REIMAGINING THE GREAT LAKES PINE FOREST

The north woods of the Great Lakes region are defined by iconic red pine forests. Once viewed as simple even-aged stands of red pine, scientists have uncovered the true nature of these forests as complex multi-aged, mixed-species woodlands. This reimagined view is changing the way these forests are managed.

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For a century, scientists and foresters have viewed red pine forests of the western Great Lakes region as structurally simple, single-cohort stands of red pine originating after stand-replacement fire. Management has largely emulated this perceived model by growing even-aged plantations of red pine. Using stand reconstructions in old-growth forests, along with historical evidence, researchers have determined that at least some of these forests could naturally have complex age structures, ranging from single age-cohorts with 60 year establishment periods to three-age-cohort structures, with trees establishing in gaps (Figure 1).

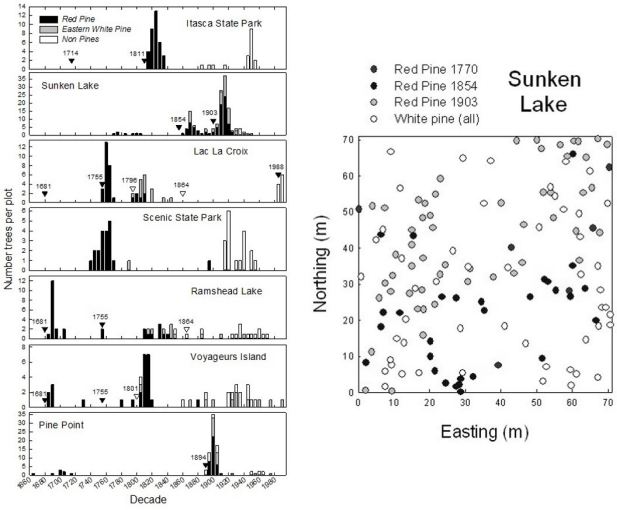
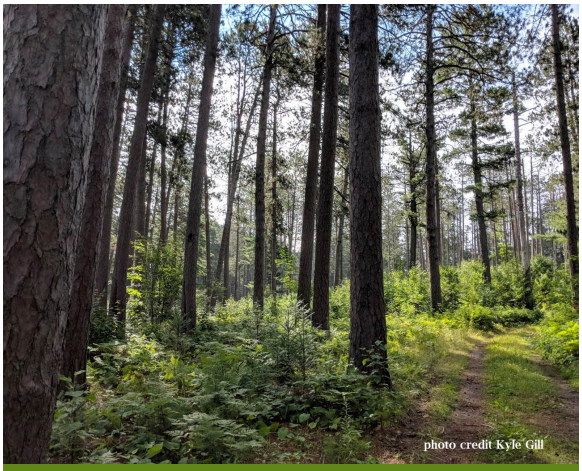


Figure 1. a) Age structures of old-growth red pine stands in Minnesota, USA, showing a variety of forms, including broadly one-cohort, two-cohort, and three-cohort structures. Dates are known fire occurrences. b) Spatial arrangement of trees in an old-growth red pine stand; Sunken Lake Natural Area, Minnesota, USA. Red pine trees are listed according to cohort establishment dates; establishment dates for eastern white pines are pooled. (Redrawn from Fraver and Palik 2012.)



MANAGEMENT IMPLICATIONS

1. Red pine dominated forests of the western Great Lakes region where more structurally complex and tree species rich than generally reflected in timber-focused management approaches.

2. These characteristics result from a mixed-severity, spatially patchy natural disturbance regime, largely from fire.

3. Variable retention harvest combined with emulation of surface fire, either with prescribed fire or another surrogate approach, can be used to achieve structural and compositional characteristics that are closer to the natural model than achieved with traditional timber-focused approaches.

4. Managers might consider silviculture of red pine forests using a natural model when their objectives include restoring or sustaining a broad range of ecosystem services in addition to timber production.

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Moreover, these forests consisted of mixtures of up to 12 tree species. Other species of varying abundance included eastern white pine, jack pine, balsam fir, white and black spruce, trembling and bigtooth aspen, red maple, northern red and bur oak, and paper birch, species spanning a wide range of silvical characteristics.

This composition and structure reflects a mixed-severity, spatially patchy disturbance regime characterized by frequent fires (e.g., 9 to 23 year mean fire return interval on the Cutfoot Experimental Forest in northern MN), along with wind and root-rot disturbances. These were mostly surface fires, but with some developing into crown fires. Importantly, fires that killed canopy trees were often (but not always) patchy within stands, and thus they could be less than stand replacing and certainly varied in their severity across a landscape. Additionally, large-gap or patch-scale tree mortality from wind and root-rot fungi, were likely important drivers of heterogeneous stand structures and variation in composition, reinforcing the complex structure resulting from patchy fire.

Armed with this knowledge, researchers have developed a silvicultural approach for red pine forests that emulates the natural model of disturbance and development. The approach centers on variable retention harvesting (VRH) as emulative of natural canopy disturbance. VRH application reflects the heavy, but partial canopy removal of natural disturbance that is characteristic of this ecosystem and resulted in more than trivial numbers of legacy trees surviving in regenerating stands. With VRH, legacy trees span a range of diameters, but favor the larger end of the diameter distribution, as this reflects the likely pattern of survival after fire. VRH can be applied in ways that vary the spatial pattern of legacy trees in and among stands, but largely in ways that reflect the pattern of spatially patchy canopy structure, with large openings surrounded by less disturbed matrix, as occurred with a natural disturbance regime (Figure 2).

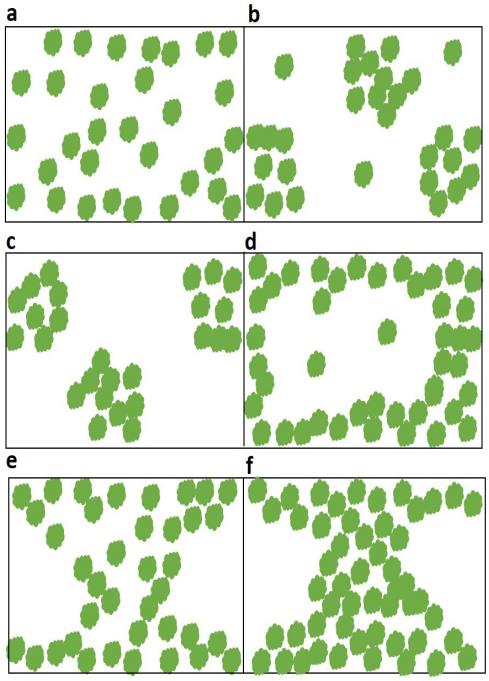

Figure 2. Conceptual representation of various types of variable retention harvesting in red pine ecosystems. Retention may be implemented as dispersed trees (a) or aggregated with or without some dispersed trees in the harvested matrix (b, c). Alternatively, retention may be implemented as large gap (patch) openings with a few retained trees in the opening (d) or as smaller patch openings with or without thinning of the forest between the openings (e,f).

With VRH, legacy trees, as well as deadwood structures, should reflect the composition of the pre-disturbance forest. Most trees, snags, and logs will likely be red pine, but eastern white pine and other tree species should be included if they occur in the stand. Finally, the long potential life spans of red and eastern white pines, with associated growth and structural development even after a disturbance, and the long potential tenure of legacy snags and down logs, requires VRH approaches that incorporate plans for documentation of retained structures and clearly stated long-term objectives for their management to maintain functionality.

The silvicultural prescription should also include emulation of frequent surface fires that reduced shrub and hardwood encroachment and exposed mineral seedbeds. Some combination of prescribed fire, mechanical site preparation and competition control, or herbicides might be used to this end.

The researchers conclude that it is only by having a deeper understanding of natural disturbance and structural outcomes than heretofore has been available can silvicultural approaches for red pine forests be designed that better emulate the natural model.

Fraver, S., and Palik, B. J. 2012. Stand and cohort structures of old-growth Pinus resinosa *dominated forests of northern Minnesota, USA. Journal of Vegetation Science 23: 249-259.*

Palik, B. J., and D'Amato, A. W. 2019. Variable retention harvesting in Great Lakes mixed-pine forests: emulating a natural model in managed ecosystems. Ecological Processes 8: 16.