

Vegetative Conditions and Management Options in Even-Age Stands on the Monongahela National Forest

Gary W. Miller
James N. Kochenderfer
James Knibbs
John E. Baumgras

Abstract—In 1998, personnel with the Northeastern Research Station and the Monongahela National Forest initiated a comprehensive survey of even-age stands that regenerated between 1964 and 1990. Preliminary results indicate that clearcutting was successful in regenerating these young stands with a variety of woody and herbaceous plant species. Early cleanings using crop-tree management techniques and control of wild grapevines (*Vitis* sp.) are recommended to enhance the development of desirable tree species that meet specific management objectives. Ecological classification appears to be useful in prioritizing silvicultural treatments at the stand level, thus facilitating control of vegetative conditions at larger scales for a variety of management objectives.

Introduction

The production of woodland benefits is closely related to vegetative conditions within a forest. For example, forest vegetation provides food, shelter, and breeding habitat for wildlife communities as well as commodity products and recreational amenities for people. As the composition and structure of the vegetation changes, so does the flow of benefits. Similarly, vegetative conditions are closely related to the ability of plants to compete for light, water, and soil nutrients and the availability of these resources after a planned or natural disturbance. Increased emphasis on maintaining the productivity of forest ecosystems calls for a better understanding of how plant communities on a given ecological site regenerate and develop in response to disturbance. Forest managers need such information to manage vegetation on relatively small land units and ultimately to maintain the production of desired benefits at larger scales such as forests and landscapes.

There are more than 1,200 young, even-age stands that regenerated after clearcutting between 1964 and 1989 on the Monongahela National Forest (MNF) in West Virginia (WV). Clearcut harvest was applied to individual stands and

the subsequent regeneration and growth of these stands has influenced the distribution, structure, and composition of vegetation at a much larger scale. The total area regenerated on the MNF after clearcutting is more than 30,000 acres. In addition, these stands are located on distinct ecological landtypes (ELT) that recently were described and mapped as part of the National Hierarchical Framework of Ecological Units. Species composition and site variables such as elevation, aspect, slope, slope position, and soil characteristics define each ELT. Because the harvest operations occurred across the forest at different times, these stands range in age from 10 to 35 years. The result is a mosaic of stand conditions that can provide valuable insight into the patterns of vegetative structure and species composition at different stages of development after major disturbance on a range of ecological sites with varying characteristics.

In keeping with the theme of this workshop, this paper describes how silviculturists can use stand-level information and an ecological classification system to facilitate control of vegetative conditions at larger scales for a variety of management objectives. In 1998, personnel with the MNF and Northeastern Research Station initiated a comprehensive study of even-age stands regenerated by clearcutting on the MNF. The purpose of the study was to (1) describe current stand structure and species composition, (2) define silvicultural treatments needed to maintain or achieve desired future conditions, and (3) relate stand conditions to ecological classification such that results can be extrapolated from the stand level to larger management scales. Although results reported here are limited in scope, additional data will be collected from more ELTs and age classes to complete the descriptive phase of this study. A second phase will focus on defining and testing silvicultural options needed to protect resources and sustain the production of multiple woodland benefits following major disturbance.

Background

In central Appalachian hardwood forests, natural reproduction of woody species usually is abundant and well distributed after both clearcutting and partial cutting operations. Reproduction occurs from advance seedlings that became established before the harvest, new seedlings that develop from seeds stored in the forest floor, and sprouts from the stumps of cut trees or wounded roots (Beck 1988).

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Gary W. Miller is Research Forester, Northeastern Research Station, Morgantown, WV. James N. Kochenderfer is Research Forester, Northeastern Research Station, Parsons, WV. James Knibbs is Integrated Resource Analyst, Monongahela National Forest, Elkins, WV. John E. Baumgras is Research Forest Products Technologist and Project Leader, Northeastern Research Station, Princeton, WV.

The eventual species composition of the dominant vegetation depends on many factors. The most important are (1) the amount of light available to new reproduction, (2) shade tolerance of the species present, (3) abundance of advance seedlings, (4) site quality, and (5) influence of adverse factors such as deer, insects, pathogens, spring frosts, and interfering plants. Partial cutting practices favor the reproduction of a few shade-tolerant species, while clearcutting favors the reproduction of numerous species that differ in shade tolerance (Trimble 1973; Miller and Kochenderfer 1998).

In the early stages of stand development in Appalachian hardwoods, there are hundreds of codominant trees competing for light, water, and nutrients. As the stand matures and competition for site resources becomes severe, tree mortality occurs until the overstory is composed of 50 to 75 codominant trees/acre (Smith and Lamson 1986). The silviculturist can prescribe early cleanings and vine control treatments to assure that the overstory is composed of vigorous trees that best meet management objectives.

Early cleanings can be prescribed in young hardwood stands to enhance the production of multiple woodland benefits. For example, crop-tree management has been used to maintain overstory species diversity and production of mast for wildlife habitat, increase tree vigor and resistance to insects and pathogens, and improve species composition and stand quality for timber production (Perkey and others 1993). The basic strategy of crop-tree management is to reduce competition around certain trees so that they become more vigorous and remain a productive part of the forest community. Once management objectives are defined, the desirable crop trees are identified and given a crown release by eliminating adjacent trees. This treatment liberates site resources for use by the selected crop trees. The released trees develop larger crowns and root systems that enable them to become more competitive on the site and develop into the dominant overstory (Miller 2000).

The uncontrolled spread of wild grapevines (*Vitis* sp.) can severely damage young hardwood stands (Trimble and Tryon 1979). Vines originate from seeds stored in the forest floor or as sprouts from existing stems, and climb up with new hardwood regeneration after a canopy disturbance. Grapevine damage usually occurs during the dormant season when the crowns of affected trees break under the weight of wet snow and ice. Vine foliage also reduces the growth and vigor of host trees by competing for available sunlight during the growing season. Consequently, vines can damage any tree species and in turn adversely affect the production of many woodland benefits. Because they are very intolerant of shade, wild grapevines can be controlled by cutting under a closed canopy or by applying herbicides (Smith 1984).

Study Areas

The even-age stands surveyed in 1999 were located on the Cheat Ranger District of the MNF in north central WV. The topography consists of low ridges dissected by northeast-southwest valleys. Elevations range from 1,800 to 3,600 ft above sea level. In general, the soils are medium textured and well drained, derived from sandstone shale with occasional limestone influence. The average soil depth exceeds 3 ft. Annual precipitation averages 57 inches and is well

distributed throughout the year. The growing season averages 145 frost-free days.

When clearcutting began on the MNF in 1964, the central Appalachian forest consisted of second-growth hardwoods that regenerated naturally after large-scale cutting between 1905 and 1910. The second-growth stands often contained three age classes when silvicultural treatments began: scattered old residuals from the early cutting, new reproduction that became established after the early cutting, and reproduction that became established after the death of the American chestnut (*Castanea dentata*) in the 1930s (Carvell 1986).

MNF personnel according to the National Hierarchical Framework of Ecological Units (McNab and Avers 1994) described Landtype associations and series. Landtype associations occupy the landscape scale from thousands to hundreds of acres. They contain repeatable patterns of soil and vegetation groupings that are further delineated at the ELT scale.

The initial phase of data collection focused on three ELTs: sugar maple-basswood (SM-BW) series, sugar maple-red oak (SM-RO) series, and red oak (RO) series. These series represent traditional classifications such as moist cove sites, moist midslope sites, and dry midslope sites, respectively. The ELTs are described as follows:

- Sugar maple-basswood series (SM-BW). Sugar maple landtype association. Elevation 2,900 to 3,200 ft, maple overstory 30 to 40 percent. Basswood overstory cover at least 10 percent and sugar /understory cover at least 10 percent.
- Sugar maple-red oak series (SM-RO). Sugar maple landtype association. Elevation 3,400 to 3,800 ft, slope 30 to 40 percent, located primarily on southerly slopes. Red oak overstory cover at least 10 percent and sugar maple overstory/understory cover at least 10 percent.
- Red oak series (RO). Red oak landtype association. Elevation 2,700 to 3,000 ft, slope 30 to 40 percent, Red oak overstory cover at least 10 percent and not in the sugar maple groups.

Methods

Data were collected from randomly selected even-age stands on the Cheat Ranger District of the MNF. Each stand regenerated naturally after clearcutting. The harvest operation included the removal of merchantable logs and felling of small stems ≥ 2.0 in d.b.h., thus each new stand comprised a single cohort of reproduction. For inclusion in the study, minimum stand size was 8 acres and minimum stand age was 8 years. Size and age restrictions were established to reduce variation associated with small stands and very young stands that have not completed the stand initiation stage of development (Oliver and Larson 1996). Within each ELT, stands were selected randomly to provide data from a range of age classes.

Fixed-area plots were used to collect all vegetation data. Aspect, elevation, slope, and slope position were recorded for each plot. For woody vegetation, 0.025- and 0.05-acre circular plots were used in stands ≤ 15 years old and ≥ 16 years old, respectively. Species, d.b.h., crown class, and stem origin were recorded for all trees ≥ 1.0 in d.b.h. on each plot. In

addition, stem quality, crown vigor, and vine damage were recorded for all stems in the dominant and codominant crown classes, and for all oak stems in the intermediate class.

Stem quality was based on two characteristics: risk of mortality and potential timber grade. Trees were rated as good if there was no evidence of risk factors such as severe lean, poor attachment, insect damage, cankers, rot, wounds, or low forks that might threaten their long-term survival. Trees also were rated as good if they had a straight, clear bole that leads to higher product value. Trees were rated as poor if they exhibited risk factors or low potential grade.

Vine damage was divided into three categories: (1) vines present, crown damage imminent in the next 5 years, (2) vines present, crown damage evident and high risk of irreversible damage in the next 5 years, and (3) vines present, crown damage evident and irreversible. These categories were defined to help clarify when and where vine-control treatments might provide maximum damage control.

For herbaceous vegetation, percent cover by species was measured on four 1-m² circular plots located at cardinal directions on the perimeter of each woody vegetation plot. The surveys of herbaceous vegetation were conducted from early June through July.

Similar vegetation data were collected in nearby 80- to 90-year-old second-growth stands that had regenerated following large-scale cutting between 1905 and 1910. These stands had not been disturbed for approximately 40 years prior to data collection and were located adjacent to or in close proximity to clearcut stands on the same ELT. Data from the second-growth stands were compared to data from the young even-age stands to examine the general relationship between stand age and species composition within a given ELT.

Data were summarized by age class and ELT. For this preliminary report, a graphical analysis is presented to show trends in species richness for herbaceous species, basal area distribution for woody species, quality distribution for overstory species, and risk distribution for overstory species affected by wild grapevines.

Results and Discussion

Data were collected from 26 even-age stands that regenerated after clearcutting and 19 undisturbed second-growth stands on three ELTs (table 1). Even-age stands averaged 15 acres and ranged in size from 8 to 25 acres. Stand acreage was not available for the undisturbed second-growth stands. The even-age stands ranged in age from 8 to 33 years. The age of second-growth stands exceeded 80 years as these stands regenerated after the heavy cutting at the turn of the century. Woody species were tallied on 604 plots and herbaceous species were tallied on 2,416 plots.

Herbaceous Vegetation

In undisturbed stands, herbaceous species richness declined along a moisture gradient from the SM-BW sites to the RO sites (fig. 1). In even-age stands less than 15 years old, the number of herbaceous species present was approximately equal to or greater than the number present in undisturbed stands within the same ELT. On the SM-BW and SM-RO sites, the number of herbaceous species declined as stand age increased. However, on the RO sites the number of herbaceous species was greatest in stands 16 to 26 years old.

High species richness in very young stands resulted from the increase in light reaching the forest floor following removal of the canopy. After clearcutting, light was less limiting to plant development, so species present before the harvest were joined by light-demanding species after the harvest. Once the canopy closed, the number of herbaceous species declined because those intolerant of heavy shade did not continue to occupy the site.

Woody Vegetation

In general, the overstory in the young even-age stands was composed of the same species that dominated the older second-growth stands. For example, the majority of basal area in 31- to 33-year-old stands and second-growth stands

Table 1—Summary of study sites and sample plots by ecological landtype.

Ecological landtype	No. of stands	Average plot size	Age of trees	No. of herb plots	No. of stem plots
		<i>acre</i>	<i>year</i>		
Sugar maple-basswood	3	15	10–14	188	47
	4	17	23–29	256	64
	6	NA ^a	80+	348	87
Sugar maple-red oak	7	13	10–11	408	102
	3	15	14–15	108	27
	2	19	31–33	100	25
	7	NA ^a	80+	272	68
Red oak	2	11	8–10	96	24
	2	18	16	136	34
	3	16	25–26	168	42
	6	NA ^a	80+	336	84

^aAcreage not available for unmanaged second-growth stands.

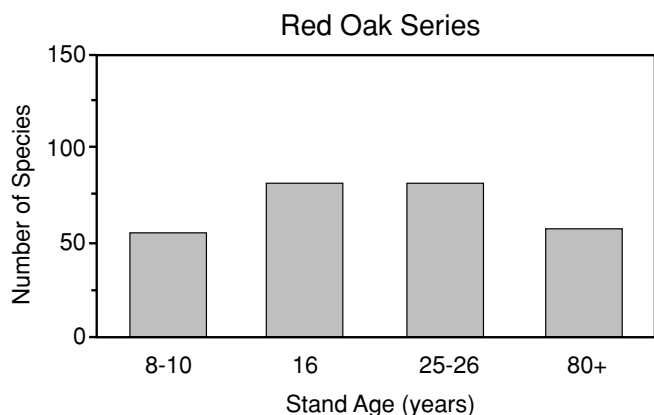
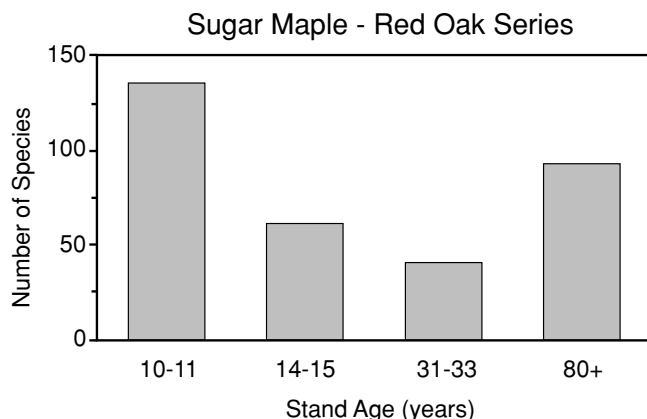
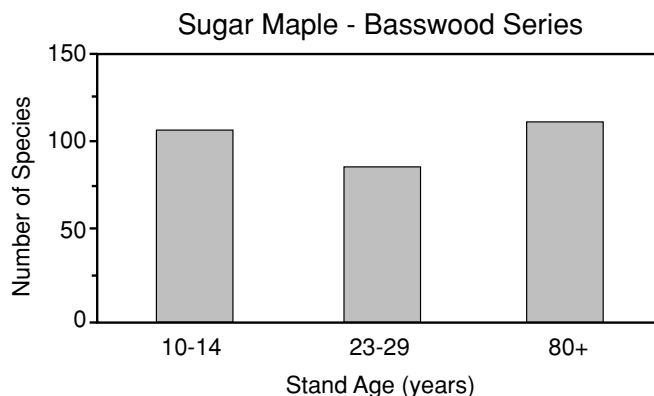


Figure 1—Number of herbaceous species observed within sample plots by stand age and ecological landtype.

on the SM-RO site was occupied by yellow-poplar (*Liriodendron tulipifera*), red oak (*Quercus rubra*), black cherry (*Prunus serotina*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), basswood (*Tilia americana*), and sweet birch (*Betula lenta*) (fig. 2). It is important to note that red oak and black cherry occupied a majority of basal area in the second-growth stands while sugar maple and red maple occupied a majority of the basal area in the 30- to 33-year-old stands. On the SM-BW sites, species composition in the 23- to 29-year-old even-age stands was similar to that in the second-growth stands, although the proportion of yellow-poplar and black cherry was greater in the 23- to 29-year-old stands. On

the RO sites, the 23- to 26-year-old stands had a much lower proportion of basal area occupied by red oak and chestnut oak and a higher proportion occupied by yellow-poplar and black cherry than the second-growth stands (fig. 2). In addition to the species listed in figure 2, the even-age stands contained 18, 11, and 10 hardwood species on the sugar maple-basswood, SM-RO, and RO sites, respectively.

Differences in species composition between the second-growth stands and young even-age stands can be attributed to at least two important factors. First, species composition is affected by the availability of stored seed, advanced seedlings, and sprouts immediately after harvest operations

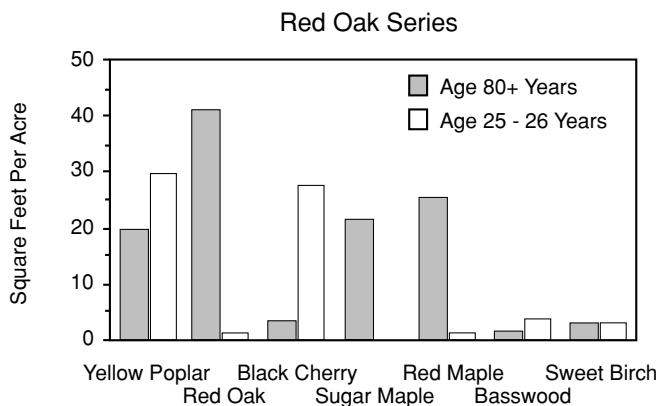
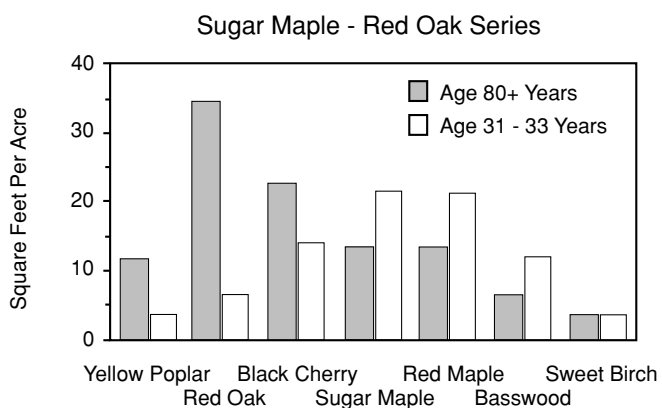
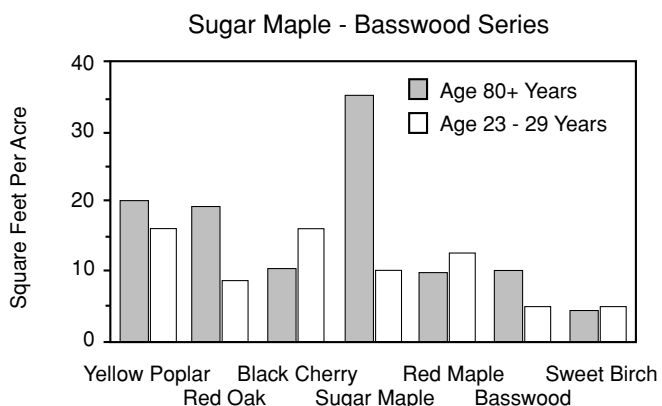


Figure 2—Average basal area/ac by stand age, species, and ecological landtype.

(Beck 1988). These primary sources of regeneration exhibit natural variation over time, so some variation in species composition is due to the timing of the harvests. Second, there was a different pattern of disturbance that followed harvest operations. White-tailed deer (*Odocoileus virginianus*) have a dramatic influence on hardwood regeneration (Tilghman 1989), and the young stands developed during a period when deer populations were relatively high.

Wildfires also influence competitive relationships among hardwoods (Van Lear and Watt 1990). Fire followed the heavy cutting at the turn of the century when the second-growth stands developed, yet fire was absent after clearcutting in the even-age stands. It follows those future disturbances, both natural and planned, will continue to influence species composition of the overstory.

A closer look at the characteristics of individual trees in the even-age stands revealed that each stand had many trees of good quality in the overstory. The data also indicated that numerous species are represented in the overstory, so the young even-age stands are capable of producing a wide range of benefits in the future. For example, stands on the SM-BW sites contained good, codominant trees in each species and age group (fig. 3). Early cleanings could be used to enhance future

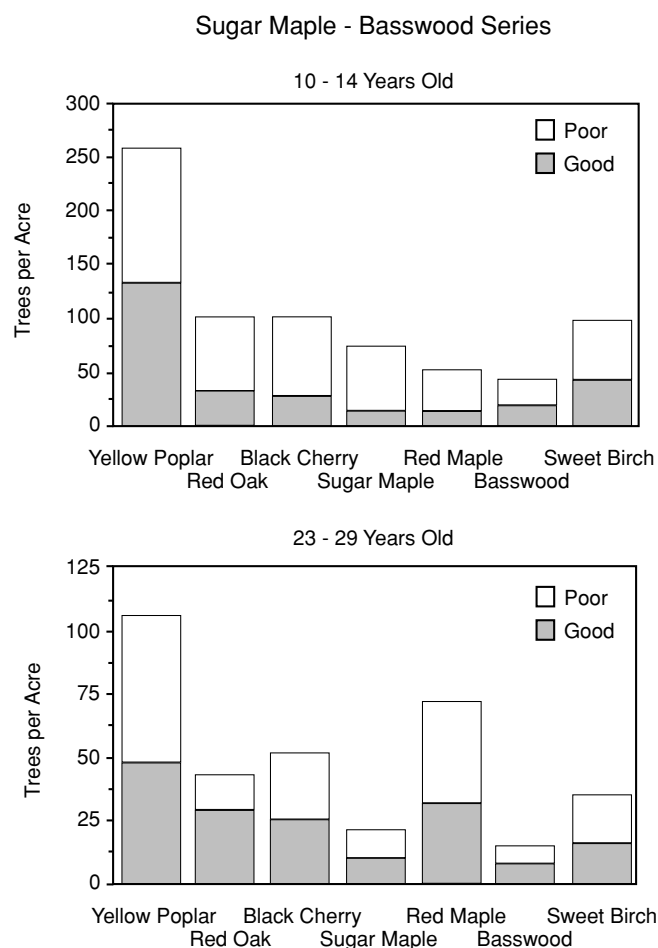


Figure 3—Average number of overstory stems/ac by stand age, species, and stem quality on the SM-BW series sites.

Table 2—Relative product market value and relative wildlife food value for Appalachian hardwoods.

Species	Relative product market value ^a	Relative wildlife food value ^b
Yellow-poplar	26	14
Black cherry	100	96
Red oak	60	100
Chestnut oak	21	100
Sweet birch	4	41
Basswood	17	14
Red maple	21	51
Sugar maple	28	51

^aValue relative to black cherry computed from Monongahela National Forest quarterly transaction evidence prices for January 1998.

^bValue relative to oaks computed from Martin et al. 1951.

most production and product values by favoring northern red oak and black cherry crop trees (table 2). Crop-tree management also can be used to enhance recreation or watershed values (Perkey and others 1993).

The opportunity to control overstory species composition declined in older stands. In general, the number of codominant trees in each species group declined due to natural competition. On the SM-RO sites, there were 25 good-quality, codominant red oaks per acre in the 10- to 11-year-old stands and fewer than 10 per acre in the 31- to 33-year-old stands (fig. 4). Crop-tree management still would be beneficial in the older stands, but earlier treatments provide more flexibility in achieving long-term goals for species composition. If treatments are delayed too long, some species may drop out of the overstory. For example, chestnut oak (*Quercus prinus*) crop trees were present on the RO sites in the 8- to 16-year-old stands but absent from the older stands (fig. 5). Crown release enhanced the growth and survival of chestnut oak crop trees in young stands (Miller 2000). As a result, early release of only several chestnut oak crop trees per acre would be effective in sustaining this species.

Wild Grapevines

It is well documented that young hardwood stands are susceptible to damage by wild grapevines (Smith 1984; Trimble and Tryon 1979). The proportion of overstory trees affected by vines varied by ELT (fig. 6). For the SM-RO and RO sites, the proportion of good quality codominant trees with vines increased with stand age. On the SM-RO sites, the proportion of good quality codominant trees with vines increased from 6 to 17 percent as age increased from 10–11 to 31–33 years. On the SM-BW sites, the proportion of good, codominant stems with vines decreased from 14 to 5 percent as age increased from 10–14 to 23–29 years. This apparent reduction in vine damage with increased stand age probably is the result of natural variation in the stands sampled. Vine damage usually increases as even-age stands develop (Smith 1984).

It is important to note that nearly every stand had numerous good-quality trees threatened by damage from vines. Consequently, vine control treatments may be needed to

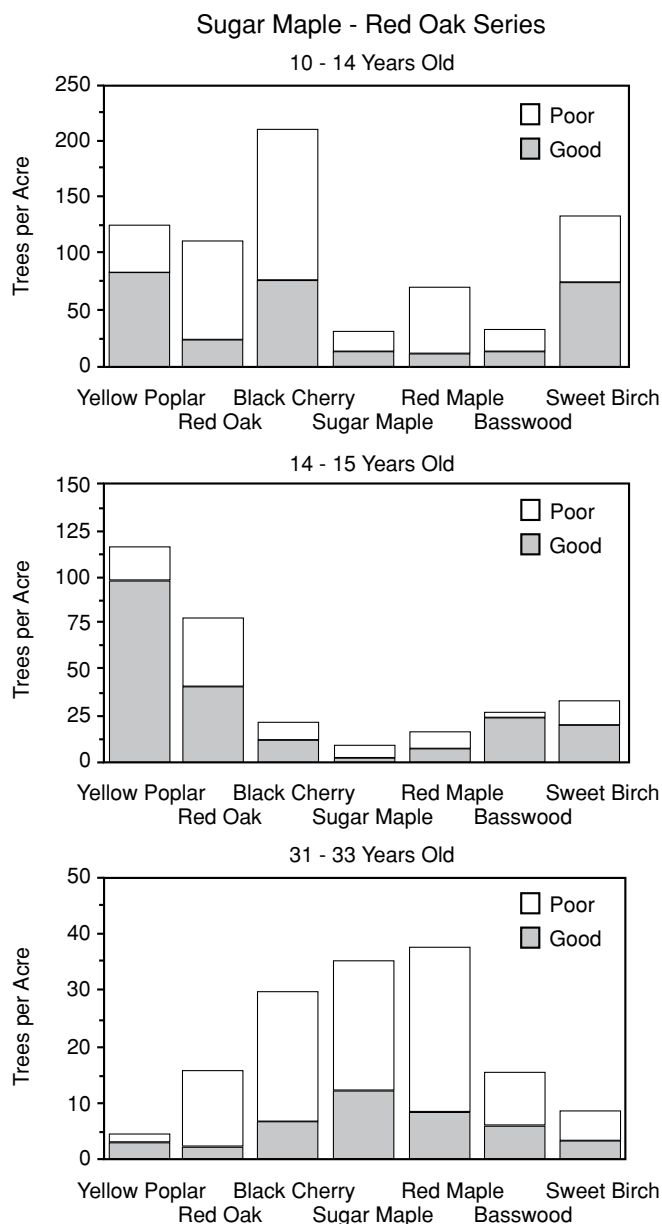


Figure 4—Average number of overstory stems/ac by stand age, species, and stem quality on the sugar maple-RO series sites.

prevent vines from damaging or killing trees that are needed to meet management objectives. The fruit of wild grapevines is valuable for wildlife, so forest managers must consider the tradeoff for controlling the spread of vines among overstory trees. Treatments can be prescribed to prevent excessive damage to crop trees and leave some vines as food for wildlife (Smith 1984).

Summary

Preliminary results summarized in this report represent an example of the type of information that silviculturists

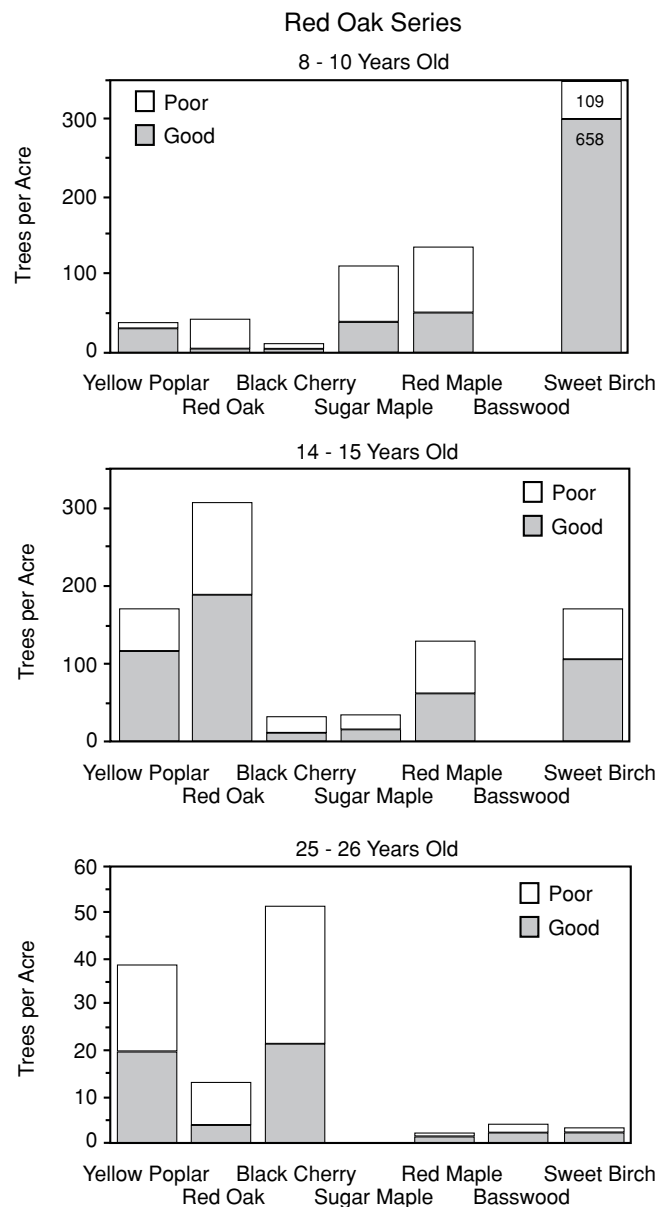


Figure 5—Average number of overstory stems/ac by stand age, species, and stem quality on the RO series sites.

need to manage vegetation and sustain the production of multiple woodland benefits. Information on the status of vegetative conditions on small land units clarifies the potential for achieving management objectives in the future. The data indicated that young hardwood stands that regenerated after clearcutting on the MNF contain hundreds of codominant trees per acre in various species groups. Because of the relatively high species diversity on each of the ELTs surveyed, these stands are capable of producing a variety of benefits. Once management objectives are defined and vegetative conditions are quantified, forest managers can describe and evaluate strategies for achieving desired future conditions.

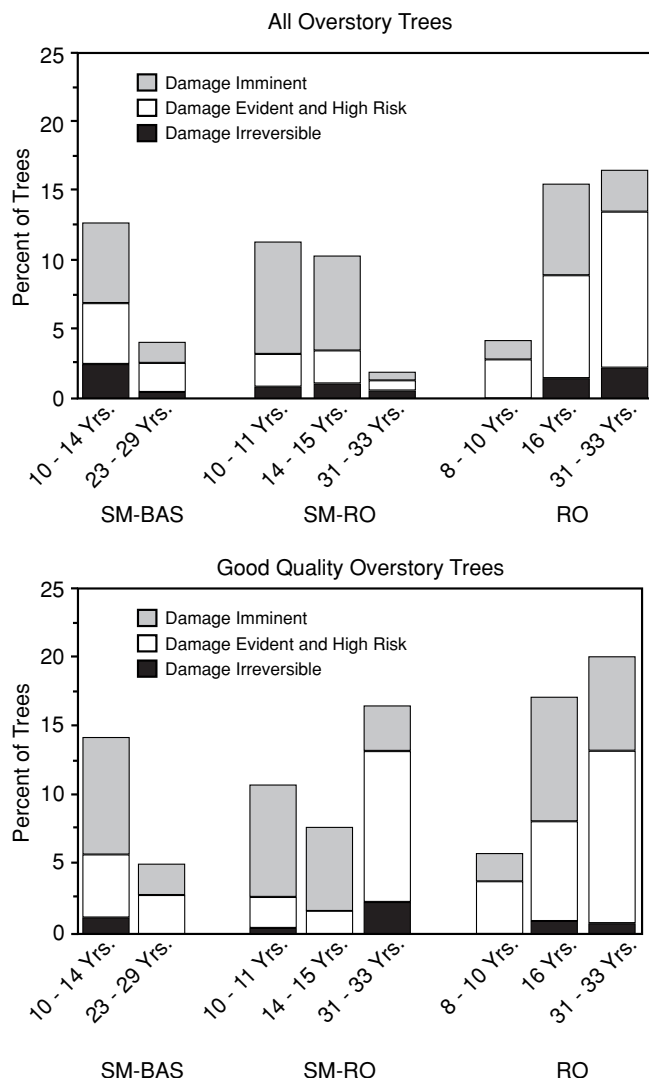


Figure 6—Average percent of overstory trees with vines by stand age, risk/damage class, and stem quality for sugar maple-basswood (SM-BAS), sugar maple-red oak (SM-RO), and red oak (RO) ecological landtypes.

The production of multiple woodland benefits such as timber value, esthetics, recreation, and wildlife habitat can be increased by silvicultural treatments. Vegetation structure and species composition changes over time as plants within a forest community compete for limited site resources. Silvicultural treatments can be prescribed to influence competitive relationships among the species present and manipulate vegetation dynamics such that the production of preferred woodland benefits is enhanced. For example, early cleaning treatments can be applied to favor the long-term survival and growth of mast-producing species. Crown release of selected oaks and black cherry can increase the proportion of these species in the overstory as well as the vigor of individual trees, thus increasing the long-term production of mast on the site. Moreover, by favoring species that provide both mast and high timber value, a single

silvicultural treatment can enhance the production of multiple benefits (table 2).

Silvicultural treatments can be applied to numerous stands with similar characteristics, providing a means to manage vegetation on a larger scale using an ecological approach. By aggregating stands with similar ages and site conditions, the silviculturist is better able to prescribe treatments based on an understanding of how vegetation will respond on a given site. For example, the proportion of overstory trees threatened by grapevines increased in both the SM-RO and the RO sites as stand age increased. This suggests that vine control should be focused on certain growing sites when stands are relatively young. As a result, vine control projects can be prioritized according to ELT and stand age using site classification maps and harvest records.

This report presents preliminary information from an ongoing study that covers a relatively large area of forestland in the central Appalachians. The study is intended to include stand data from a wide range of age classes on many additional ELTs; data collection and analysis will continue for several years. As more data are available, a more rigorous analysis will clarify the relationship between vegetative conditions, ecological site factors, and management options. The methods described could serve as a model for silviculturists who seek to manage forest resources for multiple benefits using an ecological classification system. A second phase of the study will field test the effectiveness of silvicultural treatments in achieving management objectives. Results of the study will provide insight into how certain growing sites and plant communities respond to planned disturbances.

Acknowledgments

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