A publication of the Forest Conservation Program of Manomet Center for Conservation Sciences FMSN-2004-2 May 2004

forest mosaic science notes

"Late-successional" (L-S) forest is rapidly disappearing from managed forest landscapes in northern New England. L-S stands typically contain some trees 100-200 years old. Despite having a logging history, many L-S stands share species in common with true old-growth. Conservation strategies are needed to help landowners maintain and manage for L-S forest in the landscape.

Late-successional Forest:
A disappearing age class and implications for biodiversity

by John M. Hagan and Andrew A. Whitman

Next to conversion of forest to some other land-use (e.g., to house lots, shopping malls, agriculture), the loss of older forest age classes in landscapes managed primarily for wood is a major threat to forest biodiversity worldwide. In Finland, 5% of forest species are predicted to go extinct in the next 50 years, in part as a result of economically efficient modern forest practices. Many of the species at risk depend on characteristics of older forest age classes, such as large living trees, large standing snags, or fallen logs.

The 26-million-acre Northern Forest region is one of the most remarkable landscapes in North America. Although forest cover has remained stable or even increased, the loss of older forest age classes from this vast forested landscape could be leading us down a biodiversity path that already has unfolded in Scandinavia. Current conservation strategies, such as conservation easements and sustainable forestry certification, do not yet address this issue in a biologically meaningful way. At least in part, this is because the scientific community has not made the case. Here we provide some of the ecological rationale for maintaining late-successional (L-S) forest well-distributed throughout the region.

An "Invisible" Forest

It is not widely appreciated that even commercially managed timberland in northern New England still has a biologically significant component of L-S forest—stands in which there is a cohort of trees 100-200+ years old. Such old stands have been virtually "invisible" as either a conservation problem or conservation opportunity for several reasons.

First, ecologists and the environmental community have tended to focus on conserving "true" old growth, of which there is very little in our region. What old-growth remains has mostly been protected already. But forests develop along a continuum and along complex pathways; old-growth characteristics do not develop instantaneously at some magical age, but rather they accrue over time (Fig. 1). Thus even stands with a harvest history can have old-growth characteristics. Effective conservation of forest biodiversity requires us to see the forest as plants and animals see the forest, not as black or white (e.g., pristine old-growth vs. everything else). Many old-forest species do not understand the word "pristine" and occur in L-S stands with old-growth characteristics. Forest in the L-S stage and species that use L-S forest are slipping through the coarse filter of conservation.

Second, because we have underappreciated the ecological significance of forest with harvest histories, we have not built an understanding of biodiversity in L-S forest. We are relatively uninformed about what species might be lost if this age-class is lost from the landscape. Increasingly though, scientists are beginning to realize that the abundance of L-S forest in managed forests will likely make or break our success at conserving biodiversity in forest-dominated regions.

Based on field work throughout northern Maine since 1992, using timber company stand maps as a guide, we estimate there are potentially many hundreds, perhaps thousands, of stands that still contain many trees in the 100-200 year age class

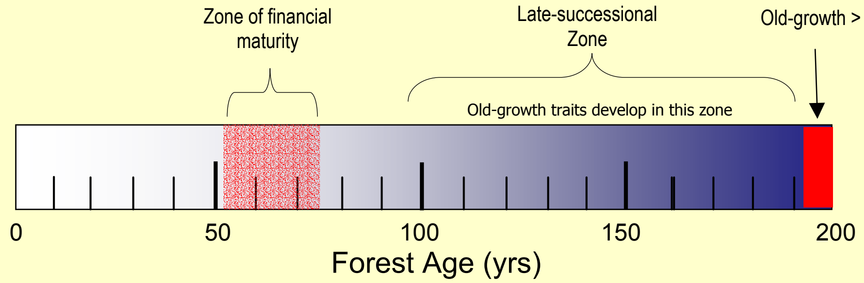

Figure 1. In northern hardwood (maple-birch) or softwood (spruce) stands, true old-growth develops at around 200(+/-) years old. Although stands can take many development pathways, old-growth characteristics begin to emerge when some trees in the stand reach about 100 years of age. Forest stands in the late-successional zone are rapidly disappearing because they are beyond the optimum financial stand age.

throughout the private, commercially-managed forest. However, most of these stands will be gone in five years unless we develop conservation strategies now. Public lands also contain some L-S forest and have a high potential to rebuild L-S forest over time, but the vast majority of the region is still privately owned and managed for timber. And that is not likely to change in the next 5 years.

Why is L-S forest still here?

Stands with 100-200 year-old trees remain today as relicts of a time when not all trees in a stand had market value. Some stands were far from the roads or waterways needed to transport the wood to mills. With an extensive logging road network today and markets for nearly all tree species of any size class, these economic constraints no longer apply. Also, there is much less incentive today for landowners to grow large trees. Large-dimensional solid lumber (e.g., 2 x 12s) is being replaced by engineered laminates that are stronger, and require only a couple of 2x4s, wood chips, and a lot of glue to make. Technology and efficiency are rendering older, larger trees much less important to wood manufacturing than just 20 years ago. Thus, the economic conditions that created the L-S forest we have today are gone.

What species are at risk?

Finland has one of the most successful and competitive forest products industries in the world. However, a time-lag effect on biodiversity has been irrevocably initiated as a result of efficiency and productivity. Approximately a thousand forest species are predicted to be lost from Finland in the next several decades (what Ilka Hanski calls "extinction debt," i.e., an ecological debt that has been incurred by past practices and that must be paid). The payment will come in the form of species loss because not enough habitat remains for *long-term* persistence; populations will diminish in size until gone.

Not all species—in fact the overwhelming majority of species—are not at risk as a result of modern forest practices. Many species benefit from timber harvesting. Not surprisingly, the species most at risk tend to be linked to L-S forest, an age class that is difficult to maintain in economically viable managed forests. Many of the at-risk species are dependent on large living trees, large dead trees, or fallen logs, features that are common to L-S forest but not younger forest or financially mature forest. They also tend to be small, non-charismatic species, such as mosses, lichens, fungi, and insects. Few of the charismatic species (e.g., birds and mammals) appear to be as tightly dependent on large *old* trees, though some do require large trees.

Neckera pennata (a moss) prefers to grow on large, old sugar maples. It rarely occurs in young managed stands unless there is a remnant 100+ year-old tree that was left during an earlier harvest. This same moss species occurs in Scandinavia, where it is considered an indicator of old forest and forest continuity.

Once old forest elements such as large trees or logs are lost from a stand (e.g., as a result of a clearcut, or even a selection cut), it can take centuries for the species to return to that location. A species first has to wait for these structural features to redevelop, and then the species has to find them. Scientists are beginning to understand that forest **continuity** is key to many forest species. Continuity refers to the persistence of big trees and big logs in a forest stand over a very long period of time (centuries), even though the stand might be subjected to many different disturbances, such as fire, wind, disease, or even selection logging. Species that move or disperse slowly through the landscape, *and* prefer large old trees or logs, are the species most at risk to the loss of L-S forest.

How much is enough?

Scientists cannot answer this question at present. Moreover, there is not enough time or money *to* answer the question before the question becomes moot. L-S stands tend to be precisely the ones scheduled for harvest in the next 1-5 yrs. Based on our field experience on many different land ownerships in northern Maine, we suspect that 4-6% might ecologically qualify as late-successional. Unfortunately, there is no publicly available dataset that can tell us how much L-S forest remains in northern New England. (Note: Two major private timber companies have offered to provide us with timber inventory data to try and answer this question). Our on-the-ground work indicates that the amount of L-S forest varies by township and is correlated with landscape harvest history and proximity to mills. However, L-S stands can be found even in heavily cut landscapes. We have found L-S forest in separation zones be-

This old (150 yr+) sugar maple is in a stand that was partially cut ~40 years ago, but only for a few species of economic value at the time. The tree is covered with mosses and lichens characteristic of old-growth. Although this stand is not "true" old growth because of its past harvest history, it nevertheless contains old-growth species. A stand does not have to be "pristine" to contain species associated with old-growth.

tween clearcuts. So far (10 years after harvest) these 250'-wide buffers appear to be holding on to L-S species. These observations, and data from several recent studies, suggest that it does not take large set aside areas to maintain these sensitive species, and that many small but very-high-quality (forest of "exceptional conservation value") areas might be a better strategy to maintain well-distributed populations of L-S species.

Current levels of L-S forest are low. The extinction debt described in Finland could already be at work. We simply do not know enough about species associated with L-S forest to know. From a conservation perspective, we would argue that we should keep as much of what remains as possible, and begin to "grow" new L-S forest, especially in commercially managed forest landscape since it dominates the landscape in our region. Remaining L-S stands will be critical, not only for maintaining existing species, but for helping to restore a larger percentage of the landscape to an L-S condition, if that becomes economically and socially possible. Once L-S forest is lost from large areas it may be simply impossible (practically and financially) to ever restore the sensitive, slow-moving, large-tree and log-dependent species.

It's the economy…

Nearly every economic trend, however, is pushing against the maintenance of L-S forest, more so than ever. L-S forest typically is in a steady-state condition whereby as much wood is dying as is growing each year. From a financial perspective such lack of "net growth" is a cost to landowners. To accrue financial value there must be net wood growth. To create net growth, L-S stands need to be cut, or at least thinned. In addition, the ability to make value-added products out of small diameter trees today places even greater counterincentives on allowing stands to reach a L-S condition.

By nearly all economic measures, such technological innovation leading to value-added products is good, even essential, for a viable wood products industry in our region, or in any region of the world. The critical question is 'can we find social, financial, and technical mechanisms to maintain and manage for L-S forest?' We do not have time for a protracted debate about how to do this. We need credible, fair, workable solutions right now.

What can be done?

The most immediate action needed is (1) to inform timberland owners about the importance of late-successional forest, and (2) to work with willing landowners to develop innovative late-successional management strategies. To begin this process we have developed a simple rapid-assessment field procedure that allows foresters to identify L-S forest during normal timber cruises (see box below). Several major timberland owners in Maine and environmental funders have facilitated development of this tool. Having such a tool is an important first step for taking conservation action on the ground; foresters have to 'know it when they see it' before they can conserve it.

The L-S Index: A rapid-assessment tool for foresters

One of the most immediate obstacles to conserving late-successional (L-S) forest is the lack of a simple tool to identify it. Ideally, we would like a field procedure that foresters could apply in a stand prior to harvesting so that they can assess its L-S quality. Such a tool should (1) be quickly implemented (<30 minutes), (2) not require any specialized taxonomic skills, (3) work in any season of the year, and (4) be accurate (it successfully identifies L-S forest). Such a tool would give foresters ecological knowledge about the stand, and thus allow them to adjust the harvest plan in order to retain as much L-S value as possible, or harvest another less ecologically valuable stand.

Andy Whitman, at Manomet Center for Conservation Sciences, has recently developed such a tool. The tool takes less than 30 minutes to conduct, and yields a score of 1 to 10 (10=old-growth). Any score over 7 indicates that the stand has substantial late-successional ecological value; the higher the score, the greater the L-S value.

The score is based on the density of large trees of selected species, the density of large logs on the forest floor, and the presence of 3 lichen species. Foresters only have to learn the 3 species, all of which are simple to identify at any time of year. For more information about the L-S Index, contact Andy Whitman at awhitman@ime.net, or call 207-721-9040.

Box 1- Some Ideas for Conserving L-S Forest

What can be done to maintain late-successional forest on private managed forestland? Below we list several ideas. None are mutually exclusive.

1. **Strengthen sustainable forestry programs**. The two leading sustainable forestry programs used in Maine (SFI and FSC) explicitly call for the maintenance of biodiversity. Consequently, effective and biologically meaningful management for late-successional forest should be a fundamental component of modern forest management planning. Several Maine landowners are pioneering "late-successional management regimes."

2. **Innovation with easements.** Paying landowners for the development rights of their forestland is already a common conservation strategy. A simple extension of this model would be to purchase timber rotation length on a portion of the landscape. That is, pay the landowner to allow some of their forest land to remain in (or grow into) a late-successional condition. Allowing forest to grow to, say, 150 years old, represents a cost to the landowner because the optimum financial return for rotation length is 60-80 years. Such late-successional stands could "move" throughout the landscape over the long term, but a fixed percent of the landscape would have to be in a late-successional condition at any point in time. The late-successional condition of the landscape could be verified with a slight modification to conventional timber inventory methods.

3. **Tax breaks.** In Maine, landowners get a tax break for land that has a legitimate forest management plan. An additional tax break could be given for acres in a late-successional condition, or in a late-successional management regime.

4. **Conservation Reserve Program model.** The federal government has paid farmers NOT to grow crops on some land so that it can return to native vegetation. An analogous program for forestland could be considered, whereby forest landowners are paid to NOT harvest wood (i.e., allow some of the forest to grow into a late-successional condition). This would not have to threaten the economic viability of the forest products industry, just as the Conservation Reserve Program has not threatened U.S. agriculture production.

5. **Late-successional "carbon credits."** Because airborne carbon is linked to global warming, carbon has been "monetized" to facilitate conservation action. Power plants, which produce carbon, can purchase "sequestered" carbon elsewhere to offset their carbon pollution. This offset is often forest in another region or country. Why not sequester carbon in the form of late-successional forest? Power plants upwind of New England could purchase late-successional "carbon credits" from Maine landowners, not only sequestering carbon but also protecting late-successional biodiversity (a great conservation value for the dollar).

Willing landowners aside, the financial challenge of maintaining enough L-S forest to be *ecologically meaningful* could be too great for landowners to bear. If this is true, we will need new financial and policy models (Box 1), as well as new silvicultural models. One potential model may be to pay landowners to maintain some portion of their ownership in L-S forest. This is the same idea as paying landowners *not* to develop their forest (i.e., the traditional conservation easement model). Landowners could be paid (compensated) to extend their timber rotation lengths on a portion of their landbase. The opportunity cost of extended rotations could be calculated, just as the value of development rights is calculated. By extending rotation length, landowners would be forgoing income from timber but providing a specific environmental value to the public—that of maintaining L-S forest as a functional part of northern New England's biodiversity heritage.

Conclusions

The goal of this report is to inform forest stakeholders about the largely unknown and highly vulnerable component of the northern New England forest. The rate at which remaining L-S forest is being lost is difficult to determine from existing datasets, but our field experience suggests that quick and creative solutions are needed. It is a reasonable supposition that once this age class is gone we will have crossed an "invisible" biodiversity threshold that will take decades to be fully understood or manifested. There may not be much time for us to avoid the biodiversity path taken by Finland—we are standing at a fork in the road.

This issue is not unique to Maine or even this region. The loss of older forest age classes is a common problem in managed forests around the world. We encourage conservation organizations, conservation leaders, land trusts, forest landowners, sustainable forestry programs, and scientists to work together to maintain late-successional forest and species, well-distributed and biologically functional, throughout northern New England, and beyond.

Acknowledgements

We thank Roger Milliken, Cathy Johnson, John Nordgren, Ben Niles, and Lucy LaCasse for valuable comments on an earlier draft of this paper. Our work on late-successional forest has been made possible by the U. Maine Cooperative Forestry Research Unit, the Harold Whitworth Pierce Charitable Trust, the Merck Family Fund, the Laird Norton Endowment Fund, the Maine Outdoor Heritage Fund, and the Joan Benson Baker Fellowship to JMH.

References and Further Reading

Esseen, P.-A., K.E. Renhorn, and R.B. Pettersson. 1996. Epiphytic lichen biomass in managed and old-growth boreal forests: effect of branch quality. Ecological Applications 6:228-238..

Franklin, J.F., D. Lindenmeyer, J.A. MacMahon, A. McKee, J. Magnuson, D.A. Perry, R. Waide, and D. Foster. 2000. Threads of continuity: disturbance, recovery, and the theory of biological legacies. Conservation Biology in Practice 1:9-16.

Götmark, F., and M.Thorell. 2002. Size of nature reserves: densities of large trees and dead wood indicate high value of small conservation forests in Sweden. Biodiversity and Conservation 12:1271-1285.

Hagan, J.M. and S.L. Grove. 1999. Coarse woody debris: humans and nature competing for wood. Journal of Forestry 97:6-11.

Hanski, I. 2000. Extinction debt and species credit in boreal forests: modeling the consequences of different approaches to biodiversity conservation. Annales Zool. Fennici 37:271-280.

Håkan, R., M. Diekmann, and T. Hallingbäck. 1997. Biological characteristics, habitat associations, and distribution of macrofungi in Sweden. Conservation Biology 11:628-640.

Hunter, M. L. Jr. 1989. What constitutes an old-growth stand? Journal of Forestry 87:33-35.

Lindenmeyer, D., and J.F. Franklin. 2002. Conserving Forest Biodiversity: a Comprehensive Multiscaled Approach. Island Press, Washington, D.C.

Nilsson, S.G., U. Arup, R. Baranowski, and S. Ekman. 1995. Tree-dependent lichens and beetles as indicators in conservation forests. Conservation Biology 9:1208-1215.

Selva, S. B. 1996. Using lichens to assess ecological continuity in northeastern forests. Pp. 35-48 *in* Eastern Old-Growth Forests: Prospects for rediscovery and Recovery (M. B. Davis, Ed.) Island Press, Washington, D.C.

For a comprehensive list of 120 relevant articles, visit our web site: www.manometmaine.org

Published by:
Manomet Center for Conservation Sciences
Forest Conservation Program
14 Maine St., Suite 305
Brunswick, ME 04011
(207)721-9040
www.manometmaine.org