US FOREST SERVICE NORTHERN RESEARCH STATION

Research *Review*

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Photo by Brian Palik, U.S. Forest Service.

Helping Great Lakes Pine Forests Adapt to an Uncertain Future

The iconic Great Lakes pine forests of Minnesota, Wisconsin, and upper Michigan are now greatly simplified in composition and structure compared to their historical equivalents from before the extensive logging and fires that started in the mid to late 1800s. Forests that had been composed of mixtures of red pine, eastern white pine, jack pine, and many hardwood species are now dominated by red pine alone or have been converted to aspen or oak. Many of these contemporary forests have simplified age structures, with trees that are mostly a single age; many of these forests are plantations.

Increasingly, organizations and agencies are interested in restoring these forests using a natural models approach, which involves management based on understanding how forests develop naturally, without much human interference. However, in this era of concern about the effects of climate change, invasive species, and changing markets for timber, among other things, the natural models approach cannot simply mean a return to past conditions. Quite simply, we can't go back; red pine shoot blight, fire suppression, and deer over-population have been let out of Pandora's box. Both managers and forests must adjust to contemporary and also to anticipated future conditions and needs.

continued on page two

continued from page one

However, restoring species diversity and age-class mixtures of forests would help make them more resilient to future, possibly difficult, conditions. When forests include all their parts, including tree and understory species, age classes of trees, and large dead wood as habitat, the options for the future are increased greatly. For instance, a forest that is compositionally diverse is more likely to contain a species that is a climate change winner or is resistant or resilient in the face of a new insect or pathogen threat. Moreover, a forest that is structured similar to its natural condition in terms of age cohorts and tree densities may be less likely to suffer major change from drought or catastrophic wildfire or wind disturbance.

OPERATIONAL-SCALE ECOLOGICAL FORESTRY STUDIES

U.S. Forest Service scientists from the Northern Research Station (NRS), led by Brian Palik of the Grand Rapids, Minnesota, laboratory, are working with colleagues from the University of Minnesota, the University of Vermont, Iowa State University, and Michigan Technological University, and managers on the Chippewa National Forest to develop and test approaches for restoring red pine ecosystems using a natural models approach, to better position them to respond to an uncertain future climate, invasive species threats, and changing timber markets. They have worked to synthesize the scientific underpinnings of "ecological forestry" based on natural models and to develop practical guidelines that are applicable and adaptable to a wide variety of forests conditions, both nationally and internationally. Part of the challenge has been to develop and implement an ecological forestry approach while also meeting the needs for more traditional commodities management. In fact, to be widely implemented, restoration and management using a natural models approach depend on having a vibrant forest industry, as well as enthusiastic adopters of the ideas in both the private and public sectors. The Lake States region, with its functional timber industry and enthusiastic adopters among its many state, federal, county, private, and tribal land managers, has been the location of choice for large-scale forestry research by the Northern Research Station.

Red pine forest over 150 years old growing in the Cutfoot Experimental Forest of the Chippewa National Forest.
Photo by Brian Palik, U.S. Forest Service.

NATIONAL FOREST COLLABORATION ON NRS EXPERIMENTAL FORESTS

Over the past 10 years, Palik and his colleagues have initiated several large-scale (500 to 700 acres) experiments to create forests that are structurally complex and tree species rich, from a starting point of forests that are greatly simplified in structure and composition.

One such experiment was installed in 2002 on the Chippewa National Forest. On the study area (640 acres), researchers are examining several variable retention harvesting approaches in which some trees are "retained" in different spatial configurations during a regeneration harvest to better emulate the partial canopy disturbances (from fire and wind) characteristic of this forest type. In the traditional regeneration approach, all overstory trees are removed during a harvest, resulting in the planting or regrowth of an even-aged stand. After the harvest treatments in the experiment, the three native pine species, red, eastern white, and jack pines, were planted to better diversify the tree component. The research team is following a wide array of responses including tree growth, plant and bird communities, and disease interactions.

The newest experiment, being installed and harvested right now on over 500 acres within the Cutfoot Experimental Forest, tests several approaches for

adapting red pine forest to a projected warmer, drier climate. The experiment uses retention harvesting approaches similar to the previous experiment, but with a focus on reducing the negative consequences of drought. One treatment enhances the resistance of red pine to drought by maintaining stands at the low end of acceptable tree density, with the idea that there will be more soil moisture available to the remaining trees during drought. A second treatment increases resilience to declining habitat suitability for red pine caused by a warmer, drier climate, by focusing regeneration on native species that are projected to be climate change winners, such as eastern white pine and northern red oak. The most innovative treatment is designed to transition these forests to future-climate-adapted species that are native to somewhat warmer, drier climate zones, including ponderosa pine and white oak. Will there be some failure of these species in the short term? Most likely, but the time for researchers to be testing adaptation approaches is now. Relevant research must include assisted migration of new species, if healthy forests are to be maintained on these landscapes.

CUTFOOT EXPERIMENTAL FOREST

Red pine is the state tree of Minnesota and an important component of northern forests, with diverse uses that include lumber, pulpwood, wildlife habitat, windbreaks, and Christmas trees. Much of what we know about the ecology, productivity, and management of red pine has been learned through long-term silviculture experiments conducted on the Cutfoot Experimental Forest in northeastern Minnesota. These experiments could not have taken place without a remarkable 65-year partnership between the scientists at the Northern Research Station and staff of the Chippewa National Forest.

One of the great challenges of maintaining such a long-term partnership is the change in staff over the years. Red pine studies on the Cutfoot Experimental Forest and elsewhere on the Chippewa National Forest have spanned the careers of three generations of scientists and national forest staff.

"The partnership success is built on mutual respect and trust and recognition that our respective organizations cannot do their jobs without each other,"* said Research Ecologist Brian Palik. *"We rely on the Chippewa to partner with us to design and implement our experimental treatments. In turn, we provide the forest with information on how to maintain the health and productivity of red pine forests."

NRS partners from Chippewa National Forest at a recent natural models workshop. Photo by Kristel Kern, U.S. Forest Service.

THE NATURAL MODELS APPROACH

Brian Palik has been active in presenting workshops to land managers about his **natural models approach**. Working with many colleagues, including Jerry Franklin at the University of Washington, he has offered a series of highly successful workshops in ecological forestry, based on the natural models approach, in the Lake States, the Pacific Northwest, and the Southeast. These workshops have reached more than 800 professionals from most natural resource management entities in most every forested state of the lower 48 states.

There are three foundational principles that underlie the natural models approach:

Incorporating legacy management into harvest prescriptions. Natural disturbances typically leave a rich legacy of structures, organisms, and patterns in the new forest that are important ecologically; these legacies are sometimes managed against by traditional forestry. A natural models approach deliberately focuses on what is left after a harvest, in terms of legacy structures, including large old trees, noncommercial species of habitat importance, and large dead wood.

This area has been managed for legacy structures and patterns during regeneration harvest, such as the patches and individual red pine in this harvest on the Chippewa National Forest in Minnesota.
Photo by Brian Palik, U.S. Forest Service.

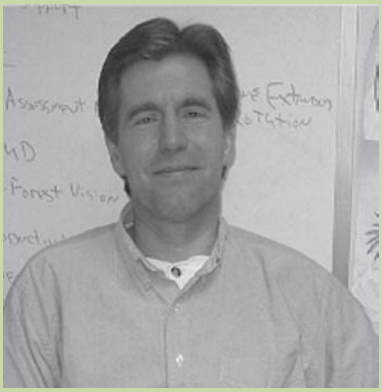
Use of intermediate treatments can accelerate development of heterogeneity of structure. Variable density thinning creates variations in tree density in this red pine plantation, including gaps where paper birch may regenerate. **Photo by Doug Kastendick, U.S. Forest Service.**

Using intermediate treatments such as variable density thinning to emulate stand development processes that create heterogeneity. Stand development processes in established stands, particularly tree decline and mortality, result in structural and compositional heterogeneity, that is not typically seen in managed forests. Variable density thinning is an approach to speed up the development of that heterogeneity, all with the aim of creating a variety of habitats for tree, plant, and animal species.

Allowing for longer recovery periods between regeneration harvests. Recovery periods between natural disturbances tend to be long enough to allow structural complexity (i.e., large old trees, big snags, dead trees on the ground, and diverse tree communities) to develop but are often greatly shortened with traditional forestry. A natural models approach bases rotation age and cutting cycles on ecological rather than financial maturity.

Appropriate recovery periods between regeneration harvest allow desired conditions to develop, including such large, old living trees and dead wood, as shown here. **Photo by Shawn Fraver, U.S. Forest Service.**

BIOGRAPHY



Brian Palik is a research ecologist at the Northern Research Station's Grand Rapids, MN, laboratory. He received his PhD in forest ecology (1992) and an MS in plant ecology (1988) from Michigan State University, East Lansing; and his BS in biology from Alma College, Michigan (1983); he also studied tropical ecology (1987) at the Organization for Tropical Studies in Costa Rica. Palik is an adjunct faculty member at the University of Minnesota; Iowa State University; Michigan Technological University, Houghton; and Lakehead University, Thunder Bay, Ontario. His research focuses on understanding how forests respond to natural disturbance and development and how that understanding can inform management. He works with many partners, including the staff of several national forests, as well as scientists and graduate students at Iowa State University, Michigan Technological University, the University of Minnesota, the Universities of Vermont and Maine, Lakehead University, and the U.S. Geological Survey.

RESOURCES AND REFERENCES

Web Resources:

Forest Management Guides: www.nrs.fs.fed.us/fmg/nfmg/

USDA Forest Service, Cutfoot Experimental Forest: www.nrs.fs.fed.us/ef/locations/mn/cutfoot/

Guide to Experimental Forests and Ranges of the United States: www.nrs.fs.fed.us/pubs/6741

Ecological Forestry Resource Center: www.forestguild.org/ecological-forestry

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There are 111 NRS scientists working at 20 field offices, 24 experimental forests, and universities located across 20 states, from Maine to Maryland, Missouri to Minnesota.

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