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# Principles of Regeneration Silviculture in Virginia



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# Principles of Regeneration Silviculture in Virginia

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The processes used to grow forest trees are similar to those required to grow agricultural and horticultural crops. It takes less than a year, however, to grow agricultural and most horticultural crops, while it takes many years to grow a crop of trees. Forest crops consequently require careful planning and proper management to be successful and profitable.

Understanding the principles of silviculture aids landowners in managing their lands to obtain a wide variety of forest products and benefits that satisfy their individual objectives. The principles of silviculture are presented in this bulletin.

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## I. Silviculture and Forest Management

**F**orest management deals with the administrative and regulatory processes that implement the policies and methods required to satisfy specific landowner objectives. Ideally, the ultimate goals of forest management are to insure a flow of forest products and services that benefit the owner, and to maintain or enhance the forest ecosystem. In this sense, forest products and services include timber, wildlife, aesthetics, watershed protection, recreation, and fisheries, either singularly or in any combination. Forest management decisions must be economically sound, biologically possible, and socially and politically acceptable.

Silviculture, the part of forest management that deals with the biology of tree growth, is the art and science of producing, tending, and manipulating forest stands. Silvicultural practices include regenerating the forest, maintaining tree growth, and harvesting trees in order to satisfy the landowner's objectives. The entire forest is considered to be the primary unit when referring to forest management, while an individual stand of trees is the primary unit when considering silvicultural treatment. A stand, then, is made up of the trees found on an area of land ranging in size from an acre to a hundred or more acres. Normally, a

stand contains a similar tree species or mix of species, on land of equal site quality, and can be readily managed as a unit. In agricultural terms, a stand would be equivalent to a field.

Silviculture is the application of the science of silvics, which is the study of tree species and how they function. The foundation of a sound silvicultural recommendation must be based on a knowledge of the silvical characteristics of the tree species that presently occupy or will occupy the site. This is especially true when determining the silvicultural practices to be used in a stand of mixed species that will rely on natural regeneration. Most of Virginia's hardwood stands fall into this category. Some of the more important silvical characteristics include the following:

1. *Extent of natural range;*
2. *Commonly associated species;*
3. *Tolerance to shade and to such site factors as poor or excessive drainage;*
4. *Place in ecological succession (plant succession being the progression of plant types and communities in nature through time);*

5. *Regeneration characteristics such as seedbed requirements, method of seed dispersal, how often a seed crop is produced, how long seeds will remain viable on the forest floor, season of seed fall, requirement for ripening after seed fall (dormancy factor), and potential for sprouting (vegetative reproduction);*
6. *Growth rate, both juvenile and mature;*
7. *Site conditions for best growth;*
8. *Longevity;*
9. *Distinctive disease, insect, or other damaging agent problems; and*
10. *Unique features such as exceptionally good or poor wildlife food, and specialty-product value.*

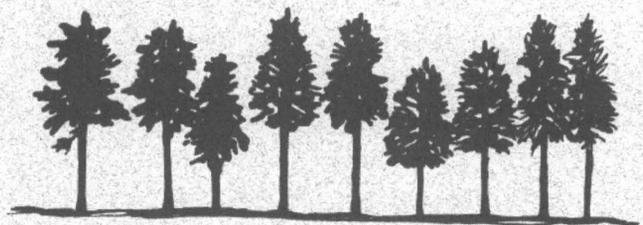
### *A. Forest Stand Structure*

As previously defined, a forest stand is a group of trees sufficiently similar in species composition, age classes, and condition to be a distinguishable unit (Figure 1). The arrangement of individual trees in a stand is called stand structure. Whenever tree removal or severe damage occurs in a forest stand, whether it is a result of a harvest operation, an ice storm, forest fire, or an insect epidemic, the remaining stand will change in structure. The exact form of the changed stand will depend on the number and distribution of trees that are removed, damaged, or die; the silvical characteristics of the remaining trees; and the amount and type of regeneration that becomes established. Structure is often characterized by a profile of tree crowns and generally reflects an age distribution (Figure 2).

Tree stands are commonly divided into three groups on the basis of age: even-aged, two-aged, and uneven-aged. Even-aged stands are essentially composed of a single age in which all trees are harvested at the same time. As the new stand grows, all tree crowns move vertically as if they were one until the trees reach a predetermined size, at which time the stand is harvested as before, and the cycle is repeated. Regeneration



*Figure 1. A well-managed, fully-stocked mixed hardwood stand growing in the upper Piedmont in Virginia.*



*Figure 2. Profile of an even-aged forest stand.*

occurs at or near the time of harvest. Intermediate silvicultural practices such as thinning may be employed during the rotation (the interval between one harvest and the next) to concentrate the growth potential on fewer trees and to improve tree quality.

Even-aged silviculture is most effective in stands of shade-intolerant species such as yellow-poplar and loblolly pine (Figure 2). It should be used to return overmature, diseased, or insect-infested stands to productivity. Virtually all plantations are managed exclusively as even-aged stands. Most shade-tolerant species such as sugar maple and hemlock may also respond to even-aged silviculture systems.

In contrast to the single age class of even-aged stands, uneven-aged stands contain at least three and usually many age classes, well-distributed in age and location throughout the stand (Figure 3). Regeneration is normally from seed and occurs either continuously or following periodic harvests in managed stands. The stand is characterized by continuous canopy cover (from the ground to the top of the tallest trees) with trees being harvested singly or in small groups to provide a continuing yield of products. In managed uneven-aged stands, harvesting not only includes the removal of crop trees of a certain diameter, but also includes improvement of the residual stand by removing cull trees (undesirable species and trees of poor form). The goal of harvesting in uneven-aged stands should be to promote growth and improve the stand

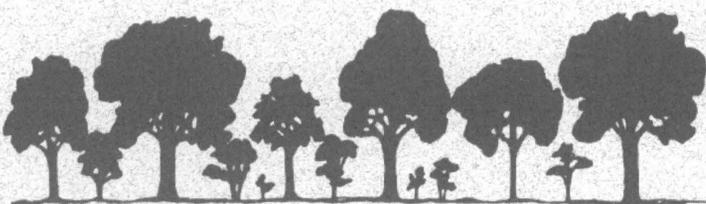


Figure 3. Profile of an uneven-aged forest stand.

structure so that there is a flow of high-quality products from desirable species on a continuous basis.

Uneven-aged silviculture works best with shade-tolerant species, especially if the stand already has an irregular structure (several distinctly different age groups present). Any site that would be adversely affected by harvesting all the trees at one time should be considered for uneven-aged silviculture. In addition, uneven-aged silviculture could be appropriate where aesthetics are of importance or where there are other use constraints.

A two-aged stand is a forest stand that has two distinct age classes (Figure 4). It is included as a separate structural group because it has characteristics that are quite different from those of even-aged and uneven-aged stands. Two-age stands can be

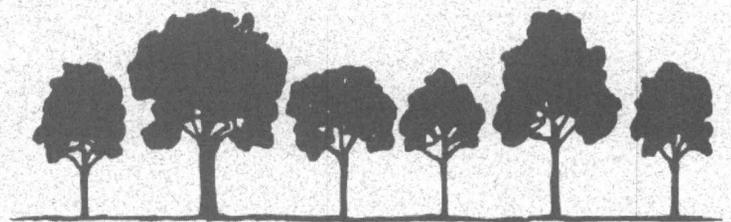


Figure 4. Profile of a two-aged forest stand.

created by harvesting most trees in a stand, and leaving a small number of healthy, strong trees behind. The new stand regenerates as an even-aged stand, but the few remaining residual trees make up the second, older age class. Sometimes two-aged stands result from the practice of high-grading, in which the biggest and most valuable trees are cut and poor-quality, weak trees are left standing. This type of cutting results in weak regeneration and a residual stand that consists of poor-quality trees with little potential future value.

The biological feasibility of developing an even-aged or an uneven-aged stand depends on the present stand conditions and the silvical characteristics of the present or desired species. It is relatively easy to convert an uneven-aged stand to an even-aged stand; however, it is difficult and will take many years (perhaps a century or more) to convert an even-aged stand to an uneven-aged stand.

## II. SILVICULTURAL SYSTEMS

“Silvicultural system” is a comprehensive term that includes all of the silvicultural practices that are to be used during a rotation. It includes regeneration methods and intermediate cutting operations. A silvicultural system is specific for each stand and is based on site conditions and constraints. It can be thought of as a solution that will result in successfully achieving forest management objectives desired by the landowner.

As mentioned, a silvicultural system is specific for a given stand. It must also fit, however, into the overall management plan for the entire forest. The proper foundation of a silvicultural system is based on satisfying several basic objectives:

1. *agreement with landowner objectives;*
2. *provisions for regenerating the stand after harvest;*
3. *efficient use of growing space and site productivity;*
4. *control of damaging agents such as fire, insects, and disease;*
5. *provision for maintaining the flow of products from the forest (sustained yield);*

6. *best use of available financial resources;*
7. *concentration and efficient arrangement of operations; and*
8. *provisions for maintaining site quality and ecosystem functions.*

There are four major silvicultural systems, the names of which correspond to the regeneration methods used in the systems. The four systems are selection, shelterwood, seed-tree, and clearcutting. These names are also commonly used to refer to the type of harvest cutting to be used. It is important to realize that the harvest cut is only a part of the silvicultural system used for regenerating a stand. As previously mentioned, a silvicultural system also includes techniques and practices such as the intermediate cuttings or thinnings necessary to develop and maintain the desired forest stand.

### *A. The Selection System*

The selection system is the only one that can be used to create or maintain uneven-aged stands. This system is further divided into the single-tree selection method and the group selection method.

The single-tree selection method, in which individual trees are harvested, favors shade-tolerant species such as sugar maple and American beech (Figure 5). In the group selection method, groups of trees are harvested (Figure 6). The area encompassed by a single group is usually no larger than one-half acre in size. In group selection the openings are larger than with single-tree selection, resulting in an increase in the proportion of shade-intolerant trees, but the more tolerant species will usually dominate.

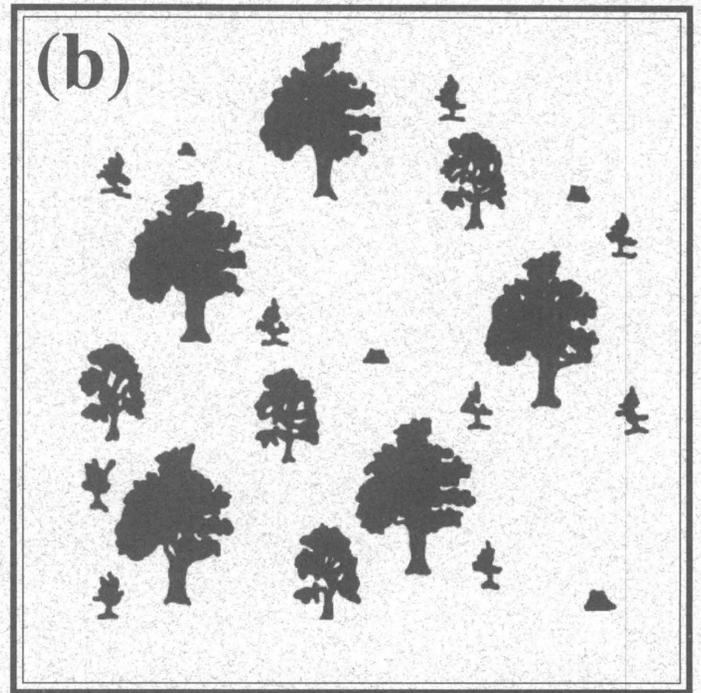
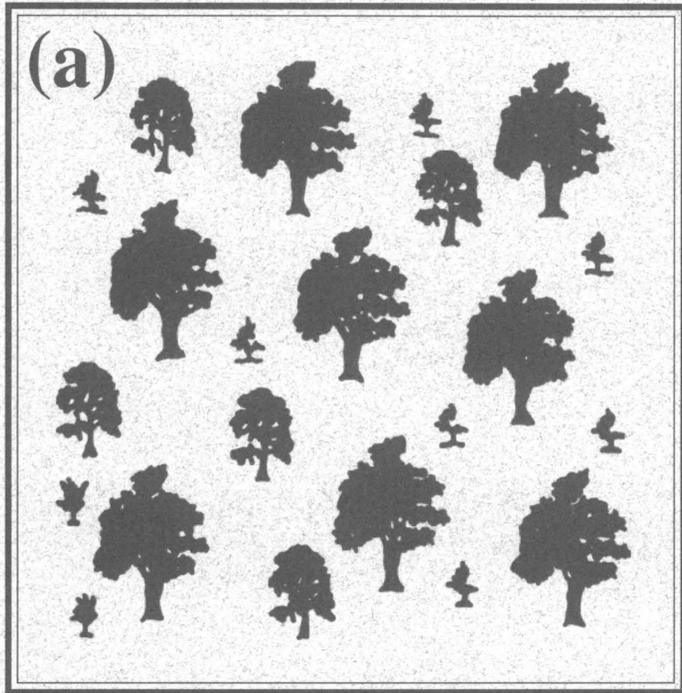


Figure 5. Diagram of the single-tree selection method of regeneration (a) prior to harvest, and (b) following harvest.

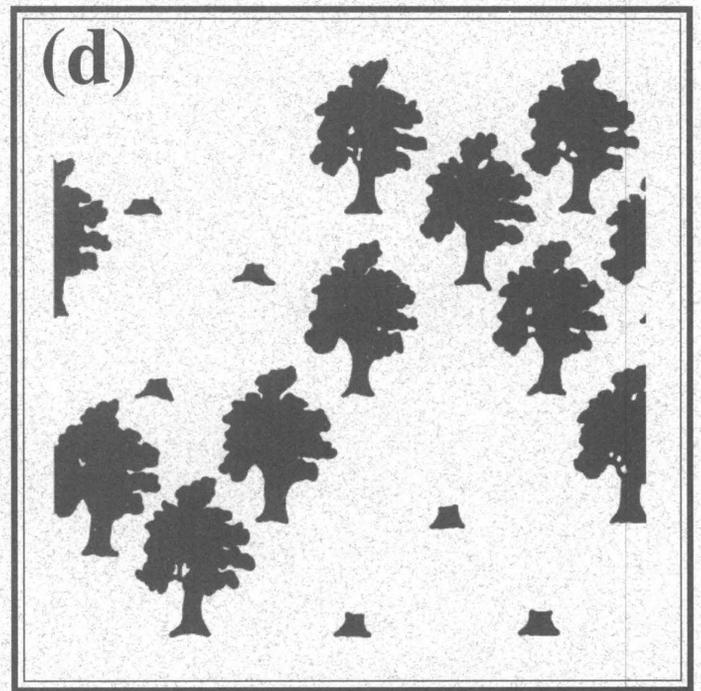
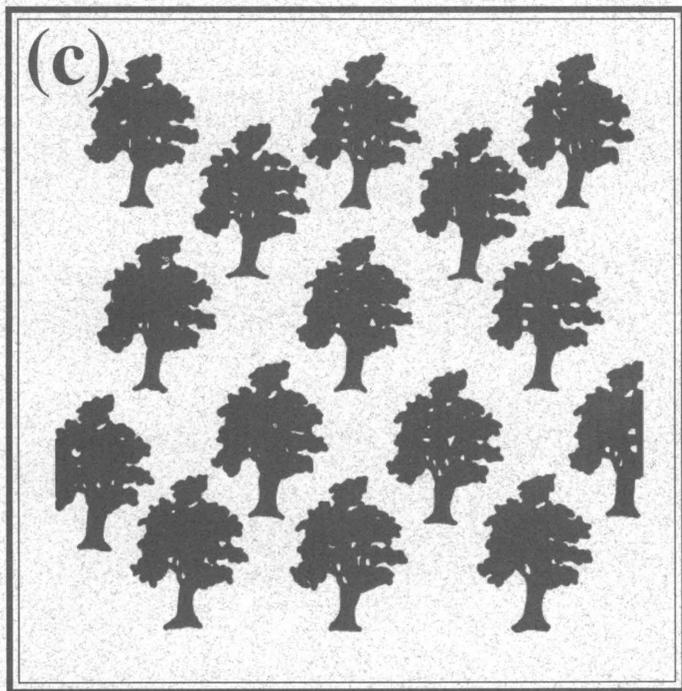


Figure 6. Diagram of the group selection method of regeneration (c) prior to harvest, and (d) following harvest.

## *B. Shelterwood, Seed-Tree, and Clearcutting Systems*

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The shelterwood, seed-tree, and clearcutting silvicultural systems are all used to create even-aged stands. The shelterwood system allows some control of species composition through selection of species during the initial cuts, and favors (to some degree) trees of intermediate shade tolerance and faster-growing shade-intolerant species. The seed-tree system also provides some species control through the proper selection of seed trees, but favors the fastest-growing trees with little regard for shade tolerance. The clearcutting system, when relying on natural regeneration, favors the fastest-growing species. Species composition under the clearcutting system can depend on the following:

1. *amount of advance regeneration already present in the stand;*
2. *seed available from harvested trees;*
3. *seeds stored in the forest floor;*
4. *sprouting ability of species in the previous stand.*

Clearcutting with artificial regeneration such as planting or direct seeding is used when the species presently growing on the site will not satisfy the management objectives, so converting to different species is desired. Artificial regeneration can also provide better distribution and stocking levels, and earlier harvests, than natural regeneration. This system allows virtually complete control of species composition, and results in even-aged plantations. It is the primary system used for managing southern pine forests.

## *C. Regeneration*

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A regeneration method removes mature trees and creates an environment that is best suited to the establishment, survival, and growth of the desired species. To understand regeneration methods, it is helpful to visualize these procedures as occurring along a scale based on the number of trees removed. At one extreme is the single-tree selection method, in which individual trees, consisting of only a small percentage of the stand, are removed at any one time. This is followed by the group selection method, in which groups of trees are harvested within a stand. In group selection, the number of trees harvested is similar to that in single-tree selection, but the number of cutting locations within the stand is substantially reduced. The next level of removal occurs with the shelterwood, followed by the seed-tree method. The most intensive harvesting occurs with a clearcut, when the entire forest stand is removed during a single operation.

In uneven-aged stands, reproduction occurs following each cutting. In contrast, reproduction in even-aged stands occurs during a relatively short period compared to the rotation length, or life of the stand. This regeneration period occurs near the end of the preceding stand's rotation and at the beginning of the present stand's rotation. Stand conditions determine the end of the regeneration period and correspond with the time when the crown canopy of the present stand approaches complete closure. At this time, competition for light and other site factors is very high, causing reproduction of new trees to be at a minimum. The reproduction period usually does not exceed 15 to 20 percent of the rotation length. Thus, for a stand managed on a 50-year rotation, the reproduction period would not be longer than 7 to 10 years.

# 1. Selection Methods

Various selection methods are used to manage uneven-aged stands (Figure 7). In theory, a managed uneven-aged stand would have all ages represented. Because it is not realistic to enter a stand every year to harvest the required trees, cutting cycles have been established. A cutting cycle is a fixed length of time ranging from 5 to 20 years. For example, if the rotation length has been established as 80 years, and the cutting cycle defined as 10 years, the stand will be entered eight times during one rotation. The stand should produce an equal volume of harvested wood at the end of each cycle.



Figure 7. Uneven-aged Appalachian hardwood stand in West Virginia regenerated by the single-tree selection method for the past 50 years.

The stand described above would have eight separate age classes. The youngest age class would have the largest number of trees and would occupy the land area where trees were harvested at the end of the last cycle.

The oldest age class would represent the mature trees, have the fewest trees, and would consist of those individuals that are to be harvested at the end of the present cycle. Theoretically, trees will progress in an orderly fashion from one age class to the next until they are harvested at the end of the rotation. The land area occupied by each age class should remain constant; the number of trees per age class, however, will be continuously reduced. Shade tolerance and species mix in the stand affect the orderly progression of trees during the rotation.

In unmanaged stands, the reduction in numbers with age is due to mortality and caused by competition for light, space, water, and nutrients. In managed stands, intermediate cuttings are used to salvage or eliminate this mortality and potential mortality, minimizing the effects of competition on the residual or remaining trees. These cuttings remove undesirable trees and are performed at the same time as the harvesting and regeneration cuttings. Thus, all silvicultural practices in harvesting, regeneration and intermediate cuttings occur at the same time in an uneven-aged stand. In this manner, the forest manager maintains the composition and structure of each age class in accordance with a predetermined structural form. This form is specific for each stand and is based on product objective, species composition, present stand structure, growth rates, and site constraints.

Uneven-aged stands can be difficult and expensive to harvest and regenerate. Many landowners, however, find the idea of the selection method of regeneration appealing, in spite of the difficulty, expense, and risk of damage to residual trees that accompany it.

If done properly, the continuous forest cover provided by uneven-aged management may be more aesthetically pleasing, and the method can provide a fairly regular flow of forest products from a small area of land. If done improperly, the selection method can quickly result in high-grading, where only the best trees are removed with no consideration given to obtaining the necessary regeneration. It can also result in a thinning and cause the structure to move toward an even-aged stand. A knowledgeable forester and skilled harvesting crew are needed to successfully apply the selection regeneration method.

The selection method is not commonly used in Virginia because most hardwood stands presently tend to be even-aged or some variation of the two-aged stand, and therefore would require a considerable amount of time to obtain the uneven-aged structural form. In addition, the generally shade-intolerant or intermediate nature of the dominant species greatly restricts the use of the selection regeneration method. The selection method works best with species such as sugar maple and American beech. Sugar maple is not widespread in Virginia, and beech is not commercially valuable.

removed in a series of partial cuts, and new regeneration occurs under the protection of a partial forest canopy. The last cut removes the remaining overstory and permits the new stand to develop in the open as an even-aged stand. This method provides a continuing cover of first large, then small trees. It is best suited to species or sites where shelter is needed for new reproduction, or where the partial canopy gives the desired regeneration an advantage over undesired competing vegetation.

The shelterwood method is generally achieved through a sequence of three cuttings. These cuttings, in order of application, are the preparatory, seed, and removal cuts.

## 2. Shelterwood Method

**T**he shelterwood regeneration method has many variations depending on stand and site characteristics. The basic purpose of a shelterwood is, as the name implies, to obtain reproduction under the partial shade and protection of the final crop trees (Figure 8). With this method, the mature stand is



*Figure 8. Loblolly pine stand in eastern Virginia regenerating under the shelterwood method. Young trees grow in the shelter of the remaining overstory trees.*

The preparatory cut is a light harvest that may be required to correct some stand characteristic or condition that could hinder reproduction. For example, the preparatory cut could change the forest floor to improve

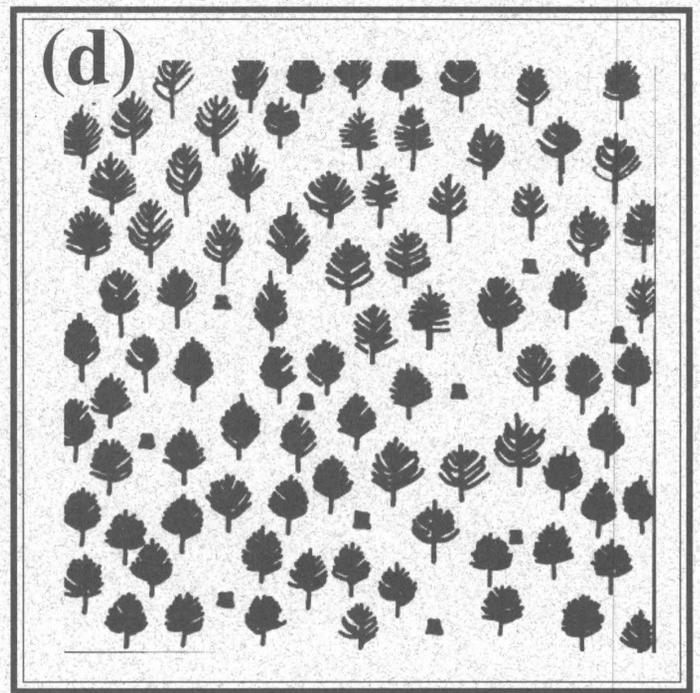
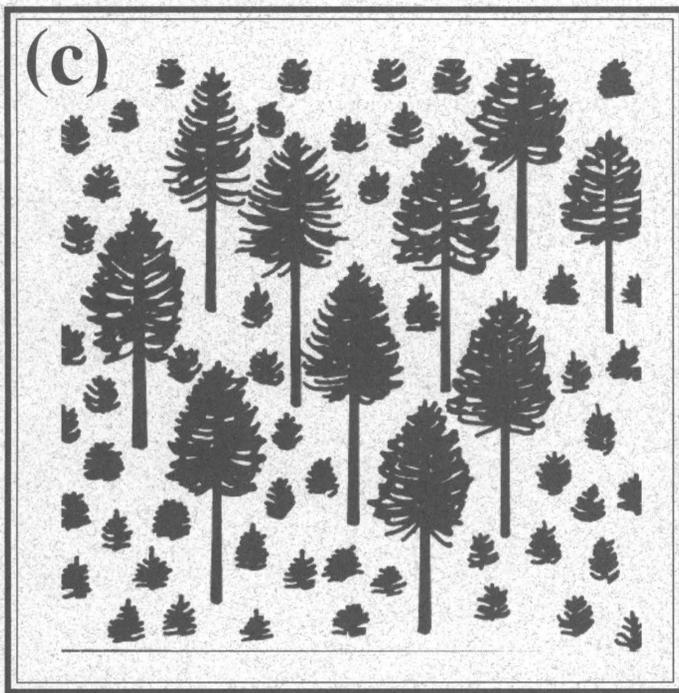
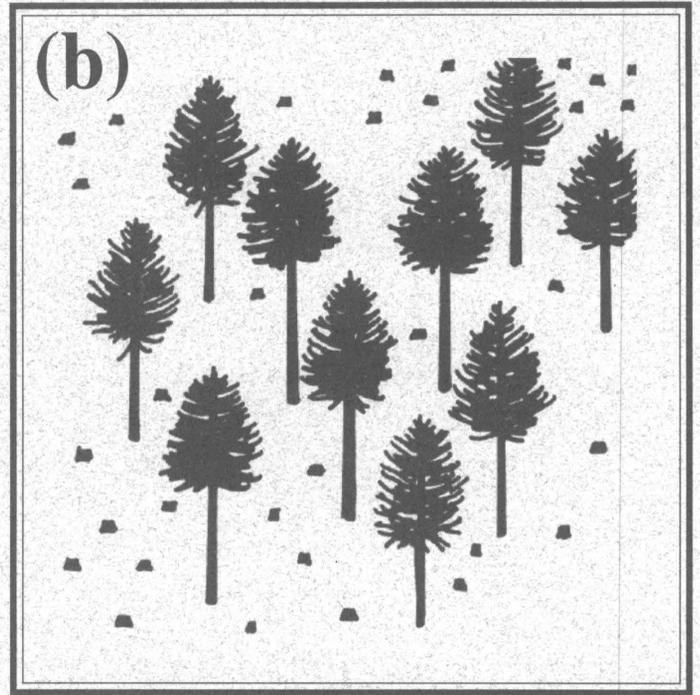
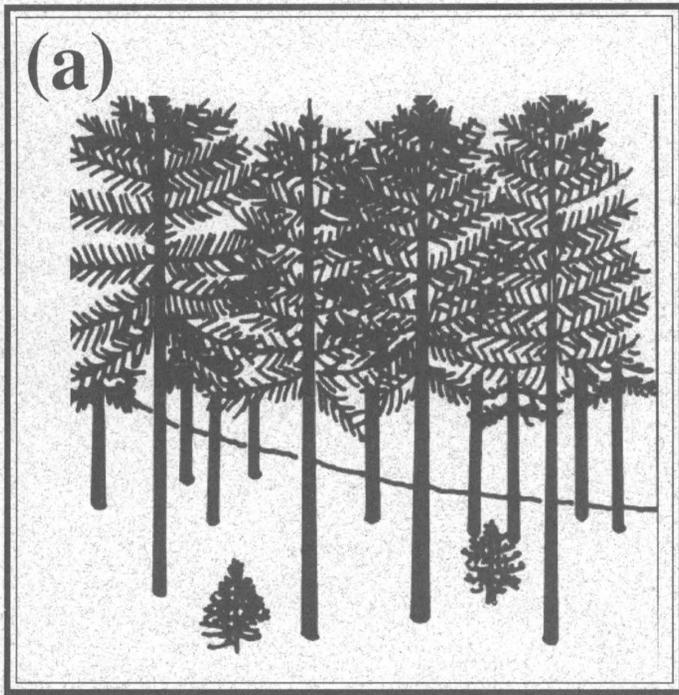


Figure 9. Diagram of a forest stand regenerating under a two-cut shelterwood. (a) Prior to harvest, (b) immediately following a combined preparatory and seed cut, (c) regeneration becomes established after the first cut, and (d) established regeneration following the second cut, or removal cut.

seed germination or survival and improve mature tree crown shape or size to enhance seed production. This practice would also provide a means of removing poor-quality trees or undesirable species and improve windfirmness. In managed stands, a recent improvement cutting or thinning could render the preparatory cut unnecessary or make it possible to combine the preparatory and seed cuts into one operation. Figure 9 shows a shelterwood method in which the preparatory and seed cuts are combined.

Guidelines for determining the time span between the preparatory cut and seed cut depend on the time required for residual trees to respond to treatment. In southeastern forests, this would normally require from 5 to 15 years. The condition of the stand will also dictate the intensity of the cut. Under normal conditions, the preparatory cut would remove anywhere from 15 to 35 percent of the main canopy. If the initial stand conditions are particularly unfavorable for successful regeneration, more than one preparatory cut could be required.

The purpose of the seed cut is to open the canopy sufficiently to allow for the establishment and survival of new regeneration. If possible, the seed cut should be made in a good seed year. The shelter trees should remain long enough for the seedlings to become well-established, but not so long that the seedlings will be heavily damaged during the removal cut. Generally, seedling establishment will require from 3 to 10 years, depending on the species and site conditions.

A removal cut will harvest the remainder of the mature stand after the new regeneration is established. The new stand must be able to successfully compete with

vegetation that may occur as a result of increased light and changes in other site factors caused by harvest cutting.

One advantage of the shelterwood method is that the best trees in the stand will increase in value as they grow at an increased rate. The difficulty of harvesting with the shelterwood method depends on the number of trees left in the overstory for natural regeneration. Usually, one-third to one-half of the total stand volume is harvested at any one time. This increases harvesting costs and there is a risk of damaging trees left in the stand.

The shelterwood method would normally be applied over a period of 10 to 20 years, or a period of time equal to not more than 20 percent of the rotation length. A variation of the shelterwood method, called shelterwood-with-reserves, has been used recently in hardwood stands in the central Appalachian Mountains (Figure 10). With this method, from 10 to 20 shelter trees per acre are left indefinitely after the last cut. These trees provide only light shade so that



*Figure 10. An 80-year-old Appalachian hardwood stand in West Virginia regenerating under the shelterwood-with-reserves method. The young seedlings and sprouts grow under the shelter of the few remaining overstory trees, which may remain for as long as 80 more years.*

the new stand can still regenerate adequately. The shelter trees provide for scenic beauty in the harvest area. This method results in a two-age stand.

### 3. Seed-Tree Method

The seed-tree regeneration method is similar to some variations of the shelterwood method, in that some trees are left after harvest to provide seed for establishing the new stand (Figure 11). Unlike the shelterwood method, however, the residual trees are not intended to provide shelter during seedling establishment, so fewer trees are left. After seedlings are established, the seed trees are usually removed. They may be left, however, if it is not economically feasible to harvest, or if

are critical factors. The number of seed trees to be left depends on tree height, seed dispersal characteristics, prevailing wind direction, quantity and frequency of seed production, and seedbed characteristics. The number normally varies from 3 to 15 trees per acre. Figure 12 depicts a seed-tree cutting.

The seed-tree method is best suited to windfirm species with wind-dispersed seed that produce fairly abundant and regular seed crops and that are best managed in even-aged stands. This method has been used extensively for regenerating southern pines such as loblolly, and has also been used with yellow-poplar.

The method resembles a clearcut in that it does not afford the new reproduction significant overhead protection. The seed-tree method has several disadvantages, though, when compared to the clearcutting method. These include uneven reproduction density as a result of seed dispersal patterns; risks of low viable seed production; less control of species composition, especially if the mature stand contained a large component of less desirable species; less accessibility for site preparation; risk of windthrow and snow and ice damage to the seed trees; and the risk of damaging the regeneration when the seed trees are harvested. In addition, many landowners do not like leaving significant volumes of lumber in seed trees. As a result of these disadvantages, the seed-tree method has largely been replaced by clearcutting as the intensity of management has increased.



*Figure 11. A northern pine stand immediately after a seed tree cut. The remaining trees will provide seed to restock the cut area, then they will be harvested after the young seedlings become established.*

harvesting would cause severe damage to the new regeneration. For adequate regeneration, the quality and spacing of seed trees

In southern pine management, clearcutting followed by site preparation and artificial regeneration with genetically improved seedlings is usually recommended because of the more uniform stand

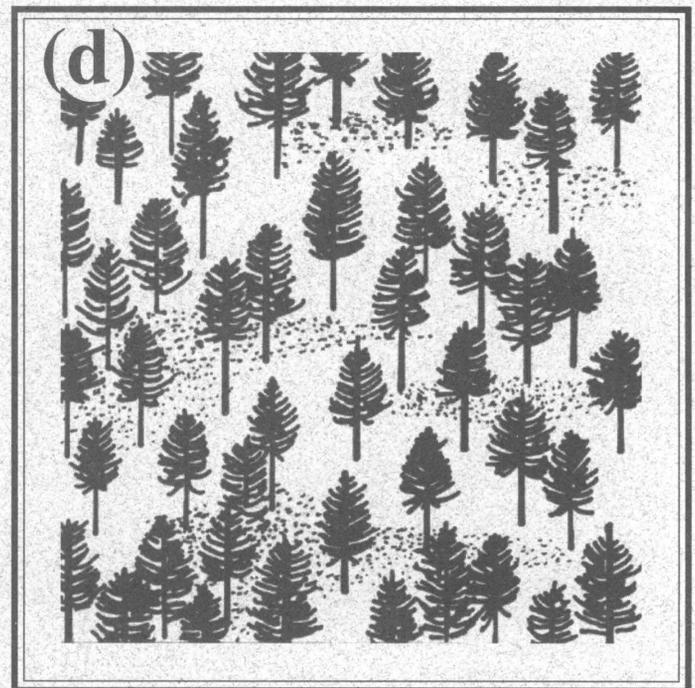
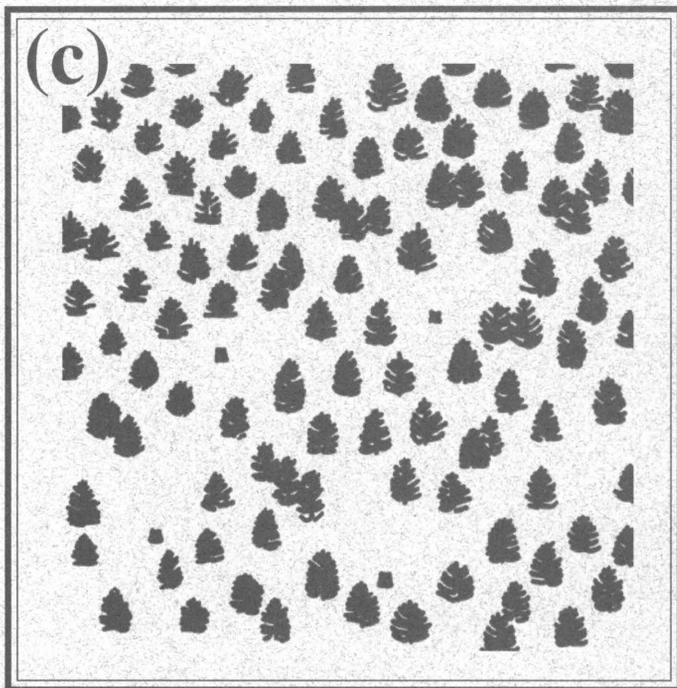
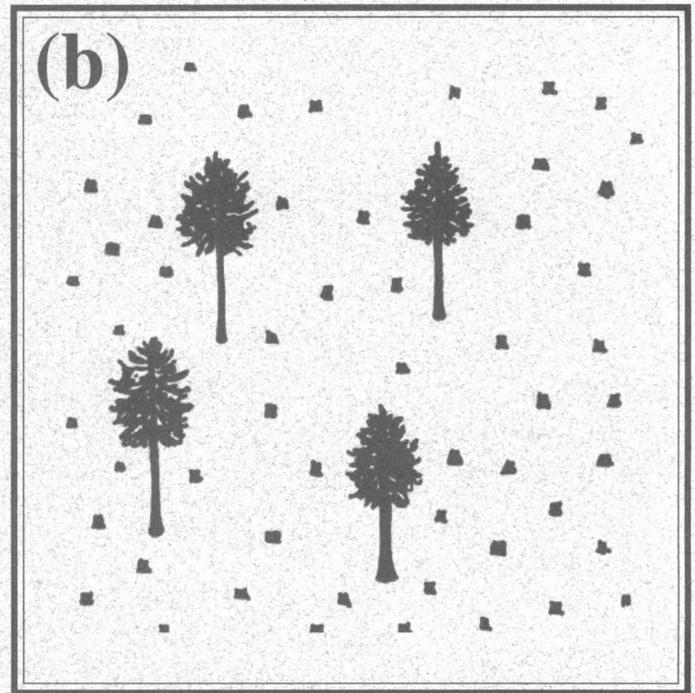
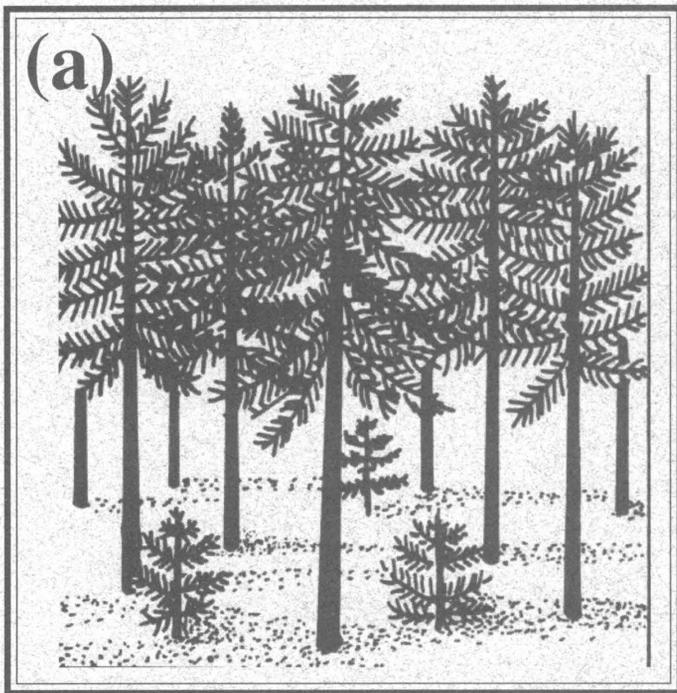


Figure 12. Diagram of a forest stand regenerating under the seed tree method. (a) Prior to harvest, (b) immediately following the seed tree cut, (c) young regeneration following the removal of the seed trees, and (d) established seedlings and saplings growing under open conditions.

conditions and significant yield increases obtained. Several states have seed-tree laws, however, including Virginia. Title 10, Article 6, of the Virginia Code as amended in 1996 requires that landowners harvest by the seed-tree method to insure regeneration, unless an alternate reforestation plan is approved by a state forester. The law applies to stands of 10 acres or more where loblolly pine or white pine make up 25 percent or more of the live trees 6 inches or more in diameter at the stump height, and requires that:

Eight 14-inch-diameter loblolly, pond, or white pine must be left per acre;

If a seed-tree 14 inches in diameter or greater is not present, two of the next largest trees in diameter of the same species must be left in its place; and

Seed trees must be left uncut for three years following the timber harvest.

When leaving seed trees, it is often advisable to leave more than the required minimum to assure better seed distribution and to provide enough timber volume to justify harvesting the seed trees at a later date. Because some trees produce more and better seed than others, seed trees should be carefully selected using the following criteria:

*straight trunk*

*windfirm*

*well-shaped, healthy crown*

*no evidence of past seed production*

*as tall or taller than the surrounding trees*

*fast-growing*

*no evidence of disease*

The seed-tree method has been used in upland mixed hardwood stands. These stands generally have an abundance of highly competitive seedlings from advanced regeneration and sprout origin. Stands of this type resulting from seed-tree cuts are similar to stands that were clearcut and naturally regenerated.

## 4. Clearcutting Method

The clearcutting regeneration method removes all trees in a stand regardless of size and species (Figure 13). This method is the most widely used in southeastern forests. It is accomplished by harvesting all trees in the stand in one cut with the objective of creating a new, even-aged stand. Regeneration can be obtained either naturally or artificially (Figure 14).



Figure 13. Loblolly pine seedlings growing in a strip clearcut in the lower Piedmont of Virginia. Seeds were provided by the mature, uncut pines in the background.

Stands are best harvested by clearcutting when the trees in the stands are mature, are not needed as a source of seed, and are not needed for protection of a new

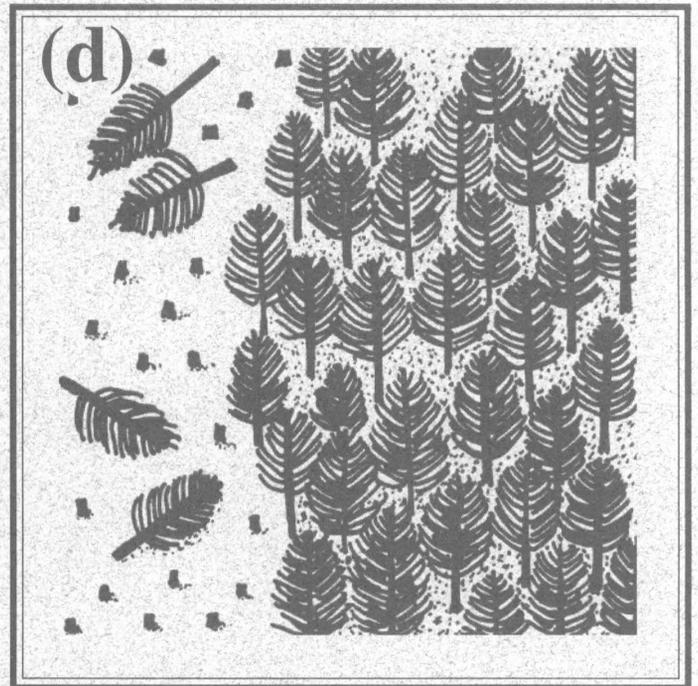
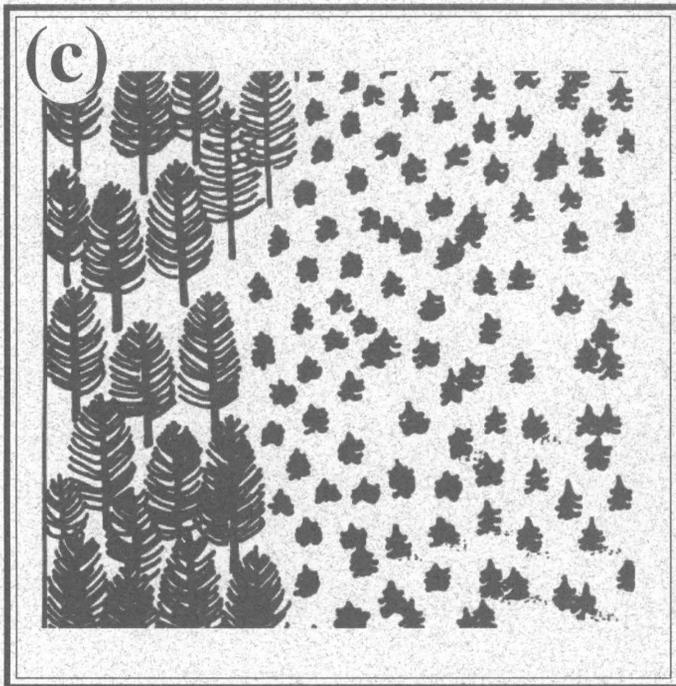
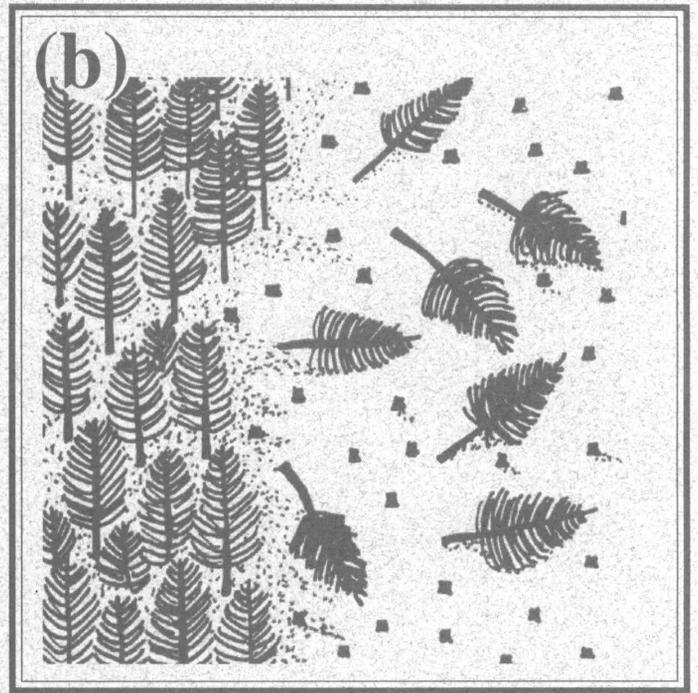
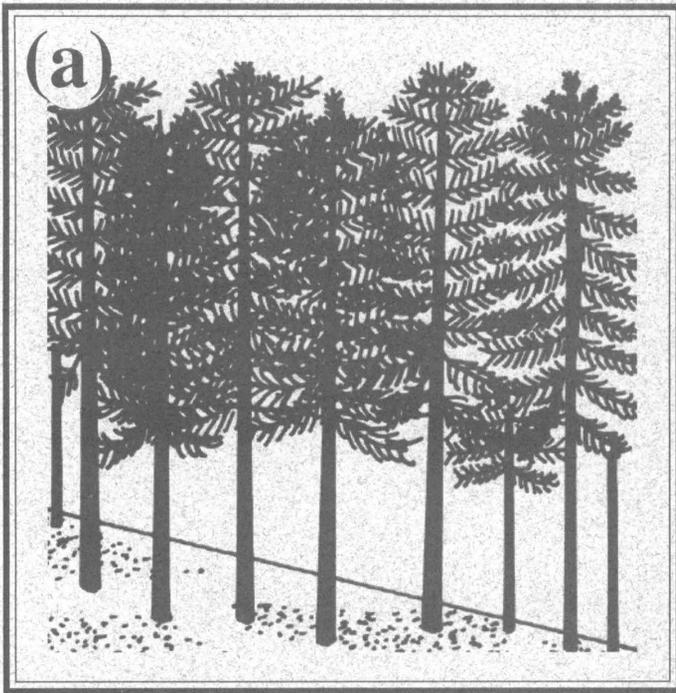


Figure 14. Diagram of a forest stand regenerating under the clearcutting method. (a) Mature, even-aged stand prior to harvest; (b) immediately following cutting; (c) young seedlings growing in the harvested area; (d) adjacent, mature timber being removed once the new stand is well established.

crop. Clearcutting is used to harvest and regenerate fast-growing, light-demanding species such as loblolly pine, white pine, yellow-poplar, and the mixed hardwoods characteristic of Virginia's Piedmont and Mountain regions. Fast-growing, shade-tolerant trees such as red maple and white ash will also be highly competitive under the open conditions afforded by clearcutting. In addition, poor, slow-growing stands resulting from a poor seed source, past damage, or improper harvesting practices are often clearcut to regenerate a new, more vigorous stand.

Upland hardwoods typical of Appalachian forests regenerated by the clearcutting method usually reproduce naturally. This reproduction can come from advance regeneration, seeds from harvested trees, seed stored in the forest floor, and sprouting. In contrast, southern pine forests that have been clearcut are typically regenerated artificially by planting nursery-produced, genetically improved seedlings, or, in some cases, by direct seeding.

The size of a clearcut can vary from a minimum of 1/2 to 3/4 of an acre to more than 50 acres, depending on site conditions and management objectives. When considering aesthetic value, watershed constraints, and wildlife habitat, a maximum clearcut size of 40-50 acres is recommended. In many cases, small, cull, and other unmerchantable and undesirable species are often left standing after a clearcut. This is undesirable for naturally regenerating stands because of the shading and competition from these remaining trees. The additional cost of removing these trees and their lack of market value are the reasons given for not harvesting these trees. Cutting of most small, residual trees from one to five inches in diameter is generally recommended to reduce heavy shade on the forest floor.

Many landowners are hesitant to harvest by clearcutting, even when it is the best method for obtaining their management objectives. They feel that the only real justification for clearcutting is economic, and that this harvesting method will damage their land and the future stand. For the logging contractor, for example, clearcutting is the most economically advantageous harvesting method. When clearcutting is properly done, however, using correct road-building, harvesting, and log-skidding procedures, it is also a biologically sound method that does not harm the site. In addition, overall wildlife habitat and diversity can actually be improved through clearcutting, and adequate regeneration of many shade-intolerant species can only be obtained by clearcutting. The visual impact of harvesting, if present, is short-lived. Even what may be an unpleasant sight to many people immediately after harvest quickly changes within three to five years as new lush vegetation rapidly becomes established (Figure 15). Harvesting by clearcutting can thus be a viable regeneration alternative if practiced correctly, depending on the site, species, and landowner objectives.

## **D. Site Preparation and Intermediate Cuttings**

Site preparation and intermediate cuttings are also important parts of a silviculture system. They will only be defined here, however, rather than discussed in depth. Site preparation is any operation done before regeneration starts that is intended to change site conditions to favor regeneration. The objectives are to dispose of debris, reduce competition from unharvested vegetation, prevent or delay new competing vegetation, and prepare the soil so that new tree growth will be improved.



**(a)**



**(b)**



**(c)**



**(d)**



*Figure 15. Development of a young Appalachian hardwood stand in southwestern Virginia: (a) Prior to harvest; (b) immediately following a clearcut harvest; (c) sapling stand after 8 years; (d) pole stand after 18 years.*

Although site preparation is not discussed in depth here, it is an important part of a regeneration method. It is of particular importance with the clearcutting method and becomes a major consideration for intensive management of southern pines when planting or seeding is used. Common methods of site preparation are drum chopping, root raking, KG-blading, discing or harrowing, bedding, prescribed burning, and use of herbicides.

Intermediate silvicultural techniques include all of the cultural practices that are used in a stand before any regeneration cuts are made. These techniques include release cuttings, thinnings, and improvement cuttings.

Improvement cuttings remove low-quality or undesirable trees from stands past the sapling stage. A thinning is an intermediate cutting operation in which the main objective is to control the growth of the stand by changing tree spacing and stand density by cutting selected trees. The

removal of these trees will concentrate the growth potential of the site onto the remaining trees, thus producing larger, higher-quality trees in less time. In addition, thinnings can provide early revenues to the landowner.

### **III. CONCLUSION**

For more information on timber harvesting or general information on managing your woodlot, contact the Virginia Department of Forestry, consulting or industrial foresters, or the Virginia Cooperative Extension office in your area.

\* This is a revision of Virginia Cooperative Extension Publication 420-405, Principles of Regeneration Silviculture in Virginia (1985), by T. J. Nichols, D. Wm. Smith, and M. C. Vodak.



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