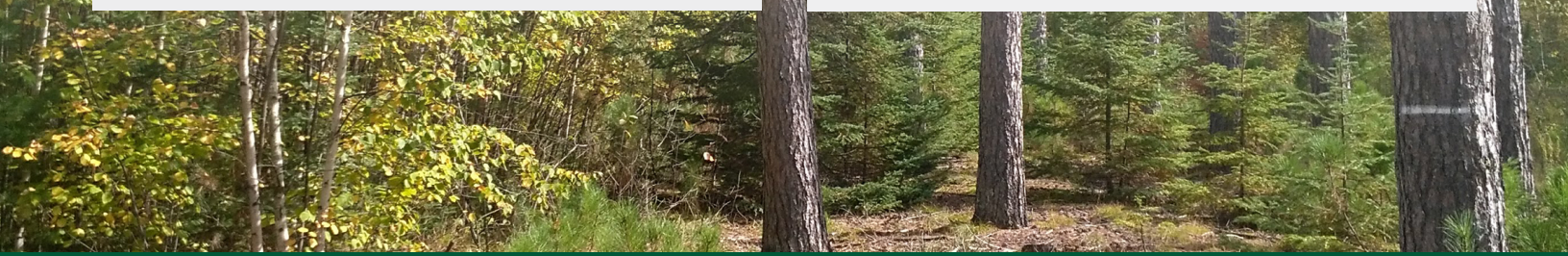
Douglas Kastendick is an ecologist with the USDA Forest Service, Northern Research Station.

Andrea Brandon is the author of this Rooted in Research science brief.

FURTHER READING

Palik, Brian J.; D'Amato, Anthony W. 2019. Variable retention harvesting in Great Lakes mixed-pine forests: emulating a natural model in managed ecosystems. Ecological Processes. 8(1): 16. https://doi.org/10.1186/s13717-019-0171-y.

Palik, Brian J.; Kastendick, Douglas N. 2023. Restoration of woody plant communities in red pine plantations on abandoned agricultural land in northern Minnesota, USA. Forest Ecology and Management. 541(3): 121095. https://doi.org/10.1016/j.foreco.2023.121095.



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 Jenna Zukswert. Technical editing by Carol Hollar-Zwick. Design and layout by Jeremy Siegrist.

Forest Service|**Northern Research Station**