Regeneration Results Using Two-Aged Management

by
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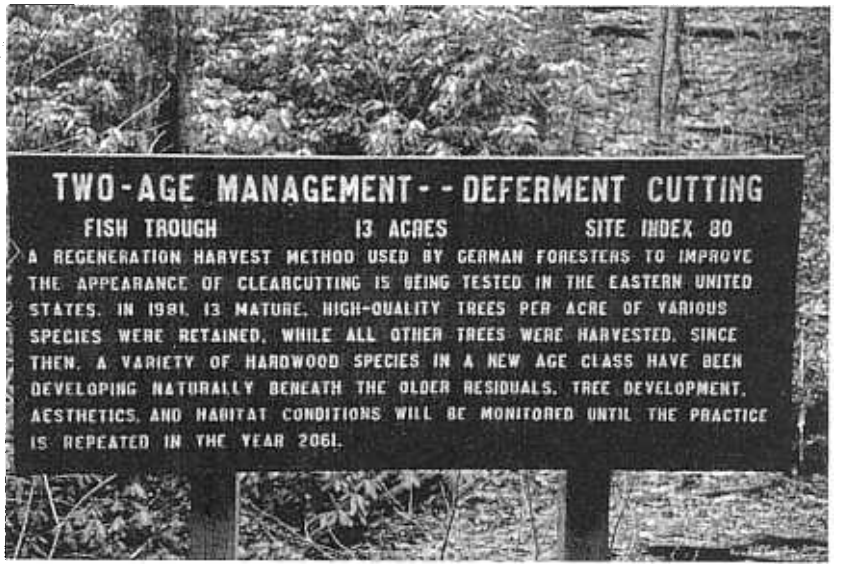
Two-aged management is receiving increasing consideration by central Appalachian hardwood managers as a tool to accomplish multiple landowner goals. On non-industrial private forests where aesthetics are often important, two-aged management has the attribute of retaining some relatively large trees on the area at all times. For many landowners this is critical. Research at the Fernow Experimental Forest near Parsons, West Virginia, shows the two-aged system can also provide a means of obtaining desirable regeneration of species that are both tolerant and intolerant of growing beneath overtopping vegetation.

By definition, a two-aged stand has trees of two distinct age classes separated in age by more than 20 percent of the rotation age. In the central Appalachians, a rotation age of 80 years is often appropriate for managed stands to accomplish landowner goals. Once established, two age classes are maintained by a harvest about every 40 years. Consequently, while the age of the two classes changes through time, the 40-year difference between the younger and older age classes is constant. When the older age class reaches 80, the younger age class is 40. When the 80-year-old trees are removed, the 40-year-old trees become the older age class. The growing space formerly occupied by 80-year-old trees is captured by regeneration that becomes the new, younger age class. This 40/80-age relationship is desirable because by age 40 the younger age class has obtained sufficient height to be in the main crown canopy. When the older age class is removed, there is less damage to main-crown-canopy trees than to understory or midstory trees.



This informational sign introduces the concept of two-aged management to visitors on the Fernow Experimental Forest. Regeneration established in 1981 is planned for harvest in 2061.

The 40-year time period also provides the opportunity to accomplish needed control of grapevines and precommercial release of crop trees. In steep terrain, when doing precommercial crop tree management, it is especially important to consider where the overstory trees will be felled when the older age class is removed.

The 40/80-age relationship can be varied somewhat to better accomplish stand objectives. Flexible timing of commercial harvests provides opportunities to accommodate:

development of advanced regeneration (doing site preparation work and waiting for a bumper seed crop).

2) selling products when market prices are favorable.

There are times when a 30/60- or a 50/100-age relationship is more appropriate. Factors influencing the appropriate choice are:

1) lifespan of managed crop trees.
2) timing of height growth of managed crop trees.
3) intensity of management.
4) importance of being able to market cut trees. (For example, are precommercial investments in the younger age class an option?)
5) site productivity.

For example, a stand with many black cherry crop trees on a productive site might be intensively managed on a 30/60-age relationship. Black cherry has a relatively short lifespan. It exhibits rapid early-age height growth, and it is frequently valuable enough to be marketed at a relatively small size.

Conversely, red oak grown on a medium site will have slower early-age height growth and a longer lifespan. If precommercial investments (less intensive management) are not an alternative, it might be grown on a 50/100-age relationship to accommodate growing trees for a longer time to achieve marketability of products from the younger age class.

A key concern is the species composition of the regeneration established under the open-canopy overstory. Major factors affecting composition are: site productivity, biotic regeneration influences, abiotic regeneration influences, residual overstory species composition (available seed source), and advanced regeneration.

Eighteen-year-old yellow-poplar crop trees are 7-10 inches dbh and thriving between scattered 20-27 inch dbh overstory residuals. Site productivity and available seed source are factors that favored yellow-poplar regeneration on this site.

SITE PRODUCTIVITY

Some species are effective competitors in a limited range of site productivity classes. For example, it is easier to get oaks into a competitive position on red oak Site Index 70 (medium site productivity) land than on Site Index 80 (good site productivity) land. In contrast, yellow-poplar is more likely to survive periods of drought and sustain rapid competitive growth on Site Index 80 and better land.

Under two-aged management, species composition of the regenerating age class can be expected to vary with site quality, much as it does under even-aged management. Sugar maple, basswood, black cherry, and yellow-poplar can be expected to be most competitive on medium and better sites. Red maple and red oak are often most competitive on the medium and fair sites. Chestnut oak is usually limited to fair and poor sites.

This red oak stump sprout should be competitive in this younger age class of a two-aged stand. Frequent occurrence of stump sprouts of a preferred browse species indicates deer pressure on regeneration was modest at the time of harvest.

BIOTIC REGENERATION INFLUENCES

Ecological conditions (plant and animal) at and around the time of canopy-opening harvest can affect species composition. In the central Appalachians, the current most prominent example of a biotic regeneration influence is the size of the deer herd relative to the availability of their preferred food supply. Some commercially desirable tree species are heavily browsed while less desirable species are undisturbed. Stump sprouts of deer-preferred species are especially vulnerable to browsing damage. Where deer populations are high, stump sprouts of preferred browse species are often eliminated as a source of regeneration. This is especially true in locations with limited recent harvesting in a large, contiguous forested area. In these instances, deer focus on the limited supply of recently created, nutritious food source.

Other biotic influences include insect defoliations, disease outbreaks, and grazing by domestic livestock. Some of these influences can be controlled by man (domestic livestock). Others (insect defoliations) can potentially be affected by human intervention, but seldom controlled. Some influences are management activities intended to affect regeneration. For example, site preparation that exposes mineral soil is a human-caused influence favoring species needing this condition in order to flourish.

The season of logging is another example of a human influence that can affect species composition. Logging during the dormant season favors establishment and development of yellow-poplar. Growing-season harvesting favors competing vegetation.

ABIOTIC REGENERATION INFLUENCES

Regeneration establishment and development can be affected by physical events like windstorms, floods, droughts, ice storms, and lightning fires. Species have varying capabilities to survive and compete when these events occur at a regenerating site. For example, species that are subject to breakage (yellow-poplar) are more likely to lose codominant position after an ice storm than a sturdier species such as oak.

RESIDUAL OVERSTORY SPECIES COMPOSITION (available seed source)

Species that exhibit rapid early-age height growth may be competitive in the new age class if there is an available seed source and appropriate site conditions (like exposed mineral soil). Species composition of the residual overstory is one indication of the availability of seed. However, species with light, wind-dispersed seed are also frequently able to successfully establish from parent trees adjacent to the treatment area. In central Appalachian hardwoods, yellow-poplar and black birch are two species that frequently establish from on-site or near-site parent trees.

ADVANCED REGENERATION

Frequently, to compete in the younger age class, species that have slower early-age height growth must be present as advanced regeneration before a major canopy-opening harvest. For example, oaks on highly productive sites are dependent on well-developed advanced regeneration to obtain a competitive codominant position in a regenerating age class.

Species that depend on advanced regeneration include sugar maple, oak, hickory, and white ash. When the deer population is very high relative to the food source, black cherry may also be dependent on advanced regeneration.

This red oak was approximately 75 years old when the harvest released advanced regeneration and provided favorable conditions for the establishment of seedlings from germinating seeds.

The regeneration profile on the following page provides information about four two-aged treatment areas on two ranger districts of the Monongahela National Forest and on the Fernow Experimental Forest. The information was taken from an article titled "Development and Quality of Reproduction in Two-Age Central Appalachian Hardwoods ~ 10-year Results" by Gary W. Miller and Thomas M. Schuler, both research foresters, Northeastern Research Station, in Parsons, WV. The table summarizes relevant information about each of the five factors, as previously discussed, that affect species composition in a naturally regenerating two-aged stand:

Site productivity
Biotic Influences
Abiotic Influences
Residual overstory species composition
Advanced regeneration species composition

A sixth factor influencing species composition in a regenerating stand is the density of any residual overstory and midstory trees. This factor is not listed in the chart because it was relatively constant across the four treatment areas. All trees larger than 1-inch dbh were cut, except for selected overstory trees intended to comprise the older age class. Post-harvest basal area ranged from 17.5 to 25.8 square feet per acre distributed on 12 to 15 trees per acre. All of the treatment areas were in stands that averaged about 75 years of age when harvested to establish the younger age class in the two-aged stand.

The last column of the table describes the species composition that resulted from the interaction of the five listed factors on the regeneration process on the four sites. Evaluation of this data provides some indication of the species composition of regeneration when two-aged management is applied in central Appalachian Hardwoods.

> *Note: To properly sequence the two age classes on these sites, the 75-year-old residual trees are expected to remain on the site until they reach age 115. At that time, the younger age class will be 40 years old and ready to transition to the older age class.*

The graphs that follow the table display the information in the "Advanced Regeneration Species Composition" and "10-Year Species Composition" columns to provide a visual means for quickly assessing the role of advanced regeneration in stand development. The advanced regeneration (commercial tree species greater than 1-foot tall and less than 1.0" in diameter) is represented by the lightly shaded box, and the dark shaded box is the commercial tree species 1.0" dbh and larger 10 years after cutting.

Two-Age Regeneration Profile on Four Treatment Areas

Treatment Area	Site Productivity		Biotic Influences	Abiotic Influences	Residual Overstory Species Composition		Advanced Regeneration Species Composition		10-Year Species Composition	
	RO Site Index	Avg. Ann. Ht. Growth of Young Age Class (Ft./Yr.)			Species	Percent	Species	Percent	Species	Percent
Riffle Creek	70	2.8	Chestnut blight in the 1930's. Medium size deer population.1/	Absence of fire for the past 50 years.	RO WO YP CO RM HI SO BC	37 34 9 8 4 3 2 1	BE SM RM RO BC CO	47 22 10 8 4 3	**BE** **SM** **RM** **RO** **BC** **CO** **YP** **BB**	**17** **8** **13** **12** **5** **9** **8** **14**
Olson Tower	70	2.6	Chestnut blight in the 1930's. Medium size deer population.2/	Absence of fire for the past 50 years. Shallow soil; widespread skidding.	RO BC SM WA RM BE	49 38 5 5 2 1	BC BE	87 9	**BC** **BE** **RM** **RO**	**80** **4** **8** **5**
Fish Trough	80	3.0	Chestnut blight in the 1930's. Medium size deer population.3/	Absence of fire for the past 50 years. 1987 precipitation 17% below mean. 1995 precipitation 19% below mean.	YP RO BA BC BE CU HI WA EL SM	59 13 11 5 3 2 2 2 1 1	SM BE WA	59 21 12	**SM** **YP** **BA** **BB**	**27** **31** **9** **10**
Shavers Fork	80	3.1	Chestnut blight in the 1930's. Medium size deer population.4/	Absence of fire for the past 50 years. 1987 precipitation 17% below mean. 1995 precipitation 19% below mean.	YP RO WA WO BA CU BC	63 27 3 2 2 2 1	BE WA SM RO	52 22 16 2	**BE** **SM** **RO** **YP** **BB** **RM**	**10** **6** **5** **45** **8** **7**

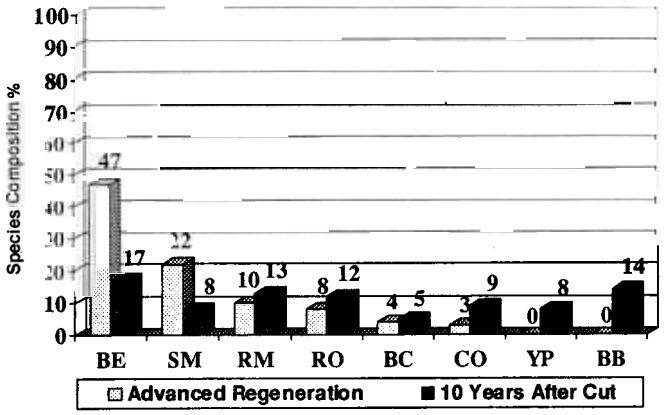
1/ Based on observation and calculation (50% of codominants are stump sprouts).
2/ Based on observation.
3/ Based on observation and calculation (42% of codominants are stump sprouts).
4/ Based on observation and calculation (62% of codominants are stump sprouts).

Species Key

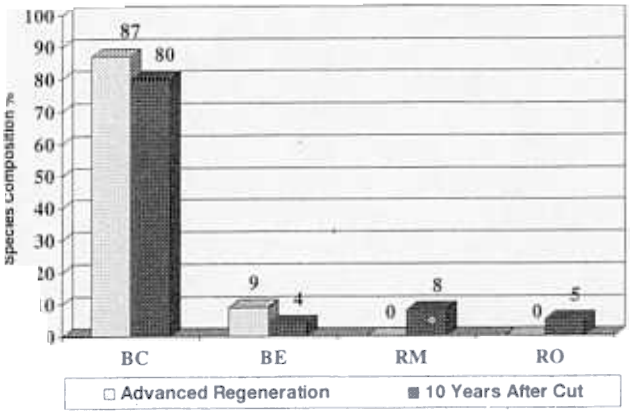
BA	Basswood	BC	Black cherry	EL	Elm	RO	Red oak	WA	White ash
BE	Beech	CO	Chestnut oak	HI	Hickory	SO	Scarlet oak	WO	White oak
BB	Black birch	CU	Cucumber	RM	Red maple	SM	Sugar maple	YP	Yellow-poplar

Graphic Display of Advanced Regeneration Versus 10-Year Species Composition

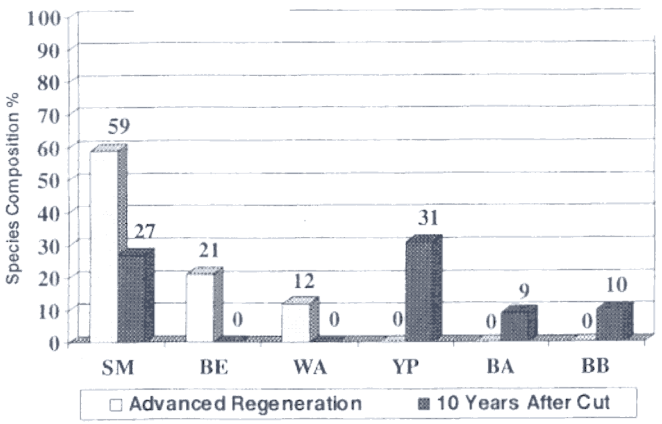
Riffle Creek
14.8 acres, SI 70
1,062 Trees/acre 10 Years After Cut



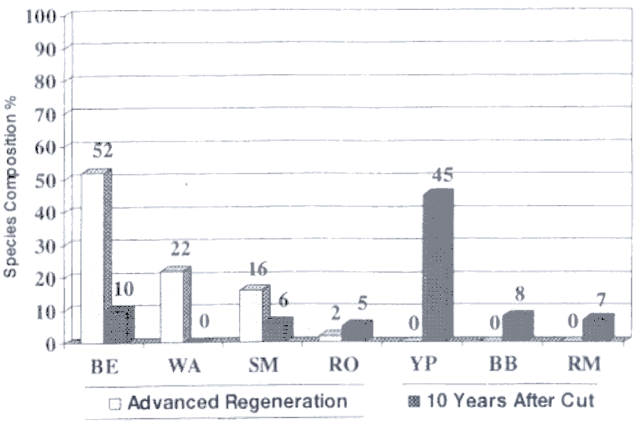
Olson Tower
12.1 acres, SI 70
933 Trees/acre 10 Years After Cut



Fish Trough
13.1 acres, SI 80
1,000 Trees/acre 10 Years After Cut



Shavers Fork
10.2 acres, SI 80
972 Trees/acre 10 Years After Cut



Advanced Regeneration: commercial tree species greater than 1-foot tall and less than 1.0" dbh
10 Years After Cut: commercial tree species 1.0" dbh and larger

Following are some observations and comments regarding the development of two-aged stands after a regeneration cut at four locations in the central Appalachians.

Leaving 12 to 15 residual overstory trees per acre and cutting all other trees 1-inch dbh and larger resulted in hardwood reproduction similar to that expected after clearcutting.

2. In three of the four treatment areas, the residual overstory is expected to be a commercially operable volume when the older age class is harvested. If there are 13 residual trees per acre and they average 200 bd.ft. per tree, that is 2,600 bd.ft. per acre. Larger trees will have correspondingly larger volumes.

3. In the Fish Trough treatment area, a sample of 10 yellow-poplar overstory crop trees was remeasured at about age 94 to determine if they were still growing well. They are. During the first 16 years of the study they grew at a rate of 2.9 inches/decade. During the last 3 years they grew at a rate of 3.2 inches/decade.

4. Residual overstory trees (the older age class) were still free to grow, with an average of 20 feet of growing space between adjacent crowns.

5. At 10 years, 70 to 85 percent of codominant reproduction had the potential to become timber crop trees. Three of the four treatment areas can be regarded as successfully regenerated with acceptable quality stems. The Olson Tower area is an exception. Cursory examination of the 15-year-old regeneration revealed disappointing results. The black cherry is heavily infested with black knot. The residual overstory is in poor condition with dead trees, dead tops, and abundant epicormic branches. This shallow soil site on a flat ridge was not a good location for a two-aged treatment.

6. The canopy of the younger age class was nearly closed after 10 years.

7. Frequently, grapevine control work is needed in the younger age class of two-aged stands, just as it is needed in young stands regenerating after a clearcut.

Grapevine control is just as critical in two-aged stands as it is in even-aged stands.

8. The younger age class is expected to develop for many years without serious competition from the older age class.

9. Species composition of the younger age class is variable, including tolerant and intolerant species, and stump sprout and seedling origin trees. Species composition at 10 years of age does not guarantee species composition at age 40. However, combined with other information in the regeneration profile and some knowledge of stand dynamics, it does give a basis to predict species composition at age 40. In the absence of any major intervening management activity, following are the three most predominant species expected to occupy the younger age class at each treatment area:

    - Riffle Creek – red oak, red maple, yellow-poplar
    - Olson Tower – black cherry, red maple, and red oak
    - Fish Trough – yellow-poplar, sugar maple, and basswood
    - Shavers Fork – yellow-poplar, red oak, and sugar maple

At the Fish Trough treatment area, yellow-poplar is predominant in both the younger and older age classes. Fifteen overstory trees of this size can be expected to cover about 40 percent of the canopy space.

The above is an indication that two-aged management can often be used to establish desirable regeneration similar to that found following clearcutting. As with any system, it is not appropriate for every site. This system is probably less financially efficient than even-aged management that includes the use of clearcutting. More frequent regeneration harvests and associated logging damage may preclude managing the equivalent number of crop trees per acre. However, the trade-off of being able to maintain some big trees on the site at all times makes this a desirable option for many landowners.

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Cover Picture: Tom Schuler, Northeastern Research Station, identifies oak regeneration in the younger age class of a two-aged stand.

***Note:** All articles contained in Forest Management Update are written by Arlyn W. Perkey (•AWP•) unless otherwise noted.*

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