Silviculture In The New Age Of Conservation

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Introduction

In his seminal book "The Practice of Silviculture," Smith (1962) compared the role of silviculture in forestry to agronomy in agriculture. Both are applied sciences dealing with managing ecosystems for human benefit. Silviculture is, as Bob Seymour notes in this volume, "where forestry meets the land." What is the relevance of traditional silviculture in an era of managing for multiple values as opposed to multiple uses? Do we need a "new silviculture" as suggested by terms like New Forestry, New Perspectives, Adaptive Management, and Ecosystem Management? What are the important gaps in knowledge about silviculture in the Lake States? How might silviculture contribute to conserving biological diversity, promoting ecosystem health and sustainability, improving forest aesthetics, and enhancing nontimber forest products?

These and many other questions were explored at the Silviculture Summit hosted by Michigan Technological University in April 2003. In my synthesis of these discussions, I explore a premise—that the emphases in silviculture on regenerating trees and on optimizing growing stock at the stand level are not sufficient by themselves to ensure ecological diversity, forest health, and sustainability at the stand level, and importantly, at levels beyond the stand. If this premise is proven, a corollary follows: to meet the broad objectives of ecological diversity, forest health, and sustainability, it is necessary to move beyond the false dichotomy of even- vs. uneven-aged silviculture.

Premise: Traditional Silviculture Has Landscape-Scale Consequences

The premise has to do with issues of scale, spatial relationships, and forest dynamics. During the past several decades, a model of forest dynamics has emerged in which forested landscapes are viewed as patchworks of individual stands at various stages of development ranging from stand initiation to old growth (Oliver and Larson 1996). The stand initiation stage follows disturbance in which a new population or cohort of trees becomes established. The stem exclusion stage is next and it is characterized by intense competition that limits tree regeneration. A third stage, understory reinitiation, occurs when the original cohort begins to decline and reductions in canopy density allow understory vegetation to establish and develop. The increases in structural complexity that occur during this stage—e.g., multi-layered canopies, the occurrence of coarse woody debris in many sizes and stages of decay, canopy gaps of varied sizes—begin to resemble an old-growth forest.

Under a regime of natural disturbances, these dynamics produce a landscape in which all stages of stand development are present at any given time. It is this variation in conditions that creates habitat (ecological) diversity that sustains ecosystem health (Aplet *et al.* 1988). Silviculture applications affect these spatial and temporal patterns, but the cumulative impacts of many individual silvicultural applications conducted at the stand level are poorly understood at the landscape level. Take the case in which no forest in the landscape is allowed to develop beyond rotation age. Doing so will effectively truncate the process of stand development and thus preclude any forest in the landscape from obtaining old-growth status. In hemlock-dominated stands in Wisconsin and Michigan, as an example, characteristics relating to tree density, tree sizes, diameter-age relations, and occurrence of logs in advanced stages of decay were related to a

minimum stand age of 275 to 300 years (Tyrrell and Crow 1994). For these forest ecosystems, stands that were 100 or even 200 years did not contain all the structural features that characterized a 300-year-old forest. When stand development is truncated, the result is a forested landscape that is less diverse than that expected under historical natural disturbance regimes.

Spatial relationships are receiving more attention in resource management because the composition, size, shape, and relative arrangement of spatial elements all affect the benefits and values that can be derived from the landscape. In one such application, Franklin and Forman (1986) evaluated the landscape-level implications of the staggered-setting system of clearcutting used on Federal lands in the Pacific Northwest. By interspersing small clearcuts within the matrix of continuous forests, the abundance of high contrast edges in the landscape increased dramatically, resulting in greater susceptibility to windthrow even after a relatively small proportion of the landscape had been harvested. A spatial pattern commonly resulting from human activities is fragmentation—that is, human activities tend to create small patches from large patches on the landscape (Bratton 1994, Mladenoff *et al*. 1993, Riitters *et al*. 2000, Wade *et al*. 2003). The point here is that land use creates landscape patterns that have social, economic, and ecologic significance, but our understanding of these relationships is rudimentary at best.

Corollary: The False Dichotomy Of Even- Versus Uneven-Aged Management

The work by Oliver and Larson (1996) on disturbance ecology and forest development provides the basis for the corollary—moving beyond the false dichotomy of even- vs. uneven-management (also Seymour, this volume). The full spectrum of stages of stand development, they argue, needs to be incorp-orated into a silvicultural system to produce a landscape in which all stages of forest devel-opment are present. The potential derivations in silvicultural applications available under the general rubric of Integrative Management, i.e., the conceptual region between Reserve Management at one extreme and Intensive Management at the other extreme, in the model presented by Brian Palik *et al*., and reviewed by Jack Rajala (this volume), seem almost unlimited. Viewing silvicultural systems and their related regeneration methods as static and rigid defies the richness and variety represented in ecological systems, the numerous environmental services provided by forests, and the basic human needs derived from these services.

Managing For Ecological Complexity

There is a new view of nature emerging that replaces centuries of scientific reductionism. Instead of viewing nature simplistically as the sum of its parts, dominated by linear responses, and near equilibrium, this new view characterizes nature as complex, dominated by nonlinear relationships, with a variety of behaviors that are expressed at different hierarchical levels within an ecological organization that often operates close to disequilibrium (Waldrop 1992). Using the new model of nature, a reasonable management goal becomes one of maintaining the complexity inherent in natural ecosystems. This is not venerating the notion that “nature knows best,” but this model does suggest there are many lessons that can be learned from unmanaged ecosystems and then applied to managing ecosystems for economic, social, and ecologic benefits.

Specific prescriptions for maintaining complexity will depend on the management objectives and the ecosystem. However, some general strategies have wide application. At the stand and landscape level, complexity involves composition and structure as well as function (process). Stands of mixed species composition can be used to achieve a variety of nontimber and timber objectives, such as enhanced soil fertility, fewer problems with insects and pathogens, and improved long-term forest productivity. Vertical structure includes the number, density, composition, and height of different vegetative layers. Creating multi-structured stands by developing species mixtures and retaining snags, other coarse

woody debris, and multiple cohorts can enhance both the compositional and structural diversity of forests (O'Hara 1998, Palik and Zasada 2003). Specific examples include maintaining spruce and fir in the understory of aspen forests in the Great Lakes region or retaining green trees as canopy residuals in Douglas-fir forests in the Pacific Northwest to enhance avian diversity (Hansen and Hounihan 1996).

Despite a common perception that uneven-aged management is a "kinder and gentler" forestry, it is not necessarily a panacea for protecting ecological diversity. Uneven-aged management tends to favor shade-tolerant trees and, furthermore, repeated entries may result in damage to the residual stand, compact the soil, and disturb understory species (Kent *et al*., in press). Uneven-aged management also requires maintaining an extensive road system that fragments the forest, creating dispersal corridors for some species and barriers for others (Forman *et al*. 2003).

Silviculturists have focused primarily on commercial tree species—a small but important part of the forest ecosystem. There is a marked difference between our knowledge about producing timber and the knowledge needed to sustain other outputs and values gained from the forest. This is not to suggest that we know all that needs to be known about producing wood; as Jack Rajala, Alan Lucier, and David Reed reminded us at the Silviculture Summit, much remains to be learned (see this volume). Producing more commercial wood more efficiently and producing higher quality wood remain important goals for silviculture. For understandable reasons, silviculturists have concentrated on those parts of forest ecosystems that provide direct benefits to humans, while those things that make ecosystems work have received much less attention. Managing to maintain complexity or managing for aesthetics may seem incompatible with maximizing wood production, but when viewed in the long term, conflicts become less apparent and even irrelevant. If managing for complexity maintains or enhances long-term forest productivity, then perceived conflicts between economic efficiency and ecologic sustainability become less onerous.

Conclusion

The reasons for applying silvicultural systems are expanding. In addition to growing wood, stakeholders now include aesthetics, sustainability, diversity, and conservation as measures of success (Cornett, Fernholz; this volume). A spatial perspective is helpful when applying silviculture techniques to achieve these broadening objectives. Without this perspective, the cumulative effects of multiple treatments in space and time can not be fully appreciated. While economic factors often promote the simplification of composition and structure in forest stands and landscapes, an "ecological approach" stresses managing for variety and complexity.

It will be necessary to develop many silvicultural systems to accommodate the many demands being placed on forest ecosystems, the great variety in ecosystem conditions, and the wide range of management goals that exist. As a result, a clear distinction between even- and uneven-aged systems will become less apparent. The limitations that we create through the rigid application of existing silvicultural systems limit our ability to adjust to changing needs and meet a broader set of goals through silviculture. Resource management is all about making better choices in a finite world; silviculture will be viewed as relevant when it helps us make better choices.

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