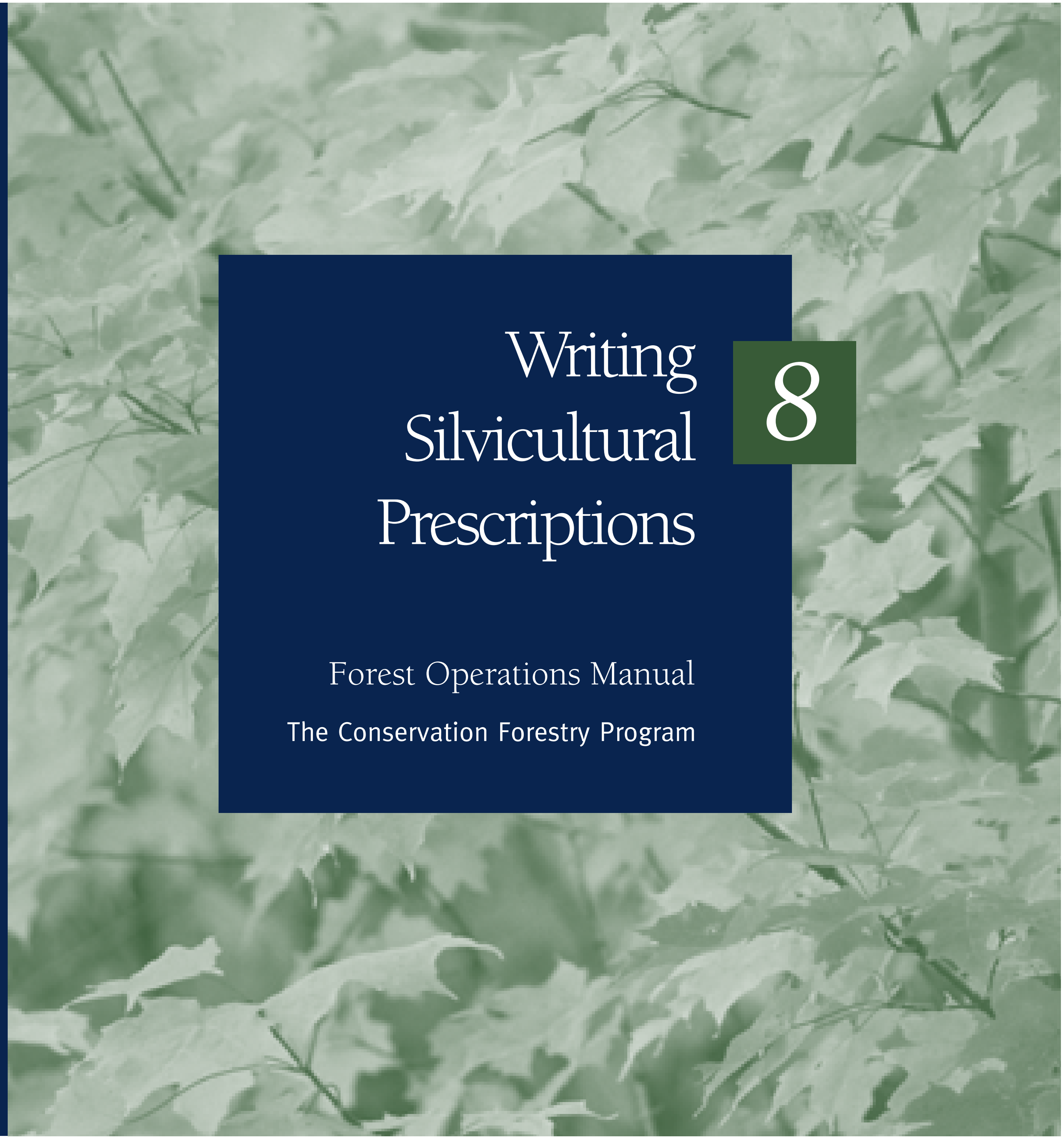


Writing Silvicultural Prescriptions

8

Forest Operations Manual

The Conservation Forestry Program

Writing Silvicultural Prescriptions

CHAPTER 8

James Willis

8.1 The Nature Conservancy Philosophy

Silviculture is the practice of cultivating trees, and it directs much of the actual on-the-ground forestry work. As Chapter 7: Writing Management Plans indicates, silvicultural prescriptions specify exactly what activities forest managers will implement, along with how and when they will be implemented, to achieve a particular set of goals. For the Conservation Forestry Program, these goals seek to balance timber production with species and habitat conservation in an ecologically sound way.

Writing an effective prescription, then, involves a whole range of factors. Along with management objectives, forest managers must consider site productivity, site limitations, tree silvics, and existing vegetation. In addition, forest managers must carefully consider the ecological and social concerns laid out in this manual, consciously protecting rare species, enhancing biodiversity, and supporting the social and economic well-being of the surrounding communities. An effective prescription combines virtually everything a forester knows to lay out the best possible course of action for a given stand.

Managers will develop silvicultural prescriptions that maintain and enhance site productivity, promote forest health, balance timber production, maintain biodiversity, and address social concerns to meet both the economic and the environmental goals for various properties.

8.2 Key Strategies

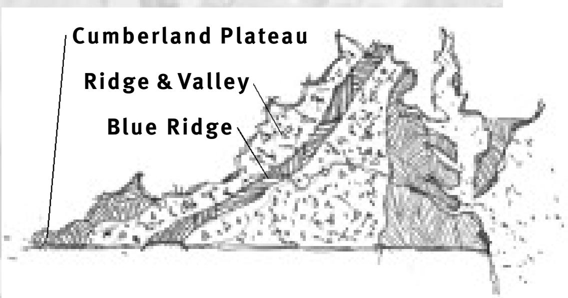
To maintain and enhance forest health, forest managers will:

- ❑ Choose silvicultural options that continually improve the quality of timber being grown
- ❑ Choose crop trees that meet both management objectives and site conditions.
- ❑ Choose harvest methods that effectively promote regeneration for the desired crop trees.
- ❑ Develop intermediate treatments that further the management goals for the whole forest.
- ❑ Have effective regeneration plans in place before beginning any timber harvest.
- ❑ Conduct operations that do not damage residual trees.

8.3 Silviculture Principles

As noted earlier, silviculture is, literally, the practice of "culturing" trees to meet a given set of objectives. Whether those objectives concern timber production, habitat enhancement, biodiversity, or even aesthetics, the property's silvicultural prescription describes all the specific activities required to meet those goals.

HARVEST typically refers to removing the mature and merchantable overstory trees, although forest managers may also select other trees for harvest to thin the stand and promote overall forest health and productivity.



In general, each stand on a tract has its own silvicultural prescription that defines intermediate treatments to promote the desired objectives, regeneration plans to effectively replace the stand after removing the existing overstory, and harvest plans to designate exactly which trees to remove to accomplish the management objectives. In many cases, the regeneration plan and the harvest plan go hand in hand; every harvest plan must consider regeneration, and often the stand's regeneration potential drives the type of harvest.

TREE SILVICS AND TIMBER MANAGEMENT IN THE SOUTHERN APPALACHIANS

The first step in developing a successful silvicultural prescription is determining what trees to cultivate in a given stand. To make that decision, forest managers must consider a broad range of factors that include not only the primary goals for the stand (timber production, non-timber forest products, wildlife habitat, forest reserve, rare species preservation, and so on), but also the forest system, site productivity, regeneration potential, social context, and related factors.

The following section describes these factors largely in relation to timber production stands. Managers should use these factors to choose a particular set of desirable, commercially valuable species that will help keep the forest sustainable over time.

Forest Systems

The Appalachian hardwood forest within the working area of the Conservation Forestry Program falls into three different physiographic provinces and five different forest types. The provinces include (from east to west) the Blue Ridge, the Ridge and Valley, and the Appalachian Plateaus (represented in the Clinch by the Cumberland Mountains). The forest types include mixed mesophytic, mixed oak/heath forests, northern forest, moist slope and cove forest, and dry slope and ridge forest. A brief description of each forest type and where it is found follows.

• **Mixed Mesophytic Forests** occur in the Cumberland Mountains of far southwestern Virginia, eastern Kentucky, and north-central Tennessee. Ecologically, these forests are the most complex and diverse in the Eastern Deciduous Forest of North America. Mixed Mesophytic forests develop best on moist, well-drained upland sites, and their dominant tree species include sugar maple, American beech, yellow-poplar, white basswood, yellow buckeye, northern red oak, white oak, eastern hemlock, and to a lesser extent, yellow birch, sweet birch, black cherry, white ash, red maple, blackgum, black walnut, cucumber tree, bitternut hickory, and shagbark hickory. Common understory woody species include flowering dogwood, serviceberry, striped maple, redbud, sourwood, blue beech, hophornbeam, and great rhododendron.

• **Mixed Oak /Heath Forests** are distributed across Virginia in every physiographic province. They have in common the fact that they occur on highly acidic soils with high iron content. They contain varying mixtures of oaks including white oak, chestnut oak, scarlet oak, red oak and black oak. Common associates include pitch pine, Virginia pine, red maple, blackgum, and sourwood. Ericaceous plants such as mountain laurel, huckleberry and blueberry are common understory associates.

• **Northern Forest** of highest elevations includes red spruce, Fraser fir, yellow birch, and red maple;

• **Moist slope and cove forest** includes sugar maple, beech, sweet birch, white ash, northern red oak, yellow-poplar, white oak, and shagbark hickory;

• **Dry slope and ridge forest**, the largest of the three, includes chestnut, scarlet, black, and white oaks, pignut hickory, and shortleaf, pitch, and Virginia pines.

Site Productivity

When managing for timber production in southern Appalachia, managers must keep the following in mind:

• Sites of good to excellent quality may produce high quality, high value hardwoods such as northern red oak, black cherry, black walnut, white oak, basswood, sugar maple, and yellow-poplar.

• Sites with fair to poor quality support lower-quality, lower-value, less site-demanding hardwood species such as chestnut oak, scarlet oak, black oak, and red maple.

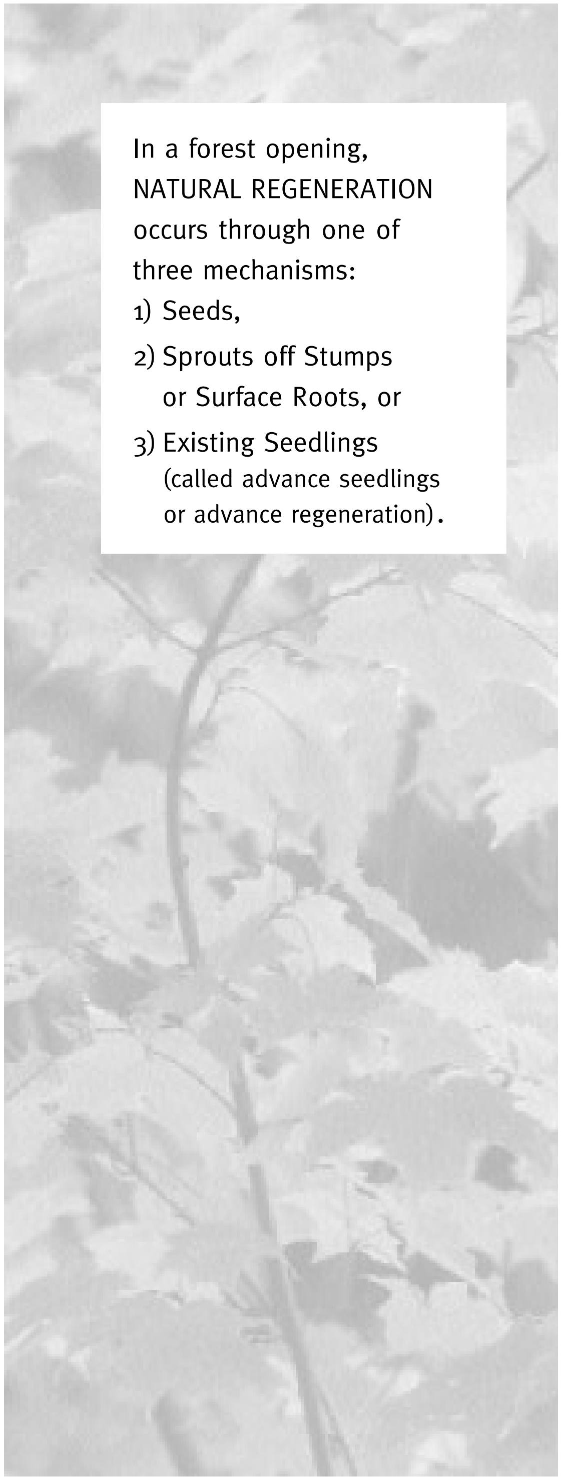
Regeneration Potential

To develop an effective prescription, forest managers need to consider which species will successfully regenerate and ultimately dominate a site given the prescribed management activities and common natural disturbances.

Successful regeneration requires the right combination of conditions, particularly light, temperature, and moisture. In addition, the early growth habits of a species influence its long-term success on a site. Shade tolerance also plays a significant role in regeneration:

- **Shade-tolerant** species such as American beech and sugar maple spend decades growing slowly in the understory and attempt to become part of the overstory whenever a gap in the canopy provides space.
- **Shade-intolerant** and **fast sprouting species** with rapid top growth such as yellow-poplar, red maple, black cherry and black locust quickly dominate a site after a disturbance but only thrive when their crowns receive full sun.
- Species with **intermediate tolerance** such as oaks, take much longer to establish themselves because they initially establish a widespread root system and therefore increase in height very slowly. They can survive in the shade producing multiple sprouts for decades, but they only thrive when they begin receive increasing amounts of sunlight.

In addition to species biology, factors such as the local deer population also play a role in regeneration success. For example, because deer prefer maple and ash seedlings to cherry, it takes more maple and ash seedlings on a site in order to produce a healthy stand of those species.



In a forest opening, NATURAL REGENERATION occurs through one of three mechanisms:

1) Seeds,
2) Sprouts off Stumps or Surface Roots, or
3) Existing Seedlings (called advance seedlings or advance regeneration).

Oak Production: A Special Case

One of the greatest challenges for foresters is regenerating oaks on high quality sites. Early growth habits pose one problem: seedlings of species with rapid height growth such as yellow-poplar and red maple quickly overtop the slower-growing oaks, restricting the sunlight these trees with intermediate tolerance need for more vigorous growth. Problems created by high deer populations, a history of damage from poor silvicultural choices including high-grading, changes in natural burning cycles, and the loss of the American chestnut compound the issue.

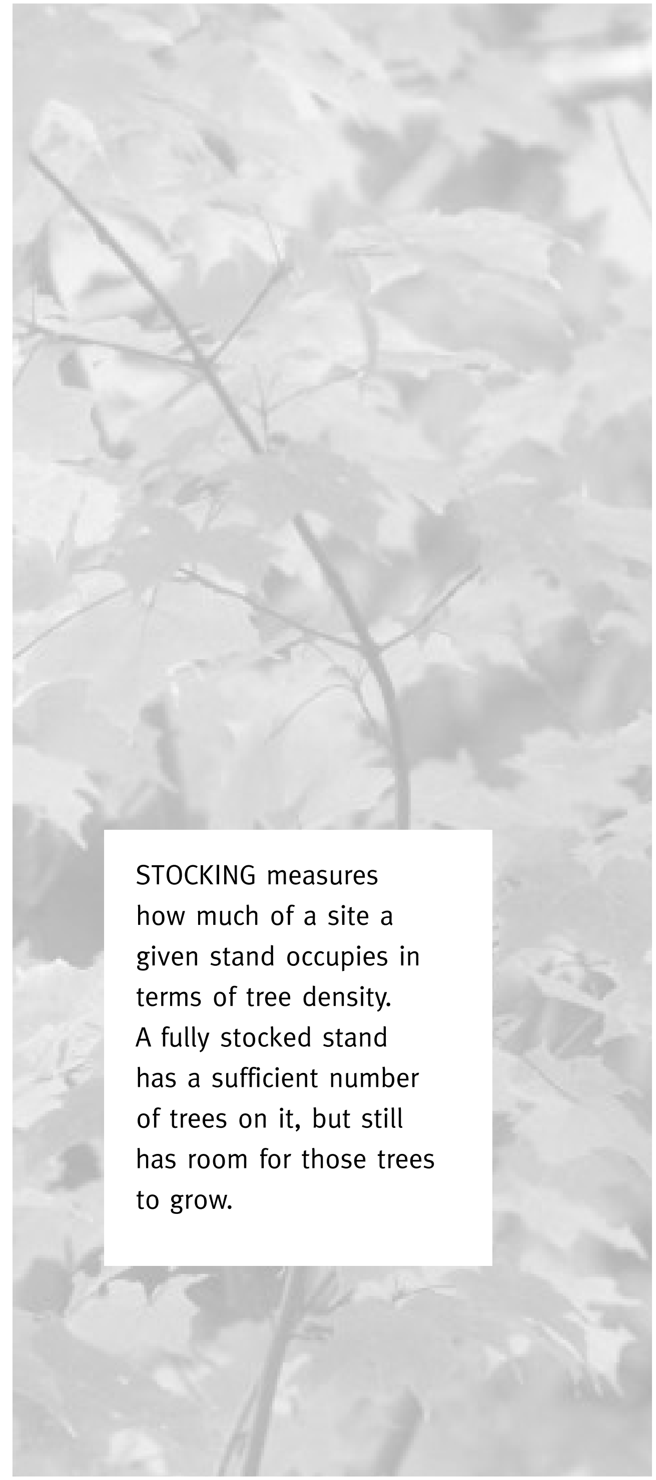
As a result, to cultivate oak production on good quality sites, forest managers must actively promote and support advance oak regeneration, implementing management strategies that establish hundreds of oak seedlings or saplings before a final overstory harvest (the larger the saplings, the fewer needed). Seedlings should be at least 4 1/2 feet tall to enable them to grow well and compete successfully with other vegetation once they are released. See Section 8.5: Planning Regeneration, for more details.

8.4 Developing Intermediate Treatments to Manage Existing Trees

Sometimes forest managers can simply “let nature take its course” in a given management area, allowing the stand to develop towards the desired conditions on its own. More often, though, they will prescribe certain activities, classified as intermediate treatments, to help reach the objectives more quickly and effectively.

PROMOTING DESIRABLE SPECIES

Whether the objectives for a management area are timber production, rare species habitat, or aesthetics, forest managers often want to promote the growth of certain desirable trees, referred to as **crop trees**, to meet those objectives. To do so, they need to focus the area’s resources (light, nutrients, space, soil, and moisture) on those trees to improve the health and productivity of the forest, whether productivity is measured in terms of sawtimber logs or full crowns of brilliant fall colors.



STOCKING measures how much of a site a given stand occupies in terms of tree density. A fully stocked stand has a sufficient number of trees on it, but still has room for those trees to grow.

In general, forest managers will work to establish **fully stocked stands** with high crop tree densities. Full stocking helps the natural growing process by stimulating early pruning of lower limbs, minimizing the tendency for forking, developing clean boles, and limiting knots and other defects to a small core.

As trees grow larger, they obviously require more resources, and as a result fewer trees can occupy a given area and still maintain a healthy forest. In response, stands naturally thin themselves out as more dominant trees out-compete their neighbors for resources and weaker trees die off. In prescribing activities to meet an area's management objectives, forest managers mimic that process, using thinning and crop tree release to choose which trees to keep and promote, rather than simply letting nature take its course. Both practices may be either precommercial or commercial, based on whether or not the trees being removed can be sold. Managers may also investigate prescribed burning for certain situations to maintain and regenerate forests.

Steve Lindeman

Thinning

Thinning is simply the process of removing trees from an area to reduce competition and thus increase growth and yield of the most desirable trees. In production stands managed for high-quality sawtimber, thinning can increase the total yield by salvaging trees that would otherwise die, increasing growth of crop trees, and concentrating growth on the most valuable stems.

To make thinning effective, forest managers should carefully regulate stand density, structure, quality, and species composition. To determine what to thin, forest managers will use the following guidelines:

- ❑ Implement pre-commercial thinnings to remove the smaller, poorer quality trees in a stand when the most valuable stems are overtopped and/or in danger of being crowded out by noncommercial species or low-quality stems.

- ❑ Implement the first commercial harvest when diameter growth begins to slow, so that most trees have developed a clear bole on the first log or two, and the cut trees have reached merchantable size, so that the harvest is economically feasible. On a high-quality hardwood production stand, this cut typically occurs between 40 and 60 years.
- ❑ Repeat thinnings at 15-20 year intervals, when crowding re-occurs.
- ❑ Stop commercial thinning 25-30 years before the final harvest to avoid degrading valuable sawtimber.

Crop Tree Release

Crop tree release is a very specific type of thinning that involves performing a “crown-touching release” to free crop trees from competing neighbors and give them room to expand. A crown-touching release removes all trees whose crowns interfere with the crop tree. Once released, crop trees grow more quickly, helping the property meet its management objectives.

Crop-tree releases can occur at any time, but they are particularly beneficial in the following situations:

- ❑ **Young stand of regeneration:** 15-20 years after harvesting a significant amount of a stand’s overstory (e.g. through a deferment or group selection cut), release 50-75 crop trees per acre. Stems should be tall enough to walk through, with a canopy at 20-25-feet; at this point, forest managers should be able to select vigorously growing crop trees for release based on crown size.
- ❑ **Middle-aged (40-60 years old) timber production stand with high commercial value:** Release 20-30 high-value crop trees per acre to help almost double their diameter growth over the next 10 years. Trees selected for release should have a butt-log potential of Grade 1 or 2, no epicormic branching on the butt log, no leaning, no splitting forks, and no sprouts with an unacceptable connection to the stump.
- ❑ **Maturing overstocked riparian area stands:** Outside established streamside management zones, release dominant or co-dominant crop trees for water quality that are expected to live at least 20 more years, with healthy crowns that are large in relation to diameter. Such trees have already established good, competitive positions in the stand and have the greatest capacity to absorb nutrients.

Steve Lindeman

CROP RELEASE is a specific type of thinning which frees crop trees from competing neighbors.

For more details on crop tree release, including information on selecting and managing crop trees for timber, wildlife, aesthetics, and water quality, see ***Crop Tree Management in Eastern Hardwoods*** by Perkey, Wilkins, and Smith.

Prescribed Burning

Along with hurricanes, ice storms, and windstorms, set fires and wildfires occurred regularly in eastern hardwood forests until the 1920s, when the Forest Service made fire suppression the rule. Because fires were part of the forest's natural development cycle, many species, including yellow pines and upland oaks, depend on them to a large degree for propagation. As a result, ecologists today are realizing the role of fire in regenerating certain forest types.

Prescribed fire may thus be an important tool for both maintaining and regenerating a forest in some circumstances. Paired with thinning, burning can prevent stagnant growth and limit susceptibility to disease and insects. This process is particularly important for both regenerating oak stands and maintaining yellow pine.

While research on fire in Appalachian hardwood stands is limited, studies do show that fire can help to:

❑ Establish adequate advance oak regeneration under a shelterwood system. As a follow-up to shelterwood harvests, burning helps maintain oaks on good Piedmont sites by mimicking natural disturbance patterns and removing less fire-resistant competitors such as yellow-poplar

❑ Promote advance oak regeneration before other types of harvests

❑ Regenerate yellow-poplar in cove sites

❑ Regenerate yellow pine species such as Table Mountain and pitch; Table Mountain pine stands, in particular, need hot fast-moving fires to open their cones without damaging the seeds and to create good open germination sites

These **burns** must be managed carefully, considering both the season and potential intensity. For example, high-intensity burns can cause basal wounds, especially on thin-barked hardwoods such as yellow poplar and red maple, that are ideal entrance points for disease that can lead to degradation and decay over time. Oaks have thicker bark which allows them to withstand low intensity fires through young stands. These same fires may remove competition such as red maple. Social concerns, including smoke management, liability for damage from escaped fire, and the prevailing regional attitude that any fire is bad, must be carefully considered before fire is prescribed as a management tool.

PREVENTING DAMAGE

In addition to promoting desirable species, forest managers must take steps to protect trees from potential damage, as described in the following sections.

Vine Control

Wild grapes are common throughout Appalachian forests, where, like trees, they thrive on rich, highly productive soils. These grapes provide food for both birds and mammals, as well as raw materials for artisans, and their thick arbors create wildlife cover.

However, in some situations, large grapevines can grow heavily into tree crowns. The vines damage trees by breaking and twisting tops and limbs, by completely covering the crown and reducing photosynthesis, and by increasing snow, wind, and ice damage. These guidelines will be followed to minimize such damage:

- ❑ When a significant number of crop tree crowns are full of grape or other vines, control the vines by cutting them at their base.
- ❑ To make this process less costly, combine vine control with another treatment such as crop tree release.
- ❑ To kill existing vines and prevent the development of new sprouts, delay overstory harvests in areas with a significant vine problem: first implement controls, then wait for the vines to die off before harvesting.
- ❑ Due to their higher fruit productivity, consider leaving some mature (2 inch plus in diameter) grape vines for wildlife.

Foresters Incorporated

Some researchers believe that over time, the forest will adapt to the GYPSY MOTH, much as it has to native insects (Gottschalk 1997).

Gypsy Moth Control

The gypsy moth arrived in the Central Appalachians by migrating south along the Appalachian mountain range. In Virginia, it has reached as far south as Botetourt County, with parts of West Virginia's central Greenbrier Valley (i.e. Pocahontas County) experiencing severe damage in the year 2000.

Because gypsy moth larvae prefer most oak species, stands with a higher percentage of oak are more susceptible to damage. The resulting defoliation can cause growth loss, crown dieback, and tree mortality. Although a tree can often refoliate in the spring after moth damage, and again produce food, the process depletes its already-limited energy reserves and makes it more susceptible to attacks from other insects and pathogens.

Mixed mesophytic forests are naturally less vulnerable due to the greater species diversity within these stands and the absence of oaks as the dominant component.

Healthy hardwoods can tolerate several years of defoliation before dieback begins. Hardwoods already suffering from some stress, such as drought or overcrowding, do not tolerate defoliation as well, and will lose much of their crowns from branch dieback or die after just one season of defoliation.

Good silviculture can reduce a stand's susceptibility to defoliation and/or its vulnerability to mortality or other damage. Silvicultural practices for controlling gypsy moth damage have several advantages in that they cost landowners little or nothing, and sometimes provide income; are ecologically preferable to chemical insecticides; treat one of the causes of the problem (unhealthy, low-vigor stands) rather than the symptom (defoliation and mortality); and allow high-priority stands to receive treatment first by using hazard and risk rating. To help minimize gypsy moth damage, managers will follow these guidelines:

❏ Treat stands at high risk before outbreaks to maintain stand health rather than salvage dead trees.

❏ To decrease susceptibility of high risk stands, maximize tree growth and vigor and increase forest diversity of age classes, structures, and composition.

❏ To decrease vulnerability, remove high-risk trees, maximize tree growth and vigor, and reduce the habitat of secondary organisms that invade and kill the defoliation-stressed trees.

For specific details on choosing appropriate treatments, follow the ***Silvicultural Guidelines for Forest Stands Threatened by the Gypsy Moth***

Additional Protective Measures

In addition, forest managers will:

❏ Stay current on threats to forest health such as oak declines, oak wilt, southern pine beetle, hemlock woolly adelgid, and more. One information source is the U.S. Forest Service's Northeastern Area State and Private Forestry web site (http://www.fs.fed.us/na/), which includes access to on-line information and to government publications such as their Forest Insect and Disease Leaflets.

❏ Stay current with state forestry programs dealing with forest health issues and get to know the personnel from these agencies that have expertise and current knowledge.

❏ Be prepared to salvage timber damaged by ice and wind storms.

❏ Contact local fire departments to have a plan in place in case of wildfire.

❏ Clearly mark and maintain boundary lines to protect against accidental harvests or disturbances from neighboring properties.

❏ Foster good relations with the community and neighbors of managed tracts for help in monitoring properties for wildfires and timber trespass losses.

❏ Foster partnerships with people that have hunting or access rights to the property to help maintain and control access to the interior of the properties.

8.5 Planning Regeneration

Because regeneration planning is crucial to the long-term health of any stand, forest managers will always have a regeneration plan in place before beginning any timber harvest. Importantly, though, timber production stands are not the only ones requiring such plans. Regeneration can also play a key role in situations such as restoring damaged sites or returning agricultural fields to forestland; the guidelines included in this section apply equally well to such cases.

Barring a severe disturbance from either human activity or natural disaster, Appalachian forests virtually always regenerate naturally after a timber harvest. However, the species that regenerate naturally may or may not match the objectives for a given stand, and that's where the regeneration plan comes in. To develop an effective plan, forest managers need to consider the factors affecting natural regeneration (including the regeneration potential, described in Section 8.3), then either implement activities to support that process or supplement nature by planting and cultivating appropriate species.

Depending on an area's objectives and planned activities, this regeneration plan may be as simple as making sure the stand has 500 advance oak seedlings before cutting timber or as complex as preparing a site and planting the desired species. In general, though, regeneration falls into two broad categories, natural and artificial.

Natural Regeneration

When assessing a stand's natural regeneration potential, forest managers need to consider six primary factors:

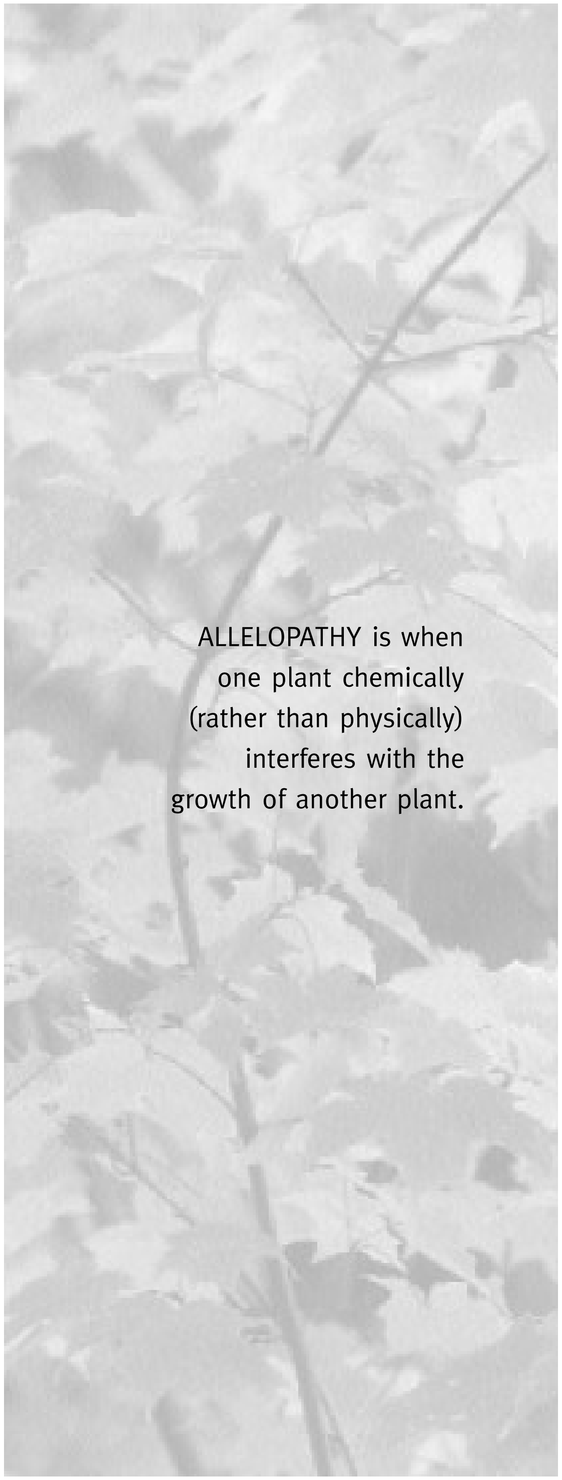
- ❏ Advance regeneration of desired species;
- ❏ Ability to coppice;
- ❏ Stored seeds on site;
- ❏ Seeds dispersed by wind, water, or animals;
- ❏ The regeneration dynamics of desired versus non-desired species likely to compete on the site;
- ❏ Competition from understory vegetation.

If conditions are right for natural regeneration, forest managers can simply select a harvest method that will promote that regeneration and proceed. If the site does not have enough advance regeneration, has a very competitive understory, or is limited in other ways, the harvest will be delayed until the stand is ready.

Advance Regeneration: The species composition of the seedlings and saplings present at harvest largely determines the composition of the next stand. To maintain a certain stand composition, therefore, forest managers must make sure that the stand has adequate advance regeneration before harvesting the overstory, particularly for *oak-hickory* stands.

"Adequacy," of course, depends on the species involved, the number and size of seedlings, and the amount of herbivory in the area. In general, though, a stand should have 4 times as many seedlings as the number of crop trees desired before an overstory harvest begins. For example, to produce 60-80 crop trees per acre, a stand should have 240-320 healthy advance seedlings. In addition, the following guidelines will be relied upon:

- ❏ To encourage advance seedlings, forest managers may need to implement partial cuttings to create gaps in the canopy and allow sunlight to reach the understory. The size of the canopy gap depends on the species; shade-intolerant species need larger gaps, while smaller gaps suffice for shade-tolerant species.



ALLELOPATHY is when one plant chemically (rather than physically) interferes with the growth of another plant.

- ❑ For oaks, stump sprouts rather than advance seedlings may provide sufficient regeneration potential, and Marquis et al. (1992) include specific guidelines on the sprouting potential of oak stems based on species size and stump diameter. However, because deer prefer these stump sprouts, this method does not work well where deer populations are high.
- ❑ Be extremely cautious when prescribing regeneration treatments in areas with poor seed sources and high deer populations, where sustaining adequate regeneration is extremely difficult.
- ❑ In general, remove saplings and small poles of poor quality or undesirable species.
- ❑ Stands that have experienced heavy cutting or other disturbance over the last 10-25 years often contain a dense sapling understory of a commercial species that can form the next stand. In these cases, cutting the overstory can release these saplings and allow them to develop, provided enough saplings exist to populate a new stand.

Understory Competition: Herbaceous and woody plants in the understory typically survive harvesting and persist throughout the regeneration period, often growing even more vigorously because of the additional sunlight. In some cases, though, these understory plants interfere with the newly developing hardwood seedlings, severely disrupting regeneration through both competition and allelopathy. Problem species include hay-scented and New York ferns, grasses and sedges, striped maple, beech root suckers, dogwood, sassafras, sourwood, blackgum, hophornbeam, blue beech, mountain laurel, and rhododendron.

Understory competition poses problems primarily in partial cuts. In general, established seedlings compete successfully with sparse to moderate amounts of interfering plants after a complete overstory harvest because the additional sunlight helps the seedlings grow rapidly. But under partial shade, such as after a shelterwood cut, the seedlings grow more slowly while the rest of the understory grows more vigorously, creating problems. Currently, the only practical way to reduce competition and promote regeneration under these conditions is by using herbicides, and possibly prescribed fire, to control the understory.

Artificial Regeneration

In harvest areas with limited natural regeneration of desired species, forest managers may implement artificial regeneration. An effective artificial regeneration plan includes:

1. Choosing seeds, seedlings, and sources;

2. Planting;

3. Protecting the seedlings and implementing follow-up treatments as needed.

Choosing seeds, seedlings, and sources: When choosing what species to plant in an area, forest managers should consider the factors outlined in Section 8.3, carefully matching the species to the site and the objectives.

Direct seeding is less expensive than planting seedlings, but survival rates dictate planting more seeds than seedlings. Direct seeding is used most often for hard mast species, particularly oak, while seedlings are used for most other species. When choosing seeds or seedlings, forest managers will use the following guidelines:

❑ Use reliable nurseries.

❑ Approximately 1 out of 4 acorns yields a healthy tree after 10 years.

❑ Do not use seeds or seedlings from parent trees located more than 100 miles south or north of the planting site (east/west variations are less critical).

❑ Seedlings should have a well-developed root system: at least an 8-inch main root, plenty of lateral roots, and a root collar diameter of 3/8 – 1/2 inch.

Planting: When planting, forest managers will use the following guidelines:

❑ Use machine planting only on clean, dry sites; plant by hand in other conditions, particularly if the soil is wet or debris is present.

❑ On old agricultural lands, prepare the site either by disking or selectively applying herbicides to reduce weedy competition and allow for rapid seedling growth. The method used will depend on how erodible the site is, and the species of weeds present.

- ❑ A high planting rate (650-900 seedlings or 2000 acorns per acre) establishes a closed canopy quickly and provides a wider range of management options. Removing trees is always easier, and potentially more profitable, than adding trees later.
- ❑ Plant acorns 2-4 inches deep; the larger the seed, the deeper the planting
- ❑ In general, plant both seeds and seedlings during the fall and winter (November to March). Plant hardwood seedlings as soon as possible after they've been lifted (which cannot occur until fall dormancy), and avoid direct seeding during hot, dry months.
- ❑ Seedlings survive best when planted on cool, cloudy days.
- ❑ Monitor the planting operation and correct improper practices immediately.

Implementing follow-up treatments: To foster seedling growth and development, control weeds through disking or spraying to speed up seedling growth and increase survival, and use tree shelters to protect expensive hardwood and pine seedlings from browsing damage. As an alternative to tree shelters, plant at the higher end of the planting rates where deer browsing will not be too heavy.

8.6 Planning Overstory Harvests

While thinning and related intermediate treatments may be considered types of harvests, typically in timber production stands forest managers design either a single harvest or a series of harvests that removes all or most of the overstory and fosters the regeneration process. Planning these harvests successfully involves determining both when to harvest timber and how to harvest it.

HARVEST CRITERIA

Management plans for timber production stands typically specify a predicted rotation, or length of time between final harvests, based on forest product objectives and growth projections for the desired species. In Mixed Mesophytic forests, rotations for large sawtimber range from 70 or 80 years to 150 years or more, while Mixed Oak forests may have even longer rotations.

As a timber production stand nears the end of its estimated rotation, forest managers must evaluate the stand and determine whether or not to proceed with the final scheduled harvest. In general, stands that meet some or all of the following criteria are ready:

- ❑ **Advance regeneration or seed sources** are adequate to begin a new stand of the desired species;
- ❑ The **crop trees are economically mature** or have reached the forest product goals;
- ❑ The **rate of stand volume growth**, and therefore the **rate of value growth**, is beginning to slow down.

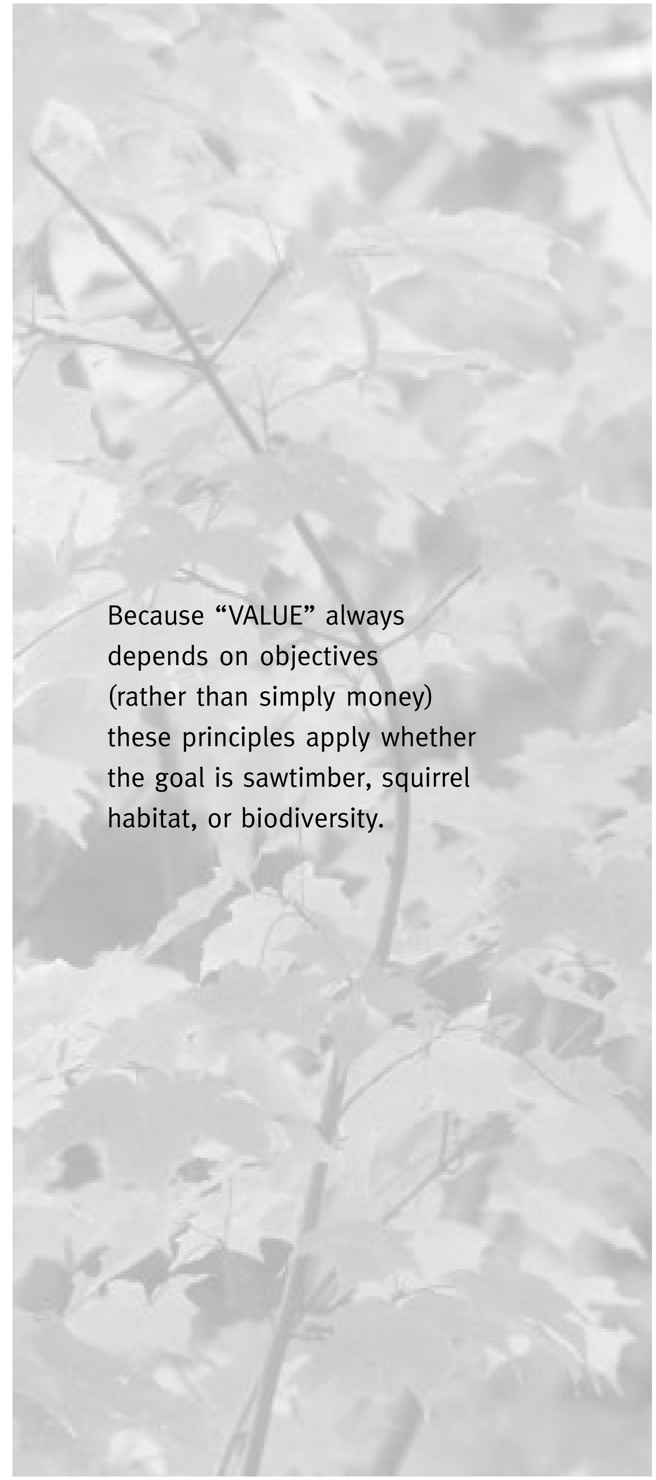
Stand value growth usually slows once a high proportion of the trees qualify for Grade 1 sawtimber or veneer; as a rule of thumb, stands on productive sites reach this point when the median diameter of merchantable trees reaches 18 inches.

Forest managers may also prescribe harvests for stands that do not have enough trees of the right quality or species, or that have minimal economic or ecological value (i.e. relative to the expected potential of the site). In such cases, "starting over" with a new stand more closely suited to the management objectives is often more effective than continuing to use the site's resources on low-value material. In quantitative terms, if less than 35% of a stand consists of desirable trees, the stand is considered mature enough for harvest, provided regeneration is possible.

HARVEST TIMING

The seasonal timing of the harvest can significantly affect regeneration, the site, and other users of the forest. Although controlling harvest schedules is not always possible due to market concerns and logger availability, managers will apply the following guidelines when possible:

- ❑ Harvesting from November through March favors stump sprout development and takes advantage of the current year's seed crops.
- ❑ Depending on the amount of precipitation, winter harvesting may make road maintenance and erosion prevention difficult during wet weather.



Because "VALUE" always depends on objectives (rather than simply money) these principles apply whether the goal is sawtimber, squirrel habitat, or biodiversity.

- Harvesting in spring and early summer potentially affects breeding songbirds, forest bats, and other wildlife that cannot necessarily move away from a logging job. There is also a higher potential for damage of the residual timber during this time period.
- Fall and early winter harvesting can disrupt hunting activities traditionally held on family or hunt club properties.

Regeneration Systems

Managers will select harvesting systems designed to meet the objectives for a given stand and support the desired regeneration. Systems fall into one of three categories:

- **Even-aged harvests** effectively remove the entire overstory so that the resulting stand will be the same age. Even-aged methods to be applied by forest managers include shelterwood and seed tree.
- **Two-aged harvests**, or deferment cuts, leave some selected trees, generally all one age, but take everything else, such that the trees that regenerate form the second age class.
- **Uneven-aged harvests** leave a variety of trees of different ages and sizes. Uneven-aged methods include single tree selection and group selection.

Each category has particular uses and benefits, as described in the following sections.

<u>Even-Aged Harvests</u>

Use even-aged harvest to 1) bring full sunlight to the forest floor to support and establish shade-intolerant or intermediate species; 2) maximize immediate income by harvesting all or most of the stand's products; 3) minimize the road mileage created and the number of times loggers must enter a stand.

The two primary types of even-aged harvest methods to be used by forest managers include <u>shelterwood</u> and <u>seed tree</u>.

Shelterwood

A shelterwood harvest uses two (or sometimes three) successive cuts to remove the mature trees in order to leave a canopy of trees to provide shelter for regeneration.

Criteria: Use shelterwood cuts to:

- ❑ increase the number and size of seedlings and sprouts in stands with poor advance regeneration;
- ❑ provide light conditions needed to foster shade intolerant or intermediate species;
- ❑ maintain stand aesthetics during harvest;
- ❑ allow advance seedlings to develop over a 5-10 year period to foster regeneration;
- ❑ minimize problems involved in timing cuts to coincide with bumper seed crops.

Method: Shelterwood harvests use two or three cuts, 3 to 10 years apart:

1. Use the initial seed cut to encourage the recruitment and development of advanced regeneration, generate timber income, and release good crop trees so that they can increase in value.

2. If necessary, use a second intermediate cut to further open up the stand, establish regeneration, and prepare the seedbed.

3. Use the final cut to remove the “shelter” (i.e. the remaining mature, high-value crop trees), generating income and allowing the established seedlings to develop into the next stand.

Guidelines: Managers will keep the following guidelines in mind when planning shelterwood harvests :

- ❑ Shelterwood cuts require an adequate seed source; stands with high herbivory require an extremely large number of seeds and the fast development of tall advance seedlings.
- ❑ If seed sources are inadequate it may be necessary to use underplanting to ensure successful regeneration.

❑ For **Mixed Mesophytic forests**, if the seed source is adequate and the site conditions do not limit regeneration, plan an initial seed cut followed in 3-10 years by a final cut.

❑ For **Mixed Oak forests**, allow a longer period for seedlings to develop and control vegetation to favor oak seedlings. In particular, remove sapling-sized woody understory.

❑ In stands with poor soil drainage or rocky soil, use three cuts: an initial seed cut followed by two removal cuts to allow the advance seedlings to establish themselves more fully.

❑ When stand aesthetics are crucial, three cuts can minimize the negative appearance of the final harvest by allowing advance seedlings to develop more fully.

❑ In stands with high herbivory, the three-cut method is less successful because it extends the time the seedlings must grow under partial shade and limits maximum height growth.

Seed Tree

A seed tree cut involves the removal of all trees except for a small number of widely dispersed trees retained for seed production to produce a new age class. The seed trees can either be harvested once regeneration is established or left to attain goals other than regeneration.

Criteria: The following factors influence whether or not to use a seed tree cut:

- **Virginia's Seed Tree Law** requires seed trees on stands that are 10 acres or larger with more than 25% of the live trees in white or loblolly pine. The harvest must leave 8 cone-bearing pine trees with a diameter of 14 inches or more uncut and uninjured per acre. If the stand does not have such trees, then leave two of the largest-diameter trees instead. Note that these trees must remain uncut for 3 years following the harvest.
- Seed cuts are typically not effective for hardwoods because seed production is unpredictable, the seed trees lose too much quality and value, and the overstory is too sparse to influence regeneration.

Method: Select 8-10 well-spaced seed trees per acre with the following characteristics:

- ❑ straight trunk
- ❑ windfirmness
- ❑ well-shaped, healthy crown
- ❑ evidence of seed production (many cones present)
- ❑ as tall or taller than surrounding trees
- ❑ fast-growing
- ❑ no evidence of disease or damaging insects

Two-Aged Harvests

Two-aged harvests offer a kind of compromise in that although they are not quite as efficient as even-aged harvests, they are more efficient than uneven aged ones, yet they still provide important benefits in terms of regeneration, aesthetics, and forest diversity. They can:

- promote regeneration for a variety of hardwoods, including shade-intolerant species;
- provide a more aesthetic appearance;
- provide stand diversity to support certain wildlife species;
- increase flexibility in harvest choices, in that the residual trees can remain in the stand until the end of the next rotation, or be harvested after 20 or 30 years to take advantage of favorable market prices and generate revenue to support intermediate treatments.

Method: A two-aged harvest, or deferment cut, resembles a seed tree or shelterwood harvest in that it leaves a certain number of trees in the stand. However, instead of harvesting these remaining trees within a few years, the residual trees remain in the stand for 40-80 years (approximately half the length of a full sawtimber rotation) to diversify stand composition and vertical structure, and to keep hard mast trees in stands that are primarily soft-masted. On good to excellent sites, after 10 years the canopy of the new trees typically closes and the codominant trees average 35 feet.

When planning a deferment cut:

❑ Leave 15-20 dominant or codominant residual trees per acre or a residual basal area of 20-40 square feet per acre

❑ Leave some flowering shrubs, mast trees, and den trees for aesthetics and wildlife

❑ Cut all other trees with a diameter of 1 inch or larger

❑ Select residual trees based on management objectives, using the following criteria:

- ✓ high value species such as northern ***red oak***, ***black cherry***, or ***yellow-poplar***
- ✓ dominant or codominant crown class
- ✓ free of epicormic branching or other signs of stress
- ✓ free of disease, low forks, shallow roots, or other risk factors
- ✓ current or potential high-quality butt log
- ✓ rough barked trees such as ***shagbark hickory*** for Indiana bats
- ✓ effective distribution throughout the stand

Guidelines: One of the most important issues in deferment cuts is minimizing ***damage*** to residual trees. Damage may result either from natural sources (windthrow and exposure) or from logging. The following guidelines can minimize such damage:

❑ Natural damage depends on the exposure of the location, so choose sites carefully.

❑ To minimize logging damage, use reliable loggers and conduct harvests between November and January, when the bark is more resistant to damage.

Cost Considerations: Deferment cuts may be less expensive than uneven-aged harvest, but more costly than clearcuts. In terms of felling and skidding costs, deferment cuts and clear cuts differ by approximately 15%. Harvests that yield similar removal volumes per acre should incur similar costs, but deferment cuts may significantly reduce productivity (and thus income) if the residual trees are among the largest in the stand:

❑ If the residual trees are selected for regeneration potential, then tree quality is critical, and a deferment harvest may significantly reduce current income.

❑ If the residual trees are selected primarily for shading or aesthetics, then size, species, and quality are less critical. In this case, leaving smaller, poorer quality trees can reduce the economic difference between a clearcut and a deferment cut.

Uneven-Aged Harvests

Uneven-aged harvests leave a substantial forest canopy in place at all times, and thus avoid large openings with the exposed stumps, slash, and soil disturbances common to even-aged harvests. They are particularly useful when:

- the stand requires only partial sunlight for regeneration (i.e. shade tolerant or intermediate species);
- the objectives involve spreading out income from timber sales into regular increments;
- site conditions such as wetness make it difficult to regenerate the stand if the entire overstory is gone.

Uneven-aged methods generally foster shade-tolerant species, which are typically less valuable in the southern Appalachians; oak stands in Mixed Mesophytic forests, in particular, cannot be regenerated through uneven-aged harvests. Even group selection cuts, which create enough open space for some shade-intolerant species, move primarily to shade-tolerant trees over time. In addition, these harvest methods reduce habitat variety, mast, and sun-loving plants, which may in turn affect wildlife diversity.

Single-Tree Selection

A single-tree selection harvest involves marking and cutting a specified number of trees every 10-25 years and establishing regeneration after every cut to maintain a given number of residual trees per acre that constitute a range of age classes (and effectively DBH classes) over time.

Criteria: Single-tree selection is rare in the southern Appalachians because it doesn't support the shade-intolerant species that dominate our forests. Within the program's operating area, however, it may be appropriate for some stands in the Mixed Mesophytic forest of the Cumberland Mountains. As long as a desirable crop tree can be regenerated after each cut, single-tree selection can provide adequate income while preserving recreational opportunities, aesthetics, and standing timber investments.

Guidelines: Because single-tree selection can affect both economics and ecology, the following guidelines will be used:

❑ To insure regular, sustained yields, do not cut more than the calculated periodic stand growth. Both cut frequency and cut volume determine financial returns over time, so plan harvests carefully in light of the stand's long-term objectives.

❑ To help develop a successful timber production stand, use the first cut to remove:

- ✓ culls (though some culls may be left as snags for wildlife, in particular leave some culls over 20" dbh for black bear den trees)
- ✓ near-culls and trees with significant stem rot
- ✓ low-grade logs (butt-log grade of 5)
- ✓ trees over 15-inch DBH with a butt-log grade of 4
- ✓ trees of low vigor, including shade-intolerant species that are already overtopped
- ✓ short-lived species such as black locust, and sassafras (unless the tree is unusually vigorous)

❑ In planning, remember that even if the stand initially includes a variety of commercial sawtimber species, over time shade tolerant species such as sugar maple, red maple, and beech will eventually dominate areas harvested under single-tree selection.

❑ To foster the higher-value, shade-intolerant species, consider combining single-tree selection with group selection.

Group Selection

Group selection resembles single-tree selection except that it removes trees in groups, rather than individually, and thus satisfies aesthetic goals while opening up the canopy to help regenerate shade-intolerant species, at least in the short term. Group selection can:

- Increase the long-term income by allowing trees to grow into higher-quality product classes;
- provide habitat diversity for wildlife;
- lessen damage to residual trees by limiting logging to selected areas within the stand;
- promote better form among trees growing in dense groups;
- remove patches of low-quality trees and promote higher quality species with a periodic cut;
- minimize costs for sale preparation and logging.

Guidelines: The size of a group selection cut can vary from a single large tree crown to the maximum size allowed by the aesthetic and/or ecological objectives for the stand, up to an acre or two. When selecting areas for cuts, forest managers will use the following criteria:

- ❑ Use a "worst-first" approach, using early cuts to remove patches of low-quality timber.
- ❑ Harvest clumps of mature trees.
- ❑ The minimum opening size for species diversity is 0.4 acre (making a 1-tree opening acceptable if the tree has a large crown).
- ❑ Appalachian hardwoods require openings of 0.5 acres or more to regenerate and develop.
- ❑ As a rule of thumb, the diameter of the opening should be 1.5-2 times the total height of the surrounding mature, codominant trees.
- ❑ Clean small openings by removing all trees with a DBH of 1 inch or more.

8.7 Related Practices

Silvicultural prescriptions are a crucial part of both creating an effective management plan and conducting a successful timber harvest. As a result, the guidelines in this chapter work in conjunction with the guidelines in *Chapter 7: Writing Management Plans* and *Chapter 10: Timber Harvesting and Marketing*.

In addition, an effective silvicultural prescription must take into account habitat needed to foster biodiversity and protect rare species, as defined in *Chapters 4 and 3*, respectively.