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Restoration of Eastern Old-growth Forests: there is no one-size-fits-all approach

By William S. Keeton

There is never a dull moment in the field of forestry. Societal expectations of forests change, new challenges arise, the science explores possible responses, and constant discussion ensues. Some might find the diversity of views in the forestry realm disheartening. These sometimes polarize, like other hot button issues. The oft competing advocacy around wilderness designation versus active, sustainable forest management is an example. These are, in my opinion, complimentary rather than mutually exclusive. Yet debate is essential for vetting new ideas and addressing complex challenges in a science-based profession like forest management.

Questions of how best to conserve and restore old-growth forests epitomize the tension between passive and active approaches at the center of U.S. forest policy debate for more than a century. Yet in recent decades great progress was made towards holistic sustainable forest management; what we might have called “the triad model” in the 80’s, “ecosystem management” in the ‘90s, or “management for complex adaptive systems” in the present day. Within this approach is the understanding that late-successional and old-growth ecosystems are key elements of complex, multifunctional landscapes. And usually that means both protecting what little old-growth forest remains as well as restoring more old-growth elsewhere to reestablish larger, more contiguous areas of complex forest habitat.

Structural and biological complexity created by tree mortality and disturbance in an old-growth forest used as a reference for silvicultural treatments tested in Vermont.

But opinions diverge on how best to restore old-growth, especially in the eastern U.S. where less than 0.5% of the primary forests extant before colonization remain today. In this context, should we rely on wildland areas where late-successional forests may redevelop passively? Or should we use silvicultural treatments to actively accelerate restoration where stand dynamics are profoundly altered or where older forest structures are severely under-represented?

As usual in forestry there is no simple answer. So much depends on the specifics. Are there invasive species? Has stand structure and composition been altered by fire suppression? How has land use history altered successional dynamics? What about the loss of keystone species and structures, like large American beech and American chestnut? How will climate change affect future successional trajectories? These challenges require a multi-pronged approach; there is no one-size-fits-all. This is where complete reliance on passive management carries great risk and takes us back decades in the forest management debate.

There is clear value in protecting remaining old-growth forests globally. But can we actually recover more old-growth into the future? The proposition that we might one day restore eastern old-growth within both protected and working landscapes is no longer theoretical, as it may have been in the early '90s when the concept was originally floated. At least a half dozen experimental studies since then, in the Upper Midwest, in northern New England, Quebec, and elsewhere, have proven that it is possible to actively restore old-growth characteristics in redeveloping secondary forests. Scientists have shown that modified gap-based silviculture, as well as irregular shelterwood and variable retention harvesting, can reintroduce some aspects of structural complexity and age-class diversity into secondary stands, while resulting in favorable regeneration, growth, and timber yield. Others have experimented with various ways of enhancing the downed log component. Most of these "natural disturbance-based" approaches add complexity to managed stands but are not intended or designed for full old-growth restoration.

Old-growth northern hardwood-hemlock forest used as reference for active silvicultural restoration, Adirondack State Park, NY.

In Vermont, I have tested a system called *Structural Complexity Enhancement* or SCE. Rather than trying to achieve old-growth structure and function overnight, the idea was to emulate the natural tree mortality and disturbance processes that direct how a forest develops over time…to push those along faster. SCE employs a variety of silvicultural techniques in tandem, each targeted at a different process of stand development or structural feature. We created small, irregularly shaped gaps to free up growing space for advanced regeneration and to regenerate new seedlings. The gaps were placed deliberately to also "crown release" many of the large, dominant canopy trees; previous work had shown that this method can dampen or arrest declining growth rates in larger trees. We used variable density marking to create horizontal heterogeneity. Some trees were either felled and left as downed woody debris, or deliberately pushed/pulled over to create both downed logs and tip-up mounds. Other trees were girdled to form snags, vital habitat for many wildlife species.

It worked, or at least mostly! SCE has proven effective at enhancing habitat characteristics for a range of late-successional biota, including herbaceous plants, salamanders, and fungi. The tree regeneration story showed ups and downs in seedling recruitment, survival, and establishment over time. But after 13 years of monitoring, SCE ultimately resulted in diverse and abundant regeneration, though competition with beech sprouts was a problem in certain patches, suggesting a need for beech control on poorer sites especially. On the economic side, the study found that SCE will at a minimum pay for itself and, when site and market conditions are favorable, generate enough profit to make it attractive for some landowners. Perhaps most exciting, however, has been the effect on carbon sequestration and storage. SCE resulted in much higher carbon storage than the conventionally harvested stands we compared against, an effect attributed to both the higher structural retention after harvest and unexpectedly high carbon uptake rates. Prospects look good for SCE and other types of old-growth silviculture as one part of the portfolio of carbon forestry options.

Structural Complexity Enhancement in a northern hardwood-hemlock forest in Vermont, 13 years following treatment.

Enthusiasm for old-growth conservation and restoration is spreading. For example, The Agency of Natural Resources in Vermont recently set a goal of transitioning 10% of the state's forest cover to old-growth. Some national forest lands in Wisconsin and Michigan's Upper Peninsula are now actively managing for old-growth structure. The Nature Conservancy is working with Maryland and other Central Appalachian states on old-growth restoration plans. Concepts borrowed from old-growth silviculture, like irregularly structured disturbance gaps and variable density thinning, are gaining popularity as techniques for managing for a diversity of bird habitats.

W. Keeton measuring tree heights in an active old-growth restoration area in Vermont. Photo credit: Kathleen Masterson, Vermont Public Radio

Many in our region are debating the relative merits of managing forests for either early- or late-successional habitats, and good arguments can be made on both sides. In my opinion, these are not mutually exclusive; we can do some of both. But we do need to be aware of the long-term implications of either approach. For example, over-use of practices like patch-cutting for early successional habitat will have the unintended consequence of shifting, over coming decades, too much of the landscape into a dense, stem-exclusion stage of development, where habitat quality and species diversity are the lowest of any successional community. At the same time, old-growth restoration might be prioritized where it would yield the greatest benefits, such as carbon storage, riparian functionality, and late-seral biodiversity, but de-emphasized where it might increase disturbance risks. Therefore, careful scheduling and planning of both early- and late-successional restoration treatments must go hand in hand at larger spatial scales.

Future old-growth in the East will differ from the past. Though our forests have shown remarkable resilience to widespread clearing in the 18th and 19th centuries, many features have changed or been lost along the way. As the climate changes and threats from invasive species expand, the deck will be shuffled again. Old-growth in some form will persist, even if forest composition changes and species ranges and co-occurrences shift. Adapting to global change will always require a suite of approaches – both passive and active – highlighting that there is no-one-size-fits all approach when it comes to either forest sustainability or natural climate solutions. Though the future is uncertain, with care and attention future generations will have the same experience of walking through an eastern old-growth forest that ours have enjoyed.