Silviculture and Management Strategies Applicable to Southern Upland Hardwoods

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Introduction

The southern upland hardwoods include extensive areas in the southern Appalachians, Cumberland Plateau and Ozark/Ouachita regions. The majority of commercial hardwoods in the south occur in the region often referred to as the "Southern Appalachian Region". For purposes of this discussion, this region includes the hilly or mountainous area west and north of the Piedmont and south of the glaciated portion of Pennsylvania. Using Fenneman's (1938) classification, this region is called the "Appalachian Highlands", and it contains parts of three physiographic provinces (Blue Ridge, Ridge and Valley and Appalachian Plateaus).

Hardwood stands in the southern highlands have experienced a similar history, including the impact of indigenous people (primarily fire), European land clearing, timber exploitation and agricultural abandonment. Hardwood forests today are mostly owned by small non-industrial private owners (NIPF) and are again reaching merchantable size bringing about a resurgence of commercial interest in them. Unfortunately, much of the harvesting being done is motivated by commercial rather than silvicultural considerations. Some of this is simply greed-motivated exploitation, but oftentimes individuals with good intentions lack the tools for making proper silvicultural decisions.

Land Ownership Characteristics

The motivation for forest activity for most NIPF owners is income, in spite of the fact that most of them do not rank commercial forest production as the primary reason for owning land. It is possible to combine commercial timber operations with forest stand improvement through application of appropriate silviculture in southern upland hardwoods. But, unfortunately, the type of timber harvesting most frequently being practiced on NIPF lands amounts to high-grading of one type or another. The contributing factors to poor forestry practices are a combination of lack of understanding on the part of landowners, a short-term view by some forest industries, consultant's fees being percentage based and poor business decisions on the part of logging contractors.

Forest landowners share certain attributes that help explain their behavior as well. Many are older. They have lived during times when much of today's forestland was in fields, a condition that they worked hard to maintain. In addition, many people, due to the practices of the past, believe that "timbering" is a once-in-a-lifetime affair. Thus many owners fail to see the value of their forestland and some, because of their age, think they may as well get it while they can.

It is incumbent on foresters to explain to landowners what planned forest management means and what is and is not possible. They need to know that even with relatively small tracts, it is possible to spread the income out over time while enhancing the future health, productivity and value of their forest. This may be a daunting task since foresters are going against beliefs that have been years in the making. Such as the fact that tree size is not necessarily a function of age.

Silvicultural Recommendations

This presentation uses concepts from my recent book *Ecology and Management of Central Hardwood Forests* (Hicks 1998) to describe the silvicultural methods that are appropriate to most upland hardwood stands. It is my goal to demonstrate that properly designed commercial harvests can utilize silviculturally sound concepts, and to provide descriptions of relevant silvicultural methods and their application to NIPF stands. I also hope to dispel the use of loose terms such as "selective cutting", and to encourage foresters to develop a vocabulary that is appropriate and descriptive of the practices being recommended. Finally, I want to stress that in hardwood stands, it is often necessary to apply several silvicultural methods simultaneously and management of hardwood stands must remain adaptable to changing market conditions and natural occurrences such as insect and disease outbreaks.

Most silviculture and forest management texts emphasize "traditional" approaches based on German methods, which evolved from working in fairly simple coniferous ecosystems. Some of these methods are appropriate to hardwoods, while others are not. Silvicultural methods are generally grouped into treatments that are used to tend existing stands (intermediate operations) and those that are aimed at regenerating new stands. Hardwood silviculture differs markedly from pine silviculture in both areas. For the most part, due to topography, economics and the abundance of natural regeneration, plantation silviculture is seldom practiced in hardwoods. Also, hardwoods almost always occur in mixed-species stands where commercially valuable and low value trees are intermingled. The objectives of management must work in concert with the natural ecosystem processes. Intermediate cuttings that are most appropriate to hardwoods are **crown thinning, improvement cutting** and **crop-tree management**. Regeneration systems that are most appropriate to hardwoods are **clearcutting, shelterwood method, and related two-age systems**. All the foregoing create even-age or two-age stands. The **single-tree selection system** and variations such as **group selection** will work well in hardwoods if the objective is to grow shade tolerant species in multi-age stands.

Intermediate Operations:

Crown thinning-

The crown thinning method is defined by Smith (1986) as thinning that involves the removal of trees in the upper strata of the canopy to favor desirable trees in the same canopy range. In crown thinning, the focus is on the better trees (potential crop trees). As with all thinning methods, crown thinning is applied at the stand level where residual stocking targets are an important consideration. Crown thinning seems particularly applicable to fully-stocked or over stocked mixed oak or mixed mesophytic hardwood stands on above-average sites. Although species such as northern red oak are capable of

responding to release at age 50 and older, appropriate candidate stands of shade intolerant species such as yellow-poplar and black cherry should be treated earlier than oaks. Heavy thinning can induce epicormic branching of residuals and/or release undesirable midstory or understory species.

Improvement cutting-

Smith (1986) defines improvement cutting as cuttings done in stands past the sapling stage for the purpose of improving composition and quality by removing trees of undesirable species, form or condition from the main canopy. Unlike crown thinning and crop tree management, the focus of improvement cutting is on the *undesirable trees.* Improvement cutting is widely applicable to upland hardwood stands. It is appropriate to mixed oak, oak-hickory and mixed mesophytic hardwood stands. The silvical characteristics of the species present are a prime consideration, but generally improvement cutting can be applied to stands well beyond age 50. Depending on owner objectives, species targeted for removal could be red maple, beech, hickories, blackgum, scarlet oak and black locust, in addition to poor quality individuals of favored species. Improvement cutting is a technique that is widely applicable to current upland hardwood stands owing to the age and current composition of many such stands.

Crop-tree management-

Crop-tree management is a technique that focuses on *individual trees* that have the potential of developing into high-value crop trees. Perkey et al. (1993) emphasizes that crop-tree value should be defined by the landowner's objectives. The two phases in crop-tree management are *assessment* and *enhancement*. Generally the assessment phase involves the selection of trees that have the *potential* for meeting the objectives defined by the landowner. Enhancement is accomplished by activities that facilitate the attainment of objectives. For example, in a timber management objective, trees of commercial species, with good quality stems that are capable of responding to release should be selected as crop trees. The enhancement operation would amount to reducing the amount of competition for the crop tree. The advantages are:

- It permits crop tree designation to fit landowner objectives.
- It is simple to apply and fits well with NIPF needs.
- It provides for an even flow of forest products.
- It allows for continuous forest cover.
- Management efforts are concentrated on trees with the highest potential gain.

Disadvantages for crop-tree management include the facts that it does not provide for regeneration after removal of crop trees and sometimes removal of low-grade interfering trees may not be commercially feasible, therefore incurring a cost to the landowner. But, generally speaking, like improvement cutting, crop-tree management is a widely applicable method that is appropriate for many existing mixed hardwood stands. The earlier the crop tree enhancement can be applied to a stand, the longer the effect can benefit the crop tree. But, assessing crop-trees at too early an age can lead to incorrect decisions.

Regeneration systems:

Clearcutting-

In the clearcutting method, the overstory is completely removed in a single operation. The method is designed to regenerate even-age, single-cohort stands, and it generally favors relatively shade intolerant species. Clearcutting mimics large-scale disturbances such as fires and windstorms that have served a historic role in the creation of southern hardwood stands. In order to provide conditions that qualify as a clearcut, openings must be at least 1- 2 acres in size. In the southern upland hardwoods, clearcutting promotes regeneration of fast-growing, exploitive species such as yellow-poplar, sweetgum, and pines. On poorer sites (south and west-facing slopes and ridges), clearcutting works well to regenerate oaks. On the best sites in the southern Appalachians, clearcutting favors yellow-poplar, often resulting in pure stands of the species. Successful regeneration can be delayed after clearcutting by the rapid development of competing vegetation such as ferns, brambles and herbaceous species as well as woody perennials such as sassafras, dogwood, rhododendron and grapevine. In most cases, commercial woody species ultimately prevail, but other factors such as over browsing by white-tailed deer can delay the process even further.

Although clearcutting is a reliable way to regenerate a variety of hardwoods, the biggest drawback is the fact that it produces a treeless landscape that is not aesthetically acceptable to most owners. In addition, with NIPF ownerships, the size of their property often does not lend itself to clearcutting. For smaller owners, in order to make a viable timber sale, it may be necessary to cut most or all of their timber at once. This creates a situation where income is only produced at very long intervals and the aesthetic value of the property is compromised for a long period.

Shelterwood and two-age methods-

The shelterwood method is an even-age management system that involves development of a standing crop of regeneration through a series of partial removals of the overstory (Smith 1986). In a three-cut shelterwood the cuts are: a **preparatory cutting**, designed to improve the quality and vigor of the residuals; a **seed cutting**, designed to encourage regeneration; and a **removal cutting** designed to remove the overstory. The two-cut variation of the method eliminates the preparatory cutting and is appropriate where most of the trees in the current stand are of the desired species. The shelterwood method is often recommended for regenerating species that are intermediate in shade tolerance (such as oaks). Combining shelterwood cuttings with prescribed fires and herbicides has been suggested by a number of scientists for oak regeneration. Use of the shelterwood method requires long-term commitment on the part of landowners and managers since it may require 10 to 20 years to complete the process. Deer browsing may become a significant problem when applying the shelterwood method, since deer often selectively browse species that are desired as regeneration.

Two-age silvicultural methods resemble the shelterwood method in superfical ways, especially in the leaving of a residual overstory. However the objectives of two-age systems are somewhat different. They aim to regenerate the stand with shade intolerant species by leaving a sparse overstory of approximately 20 sq. ft. basal area per acre. The residuals are tended through the entire rotation of the new stand and harvested when the regenerated cohort is mature.

Selection system-

The single-tree selection system is designed to develop a multi-cohort (all-age) stand of shade tolerant species. It involves establishing several criteria such as a residual basal area target, largest-tree-to-grow, a "q" factor and a cutting cycle length. Single-tree selection is complex to apply, requires long-term commitment and requires the presence of commercial species that are shade tolerant. In the southern Appalachians, the only areas where it may be applicable are high elevations that contain sugar maple. Modifications of this method involve cutting trees in small groups or patches. These "group selection" systems may be more appropriate in the southern upland hardwoods than single-tree selection. One of the common mistakes made by both foresters and landowners is to refer to "selective cutting" (cutting some trees and leaving others) as a legitimate silvicultural activity. The similarity of this terminology with the "selection system" is unfortunate and leads to confusion in an already confused situation. In general, the selection system has limited applicability in southern upland hardwood management.

Conclusions

Because of the ownership characteristics, age and composition of stands, and the silvical characteristics of the species present, many upland hardwood stands in the south are appropriately managed using intermediate methods (notably improvement cutting and crop-tree management). The method of harvest regulation that seems most appropriate to upland hardwood stands is volume regulation, since it is more compatible with partial cutting methods.

Selecting the method of regeneration is more troublesome. Shelterwood, or some modification thereof, is the most appropriate. But clearcutting and group selection may have limited use as well. Maintaining an adaptive strategy to take advantage of bumper crops of advance regeneration and to capture value from market changes is important in hardwood management. As long as certain rules are obeyed, such as balancing harvesting and periodic growth, avoiding high-grading and providing for regeneration, management of southern upland hardwoods can be accomplished with a great deal of flexibility.

A forest management tool: *Encyclopedia of Southern Appalachian Forest Ecosystems*

As the previous discussion outlined, many options exist for the sustainable management of upland hardwoods in the southern Appalachians. Deciding which management approach is best for a specific forest landscape and owner combination is a challenging task. Forest managers must typically consider a multitude of management objectives and a large diversity of client needs. Increasingly, land managers need improved access to research knowledge that is thoroughly organized, condensed, and presented in a form that is useful for problem solving.

The *Encyclopedia of Southern Appalachian Forest Ecosystems* (www.esafe.srs.fed.us) makes research knowledge of southern Appalachians hardwood forests more accessible and more understandable to users. The *Encyclopedia* synthesizes and integrates the past 65 years of research on southern Appalachian upland ecosystems in a hyperdocument-based encyclopedia system accessible over the Internet.

Hyperdocument technology provides the power to develop organized and compressed knowledge-bases, thereby improving the speed and accuracy with which data, information, and knowledge are managed. Anyone who has accessed the World Wide Web has been exposed to hyperdocuments—a highly nonlinear and interactive mixture of text, graphics, images, video, and audio. The *Encyclopedia* is more than a Web site, however, because it incorporates "intelligent" tools that enhance the use and navigation of the encyclopedia and allow it accommodate users of various skill levels and interests.

Hyperdocument Development

Producing a hyperdocument is a mixture of the planning required for a software project and that required for writing a book. The following methods were used to create the *Encyclopedia of Southern Appalachian Forest Ecosystems.*

Identifying scope and assembling material. The first step in developing the *Encyclopedia* was to precisely identify its scope. We focused on southern Appalachian forest types that have oak as a major component- mixed mesophytic hardwood, oak, and mixed pine-hardwood forest- these constitute 75% of the forest land in the southern Appalachians. We also included additional ecological and socioeconomic topics directly or indirectly related to forest management.

Site quality evaluation and classification	Forest insects and diseases
Predicting and modeling hardwood regeneration	Air quality, water quality
Concepts of silviculture	Ecology and management of aquatic resources
Oak ecology and management	Ecology and management of wildlife
Yellow-poplar ecology and management	Non-timber forest products
Silvics of other hardwood species	Biogeochemical cycles
Managing low-quality stands	Disturbance types and successional processes
Alternative silvicultural systems	Wilderness and roadless areas
Methods and effects of prescribed burning	Recreational supply, demand, and impacts
Timber harvesting and use	Threatened and endangered species
Timber supply and demand	Old-growth forests
Decision making in forest management	Biodiversity

After identifying these topic areas, we assembled source material for each area. We focused primarily on secondary literature (review articles, monographs, and textbooks) because it generally offers an organized synthesis of useful knowledge gleaned from the

primary literature. Wherever possible, we asked various experts to identify important pieces of secondary literature. Once collected, this source material was scanned to create electronic versions using optimal character recognition software.

Identify knowledge content and structure. The next step in the E*ncyclopedia'*s development was to design a comprehensive outline for the entire hyperdocument. We used Frontpage, an HTML editor, which offers a convenient navigational view ideal for constructing the hyperdocument's structure. Using this outline in Frontpage, paragraphs from the electronic versions of source documents were unceremoniously dumped into appropriate pages until all paragraphs of all source material had been "paged."

Writing and editing pages. After the paging process, each page in the hyperdocument contained numerous paragraphs from difference source material roughly covering the same subject matter. Hypertext authors then organized this disparate material, synthesized the main ideas and wrote an original summary with appropriate citations from the original literature source. After all pages had been rewritten, hyperlinks were inserted to cross-link logically related pages. Simple navigational tools were also created at this time, such as keyword search systems, tables of content, alphabetical indices of keywords, tables, and figures, etc.

Developing Intelligent navigational aids. Currently, intelligent navigational aids are being developed for the encyclopedia that will help users select paths through the hyperdocument. These navigational aids are constructed uniquely for each user each time that user enters the hyperdocument.

Evaluation and Verification. Evaluation and verification of the *Encyclopedia* began as soon as a prototype was available, and will continue throughout the entire development phase. This step is important in ensuring link consistency and correcting global and local navigational problems. Three types of people are involved in this process: 1) copy editors, 2) subject matter experts for content accuracy, and 3) representatives of the target audience to verify ease of use and clarity.

The *Encyclopedia of Southern Appalachian Forest Ecosystems* constitutes a framework for organizing what knowledge currently exists on southern Appalachian forests and for improving access to that knowledge. It provides a core knowledge management aid for private landowners and professional forest managers in the region. Because our needs in southern Appalachian ecosystem management are not unique, the concepts and techniques developed in this encyclopedia project could be broadly applied to other knowledge application needs in other land management disciplines.

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