

The Changes in Southern Appalachian Assessment Forest Vegetation from Natural Processes and Human-Caused Disturbances

Question 5:

What changes and/or trends in forest vegetation or soil productivity are occurring in different ecological subsections in the Southern Appalachians in response to human-caused disturbances or natural processes?

Question 6:

What are the potential effects of the presence or absence of fire on forest health?

Ecosystems and their constituents respond to changes in climate, geomorphology, and soil environments. Changes, or disturbances to prevailing conditions, occur continually. There are three major dimensions of disturbance: the size, the time involved, and the magnitude or intensity. The size of a disturbed area may range from the gas formed from the loss of a single tree to tens of thousands of acres. Some changes, such as long-term climate and weathering of rocks into soil, occur slowly over tens to thousands of years. Others, such as the effects of fire, may take less than a day. Intensity of disturbance also varies.

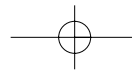
Disturbances can be broadly grouped into those resulting from human influence and those not caused by humans. Human-caused changes, such as introduction of exotic pests, extirpation of species, and utilization of natural resources, raise particular concern because their long term consequences often are unknown.

Natural disturbances may be similar to past disturbances, whereas human disturbances are

much greater in magnitude today than at any previous time. Humans have been part of ecosystems in North America, and the Southern Appalachian Assessment (SAA) area, for over 10,000 years. They have shaped the ecosystems in which they live. Prior to European settlement and industrialization, native Americans affected ecosystems through agriculture, hunting, village construction, fire, and dispersal of plants and animals to new areas during their travels. Modern society has dramatically increased disturbances because of industrialization, new technologies, and human population increases.

Recent human-caused disturbances include the exclusion of fire and the impacts of exotic forest pests such as chestnut blight, gypsy moth, Dutch elm disease, balsam and hemlock woolly adelgids, many exotic plants, and feral hogs. The role of fire and vegetation responses to its impact in the pre-European settlement forests across the Southern Appalachian landscape may have been much more pronounced than today. Because of modern human-caused disturbances, the current landscape is probably unlike anything that occurred in the past. Future vegetation is likely to be greatly affected by the direct and indirect impacts of exotic pests. Some factors are: (1) the amount and distribution of older-age forest stands, (2) fire suppression, (3) air pollutants, and (4) introduced pests. Silvicultural activities designed to manage vegetation and regenerate commercially valuable tree species are also major human disturbances. A range of silvicultural techniques will be discussed at the end of this chapter.

Changes resulting from some natural causes, such as earthquakes, storms, and droughts, cannot be controlled and are generally accepted. Changes that result from management or utilization of natural resources can be



evaluated and altered as part of management policy. Examination of the impacts of alterable changes, therefore, is an essential part of management planning.

In this chapter, the Terrestrial Team addressed two questions related to disturbance. The first question is, "What changes and/or trends in forest vegetation or soil productivity are occurring in different ecological subsections in the Southern Appalachians in response to human-caused disturbances or natural processes?" Lightning-caused fires can be, and have been, suppressed. Because many forest ecosystems evolved in response to natural fire patterns, fire exclusion can cause subtle, but potentially important, changes in future forest composition, structure, and productivity. The second question, therefore, was, "What are the potential effects of the presence or absence of fire on forest health?" Before addressing these questions, we briefly summarize current knowledge about disturbance in Southern Appalachian ecosystems.

Natural Disturbance

Disturbance dynamics

Plant communities of the Appalachians are characterized by compositional fluctuations, as individual plants grow, die, and are replaced (McGee 1984). Some vegetation changes are driven by characteristics of the individual plant species independent of their environment. Other changes are caused by factors outside the vegetation and independent of its nature. A commonly used term to describe changes in species composition that dominate a given area through time is "succession" (Barbour, Burk, and Pitts 1987).

Gap phase reproduction (patch disturbance) results from single trees or small groups of trees dying. The small openings that result from these perturbations are quickly revegetated by new plants that become established or by existing understory vegetation that is released from overhead competition.

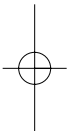
Average rates of canopy gap formation have been estimated in several cases. Studies in the Southern Appalachians have found canopy gaps forming at an average of 0.4 to 2.0 percent of the land area annually (Runkle 1985) with canopy resistance ranging from 50 to 200

years. Lorimer (1980), working in a primary "virgin" cove and hemlock forest at Joyce Kilmer Memorial Forest, estimated that the average canopy mortality in a decade was 5.5 percent, with 3.8 percent in low-disturbance decades and up to 14.0 percent in those decades with major disturbance events. Disturbances of higher than average intensity occurred at about 30- to 40-year intervals. Runkle and Yetter (1987) found that gaps formed at a rate of 1 percent of the land surface per year in their study areas. Runkle (1982) estimated for old-growth mesic forests in general, that recognizable gaps occupied 17.3 percent of the canopy in Joyce Kilmer Memorial Forest and 8.9 to 24.2 percent of the Great Smoky Mountains (Schafale and Weakley 1990). Timber harvests that resemble gap-phase dynamics (e.g. single-tree-selection and group-selection cuttings) might be carried out in appropriate forest types at a rate of 1 percent per year and be within the normal variability of natural processes. This approach has been suggested as a means of hastening the development of old-growth characteristics (Runkle 1991) and is worthy of investigation (Lorimer and Frelich 1994).

Large-Scale Disturbances

A number of climatic, edaphic, and biotic factors can create catastrophic disturbance. Although the causes are external, community attributes often influence the degree of change and gradient of effect. An example of this can be seen with Virginia pine (*Pinus virginiana*) dominated communities. This species tends to occur naturally in even-aged stands of relatively pure composition. The species is relatively short-lived and often found growing on shallow soils. Since it is shallow-rooted, it is prone to windthrow, particularly when crowns are heavy with snow and ice. Thus, wind, ice, and snow can remove a large section of Virginia pine forest, while barely affecting other pine or hardwood types of similar size and age.

Table Mountain pine (*Pinus pungens*) is a fire-dependent species native to the Southern Appalachians. It has serotinous cones that open when exposed to high temperatures resulting from medium- to high-intensity fires. It can begin producing cones with viable seeds at a young age. It typically grows on fire-prone southeast to southwest facing slopes and



ridgetops that are often droughty. Table Mountain pine is well adapted to this pyric environment which excludes most tree and shrub species adapted to more mesic conditions. A recent study using tree-ring analysis of fire-scarred trees of Table Mountain pine forests on Brush Mountain in southwestern Virginia indicated that from 1798 to 1944, fires burned approximately every 10 years. After 1935, following acquisition by USDA Forest Service (FS), the study area burned only once. The study concluded that continued fire exclusion would lead to oak-dominated plant communities (Sutherland and others 1993).

Native American Caused Fires

Fire disturbance is the most well researched of all natural disturbances operating in North America (White 1979). Fire is particularly important in conifer-dominated forests and can also be important in drier types of deciduous forests. The frequency and intensity of fire depend on precipitation amounts, fuel accumulation, and seasonal characteristics of the vegetation. Fire may be the common denominator for the development of oak forests on upland sites and their past and present ecological status (Abrams 1992, Barrett 1995).

The pattern of fire during the past 10,000 years by native Americans and early European settlers has affected the current composition of most forests in the SAA area. Periodic burning likely plays a major role in promoting advanced oak regeneration. Early historical accounts describing the impacts of native Americans on the forests and grasslands in the Southern Appalachians are largely anecdotal and sometimes controversial. Unfortunately, there is a lack of empirical evidence documenting the role of fire and the abundance of oak in the Southern Appalachians.

Perhaps the best, and most objective, evidence about the composition of forests before European settlement is the pollen record from pond and bog sediments that have accumulated for thousands of years. Research in eastern Tennessee indicates that during the Early Archaic period, 8000 to 6000 years before present (BP), major wood-charcoal hearth fire constituents were oak. By the Late Archaic period, 4000 to 1500 years BP, disturbance-favored (early successional) species comprised 25 percent of the wood charcoal preserved as

ethnobotanical remains (Delcourt and Delcourt 1986). *Quercus* (oak), *Castanea* (chestnut), *Carya* (hickory) and *Pinus* (pine), constituted the majority of total tree pollen during the Woodland (1500 to 1000 years BP), Mississippian (1000 to 500 years BP), and Historic (300 years BP) cultural periods for Tennessee sites.

In the late Holocene Epoch, the forests near Black Pond in the Central Ridge and Valley section of east Tennessee were predominantly oak and pine with subdominants of hickory and chestnut (Delcourt and others 1986). At the time of European settlement, landscapes of the southeastern United States were not covered by extensive unbroken old-growth forests. Instead, vegetation patterns at 500 years BP were the result of continued individualistic responses of plant populations to long-term changes in climate, prevailing disturbance regimes, and native American activities that included the use of fire and development of agriculture (Delcourt and others 1993).

Oak species are apparently well adapted to an environment that includes periodic fire. Relative to other hardwoods, fire favors oaks because of their thick bark, sprouting ability, resistance to rot after scarring, and the suitability of fire-created seedbeds for acorn germination (Lorimer 1985, Abrams 1992). Studies have shown that stands which had been thinned, grazed, or lightly burned during the past two decades generally possessed a greater reservoir of oak regeneration than undisturbed stands (Carvell and Tryon 1961). Periodic fire probably checks succession in oak forests, because most later successional species, such as red maple (*Acer rubrum*), exhibit low resistance to fire. Recent studies have indicated the potential for widespread oak replacement by more shade tolerant species in mature forests (McGee 1986, Fryar 1993).

An oak study that included data from Forest Inventory and Analysis (FIA) plots on the Cherokee National Forest in 1989 showed that 38.0 percent of the total live volume of growing stock on the forest was oak and 14.2 percent of all live stems were oak. However, only 7.9 percent of all live stems in the 1 to 7 inch d.b.h. were oak. In comparison, there were over seven times as many soft maple, white pine, and dogwood stems (collectively) as total oak stems in this diameter range. This study concluded that the future of many oak stands

was uncertain (Fryar 1993). The loss of oak dominance may vary with soil and site factors and probably will be slower on dryer sites. Loss of oak dominance in forests where fire has been mostly excluded during the twentieth century, and the lack of such patterns in forests periodically burned, should be considered important indirect evidence that fire played a vital role in maintaining oak dominance before European settlement. If, in the current oak forests, factors antagonistic to oak regeneration (such as a lack of fire) persist into the twenty-first century, a reduction in oak dominance seems inevitable (Abrams 1992).

Lightning-Caused Fires

Data on 1986 to 1993 occurrence of lightning-caused and human-caused fires are available for national forests and national parks (fig. 5.1). On the Cherokee National Forest in Tennessee, during the 16-year interval from 1977 to 1993, 114 fires occurred, with an annual mean of about seven. For the time period spanning 1915 to 1993, 290 fires on the George Washington National Forest in Virginia were attributed to lightning, with a mean of about 4 fires per year. Lightning fires are more frequent on slopes facing southeast to southwest. In the Great Smoky Mountain National Park, lightning fires averaged six per year over an area of approximately one million acres. Data from all sources indicate that approximately 15 percent of fires in the SAA area are attributable to lightning.

A survey was conducted in the SAA area to determine statistics for fire occurrence in general. The following tabulation presents wildfire frequency and size during the period 1988 to 1993 by ownership:

Ownership	Fires (Number)	Area (Acres)
State and private	29,834	212,342
Federal	2,240	241,844
All	32,074	454,186

One percent of these fires was larger than 100 acres when extinguished. Lightning represented a small, but significant, proportion of ignition source for these fires, as shown below:

Ownership	Lightning (%)	Arson (%)	Other (%)
State and Private	3	34	63
Federal	12	48	40

The greater proportion of lightning sources of ignition on federal lands is partly a result of their location in mountainous terrain where almost half of all lightning strikes occurs on ridge tops. For the case study areas, an average of approximately 15 percent (one out of every six fires) was lightning caused.

Annually, an average of six lightning fires per one million acres occurs in the Southern Appalachians. This frequency is greater than that recorded for the Great Plains, Mississippi Basin, or northeastern United States, but less than portions of the western and southeastern United States where up to 20 or more lightning-caused fires per one million acres are recorded (Schroeder and Buck 1970).

Windstorm

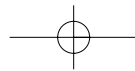
Thunderstorms occur primarily in late spring and summer. Some thunderstorms and sustained high winds associated with hurricane tracks occur in the late summer or early fall.

Occasional high winds are associated with coastal winter storms. These storms can be quite severe due to ice or snow loads on trees and other vegetation. Windthrown trees result in pit and mound microrelief, providing an agent of soil mixing and producing different kinds of rooting sites for seedlings (White 1979).

Winds in association with heavy precipitation or snow melt that lead to soil saturation can increase windthrow and landslides, particularly on shallow soils. Fire or insect outbreaks sometimes occur in years after windstorms damage vegetation. The dominance of species adapted to open growing conditions on wind-exposed knolls and steep slopes in forested regions has been noted (White 1979).

Ice and Snow

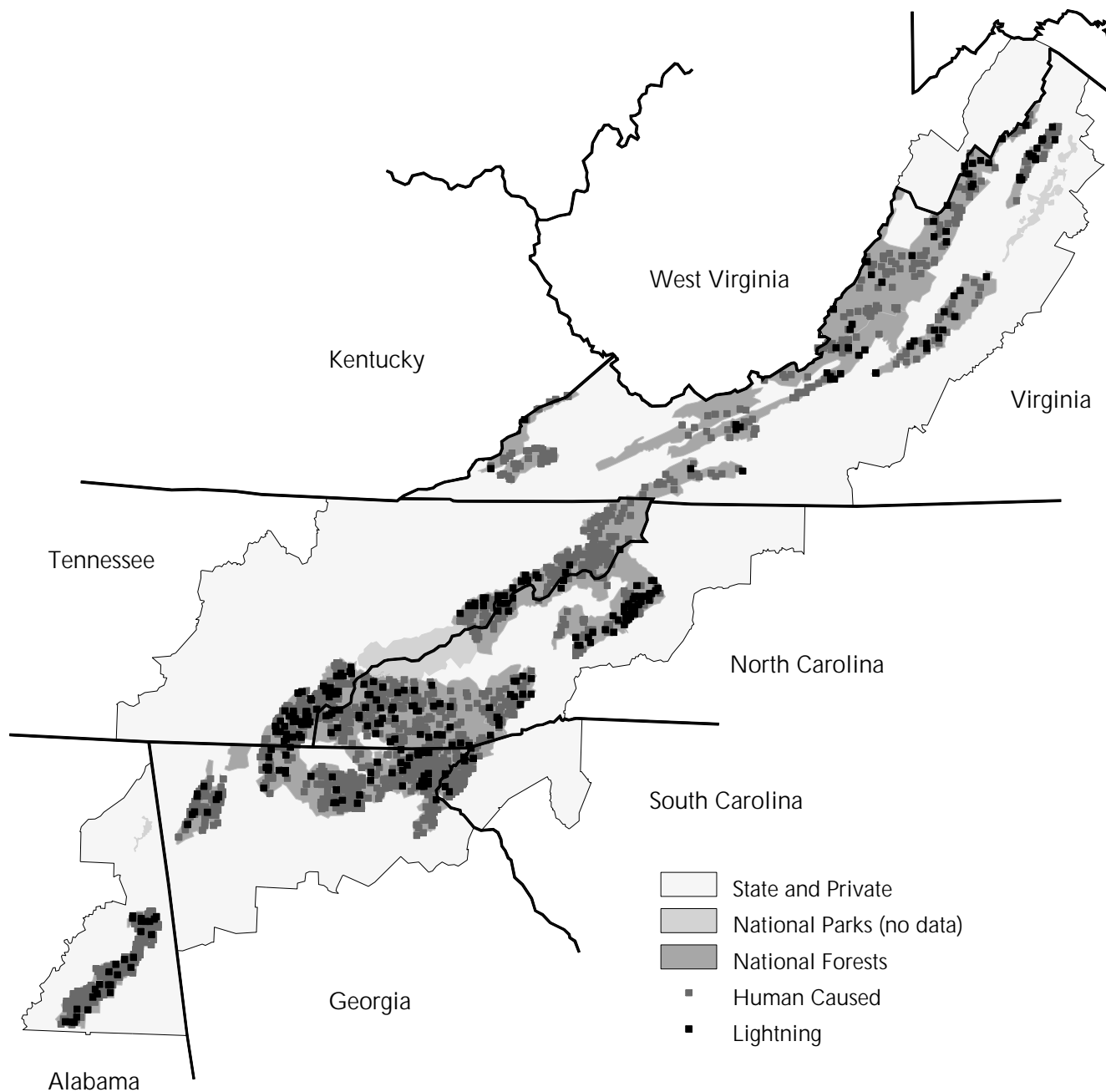
Some trees are more prone to damage by ice storms than others. Studies have shown that some oaks, hickory, white pine, and hemlock are resistant to extensive glaze-induced damage while black oak, yellow-poplar, chestnut oak, black cherry, northern red oak, black



locust, and other pines are not (Whitney and Johnson 1984; Carvell, Tryon, and True 1957; Abell 1934). Ice storms may limit the elevational range for some tree species in the Southern Appalachians. In conjunction with wind, ice and snow loads can cause wind throw. Damage to trees from ice and snow can increase the risk of pest problems and increase fuel loads, resulting in high-intensity fires.

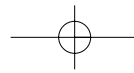
Landslides and Earth Movement

The frequency of landslides and the response of vegetation have been studied in the Southern Appalachians (White 1979). Intense rainstorms, often on previously saturated soil, seem to be the major factor initiating landslides in the Great Smoky Mountains and other portions of the Blue Ridge. Numerous sub-surface geologic faults exist within the SAA area. Minor



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Figure 5.1 Lightning-caused and human-caused wildfires occurring on national forests and national parks during 1986 to 1993 (Data source: National Interagency Fire Management Integrated Data Base)



earthquakes occur periodically but do not affect vegetation.

Precipitation Variability

Variations in precipitation cause flooding, landslides, water-level fluctuations in ponds and bogs, drought, and increased fire frequency and intensity. Drought periodically reduces the importance of mesic species and causes irregular compositional fluctuations in forests. It also reduces growth rates and affects seedling establishment of some species. Severe droughts kill some trees outright and physiologically weaken others. Drought can trigger or intensify decline and mortality in some tree species. High basal areas can exacerbate the impacts of pest epidemics following droughts.

An extraordinarily severe drought occurred in the Southern Appalachians in the summer of 1925. Over a 4-month period, rainfall near Asheville, NC, totaled 5.11 inches or 32 percent of normal. A follow-up study showed that black oak, red oak, and scarlet oak were particularly susceptible (Hursh and Haasis 1931).

Among plant communities in the Southern Appalachians, the ones most affected by variations in precipitation are on wetlands, and dry-to-xeric sites prone to fire, and on sites vulnerable to insect and disease epidemics. Imbalances in age-class distributions can further increase effects. Currently, a majority of stands on public lands in the Southern Appalachians is relatively even-aged and between 70 and 90 years old. Vulnerability to drought and to subsequent insect and disease outbreaks is high.

Frost Damage

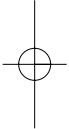
Freezing temperatures just before or during budbreak in the early spring damage plants. Damage is greater when freezing temperatures follow a period of warm weather, which promotes growth and budbreak. Most plants are susceptible to frost damage. Budbreak for oak species normally overlaps late spring freezes and frosts. Shaded oaks tend to break bud earlier than oaks growing in open conditions. Released oaks with extensive recent growth are often damaged by frosts. McGee (1988) suggests that weather and budbreak are often related to regeneration problems with oaks.

Biotic Disturbance

Animals, insects, and diseases alter vegetation continuously or periodically. Natural biotic agents play an important part in ecosystem function. Insect outbreaks, for example, may facilitate nutrient cycling and balance of energy flows. Insect damage can often follow other disturbances such as wind, ice storms, drought, or fire. Some insects, such as bark beetles (*Ips* spp.), attack stressed trees first and provide "natural" thinning regimes in overstocked pine stands.

During droughts, defoliators such as locust leafminers (*Xenochalepus dorsalis*), elm spanworms (*Ennomos subsignarius hbn.*), and fall cankerworms (*Alsophila pometaria*) may become epidemic and defoliate large areas. These processes, however, may help balance nutrient budgets, particularly on sites of low productivity. Disease may function similarly to remove individually stressed trees or stands that have been weakened by other causes.

The effects of mammals and birds on forest vegetation usually are less significant than those of insects, but they can be locally important. Damage from deer browsing on hardwood regeneration is common in some parts of the Southern Appalachians and may limit establishment and growth of oak regeneration. Deer tend to be selective in browsing herbaceous plants and may limit the occurrence and abundance of some lilies and orchids. Beavers (*Castor canadensis*) historically played a very extensive and underestimated role in creating and maintaining an ever-changing mosaic of ponds and wetlands along streams in valleys. They were extirpated from many parts of the SAA area but they are returning and creating conflicts with other land uses. Now-extinct or absent species including elk (*Cervus canadensis*), bison (*Bison bison*), and passenger pigeons (*Ectopistes migratorius*) undoubtedly helped to shape the pre-European vegetational landscape. It has been suggested that large herbivores were partially responsible for the maintenance of high elevation grassy balds (Weigl and Knowles 1995). The small, prairie-like grasslands with endemic grassland plants now found in the Shenandoah Valley of Virginia are remnants of a vegetation type that occurred extensively in the "Great Valleys" of the Appalachians and were undoubtedly maintained in part by large herbivores.



Exotic pests, often introduced by human commerce, have the potential to affect forested ecosystems dramatically. The absence of natural predators and lack of genetic resistance among hosts can result in significant resource losses. Some exotic animals, insects, and disease problems have greatly affected vegetation in the Southern Appalachians. Feral hogs have severely damaged vegetation in the Great Smoky Mountains National Park and threaten to do so elsewhere. Chestnut blight, Dutch elm disease, dogwood anthracnose, butternut canker, balsam (*Adelges picea* Ratz.) and hemlock woolly adelgids (*Adelges tsugae*), and gypsy moth (*Lymantria dispar* L.) are exotics that have already had dramatic effects in Southern Appalachian forests.

Oak decline has affected thousands of forested acres where some oak species (especially scarlet oak and black oak) dominate. This complex phenomenon is caused by a combination of tree age, site factors that induce stress, and normally nonaggressive insects and fungi. As oaks mature, stresses alter tree physiology and render them susceptible to root disease and insects. Susceptible trees dieback and eventually die. Oak decline is a natural process, but its impacts are compounded by past land use, loss of species such as American chestnut (*Cantanea dentata*), replacement with species less adapted to the site, and other forces and conditions.

Silviculture and Prescribed Fire

Types of Silvicultural Activities

Disturbance drives the dynamics of forest communities. Damage or death of plants makes resources available in the ecosystem. Because disturbance is so variable, responses are also variable. Silviculture is based on an understanding of responses to disturbance. Its application might be viewed as a way of increasing predictability in the system by controlling the timing and types of disturbance. Silvicultural systems are planned processes in which a stand is tended, harvested, and re-established, very much as a gardener might plant, tend, and harvest a corn crop. The system name is based on the number of age classes and/or the regeneration method used.

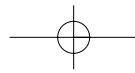
Even-Aged Silvicultural Systems

An even-aged silvicultural system is a planned sequence of treatments designed to maintain and regenerate a stand with one age class. The range of tree ages is usually less than 20 percent of the rotation length. The four basic methods of even-aged silviculture are:

1. Clearcutting: A method of regenerating an even-aged stand in which a new age class develops in a fully exposed micro-environment after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, and/or advance reproduction.
2. Coppice: A method of regenerating an even-aged stand in which all trees in the previous stand are cut and the majority of regeneration is from stump sprouts or root suckers.
3. Seed Tree: A method of regenerating an even-aged stand in which a new age-class develops from seeds that germinate in fully exposed micro-environments after removal of all the previous stand except for a small number of trees left to provide seed. Seed trees are removed after the regeneration is established.
4. Shelterwood: A method of regenerating an even-aged stand in which a new age class develops in the moderated micro-environment provided by residual trees. The sequence of treatments can include three distinct types of cuttings: (1) an optional preparatory cut to enhance conditions for seed production, (2) an establishment cut to prepare the seedbed and create a new age class, and (3) removal cut(s) to release established regeneration from competition with the residual trees (overwood).

When even-aged stands are created using the clearcutting method, successional stages 1 (grass/forb), 2 (shrub/seedling), 3 (sapling/pole), 4 (mid successional), 5 (late successional), and 6 (old forests) develop sequentially as the stand ages.

Conditions created by the seed tree method of regeneration are identical to clearcutting, except that a small number of seed trees scattered throughout the stand is retained in the stand during successional stages 1 and 2 and, sometimes, into successional stage 3.



In a typical shelterwood system, overwood is retained into successional stage 2 or 3. Depending on the amount of overwood retained (which can vary widely in shelterwoods), stages 2 and 3 may be somewhat prolonged due to height growth suppression resulting from reduced light penetration to developing regeneration. After overwood removal, successional stages 3, 4, and 5 occur sequentially.

One or more of the even-aged silvicultural systems can be applied in all of the forest habitat groups. Clearcutting with planting has been widely used to establish stands of loblolly, shortleaf and white pines. Planting of hardwoods has not been successful. Using the clearcutting method to regenerate hardwoods requires that appropriate regeneration sources be present at the time of harvest. The coppice method is only appropriate for sprouting species. The seed tree method has been widely used in loblolly and shortleaf pines. It is not used in hardwood regeneration because hardwood regeneration strategies do not depend on seed dispersal after cutting. Because they can create the wide range of conditions for regeneration, shelterwood methods are applicable in all forest habitat groups. Some shelterwoods are designed specifically to influence species composition of the new stand, e.g. to maintain an oak component in the new stand and, therefore, may have a significant impact on wildlife habitat.

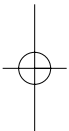
Two-Aged Silvicultural Systems

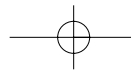
Two-aged silvicultural systems involve a planned sequence of treatments designed to maintain and regenerate a stand with two age classes. The resulting stand may be two-aged or tend toward an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes. There are a number of variants. One or more of the two-aged silvicultural systems can be applied in all of the forest habitat groups.

1. Clearcutting with Reserves: A clearcutting method in which varying numbers of reserve trees are left standing to attain goals other than regeneration. The regeneration phase of this system creates successional stages 1, 2, and 3, but, in contrast to the clearcutting system, some overstory trees are retained to

meet specified objectives. The overstory trees retained, called reserve trees, may be small or large trees, or combinations of small and large trees, retained for: future growth; certain species components; current or future den trees; future sources of snags or coarse woody debris; or some level of visual quality. Due to the retention of a few overstory trees, a somewhat two-storied vertical structure develops during stages 2 and 3. Late in stage 3 or early in stage 4, the younger age class will begin to merge vertically with the older age class, although some vertical structure will remain in stage 4 and, perhaps, increase in stage 5 due to differential species development in mixed species stands. Depending on the kinds of trees initially retained, stages 4 and 5 may contain trees much larger than would normally be found in mid- or late-successional stands. Therefore, at least some of the attributes of much older stands can be provided in stands managed with this system.

2. Coppice with Reserves: A method of regenerating a stand in which the majority of regeneration is from stump sprouts or root suckers, and in which reserve trees are retained to attain goals other than regeneration. The conditions created with coppice with reserves are the same as with clearcutting with reserves or shelterwood with reserves, depending on the number of reserve trees retained.
3. Seed Tree with Reserves: A seed-tree method in which some or all of the seed trees are retained after regeneration is established to attain goals other than regeneration. The conditions created in a seed tree with reserves is identical to that created by clearcutting with reserves. The only difference between the two systems is that in the regeneration period, the trees retained have the specific function of producing seed to regenerate the stand.
4. Shelterwood with Reserves: A variant of the shelterwood method in which some or all of the shelter trees are retained well beyond the period of normal retention to attain goals other than regeneration. Initial conditions created are identical to those for the even-aged variant of this method, i.e., a micro-environment moderated by retention of residual trees. However, retaining overstory





trees beyond 20 percent of the rotation creates a distinct two-storied condition that persists for 20 to 40 years. Stand density or stocking must be reduced enough to allow for the long-term development of the new age-class. Stands develop through all successional stages with some residual trees in place. As in the other two-aged systems, some of the attributes of much older stands can be provided at a younger age in stands managed with this system. The choice of residual trees is dictated by management objectives. Choosing residual trees for cavity trees, mast producers, growth, or future snags or coarse woody debris provides the values associated with those trees. After 40 to 60 years, several silvicultural options are available, depending on management objectives: (1) the older trees can be retained into the future along with the younger age class, (2) the older age class can be removed, leaving the younger age class as an even-aged stand, or (3) the regeneration process can be initiated again by reducing stand density or stocking to an appropriate level.

Uneven-Aged Silvicultural Systems

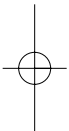
Uneven-aged silvicultural systems are planned sequences of treatments designed to maintain and regenerate uneven-aged stands, meaning stands with three or more age-classes. There are several variants:

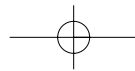
1. **Single Tree Selection:** A method of creating new age classes in uneven-aged stands in which individual trees of all size classes are removed more or less uniformly throughout the stand to achieve desired stand structural characteristics. In application, cuttings are made to control the frequency distribution of tree diameters using the negative exponential (reverse J-shaped) distribution as a target. For a given application, this target distribution is completely defined by stand basal area, maximum tree diameter, and 'q,' the exponential decay parameter. The resulting stand is one that has a continuous canopy cover containing a broad range of tree sizes. Single tree selection is very restricted in its application, due primarily to the ecological characteristics of Southern Appalachian species. The continuous forest canopy characteristic of single tree selection requires, for

successful application, species that can regenerate and develop under shaded conditions. Most Southern Appalachian forests are comprised of canopy species that are intolerant or intermediate in their tolerance of shade. The exceptions are forests that contain hemlock, white pine, sugar maple, or beech, all of which are relatively shade tolerant and to which the application of single tree selection should theoretically be possible. Single tree selection has been successful in the beech-birch-maple forests of the northeastern United States, but the distribution of this type in the Southern Appalachians is extremely limited. Trials are currently underway in white pine, but research efforts to use single tree selection in mesic Southern Appalachian hardwoods, and in mesic to somewhat xeric oak stands, have been unsuccessful. Single-tree selection has been successful in loblolly pine stands in the South, but only with the application of herbicides to control hardwood competition.

2. **Group Selection:** A method of regenerating uneven-aged stands in which trees are removed and new age-classes established, in small groups. The maximum width of groups is approximately twice the height of the mature trees, with small openings providing micro-environments suitable for shade-tolerant regeneration, and with the larger openings providing conditions suitable for more shade-intolerant regeneration. Regeneration cuttings create, through time, a mosaic of patches of different ages. The range in patch sizes in Southern Appalachian conditions is from 0.2 acres up to about 1.5 acres. Within each patch, successional stages 1 through 6 develop sequentially.
3. **Group Selection with Reserves:** A variant of the group selection method in which some trees within the group are left standing to attain goals other than regeneration. The conditions created are identical to group selection, except for the effects of residual trees.

Successful regeneration can be achieved with both group selection and group selection with reserves with all forest habitat groups due to the variety of opening sizes that can be created using group selection.





Other Silvicultural Treatments

Intermediate Treatments

In addition to regeneration cuttings, silvicultural systems may include a number of other treatments needed to accomplish management objectives. Collectively, these are usually called intermediate treatments, and they include cleanings, liberation cuts, weedings, and thinnings. Cleanings are release treatments made in an age class not past the sapling stage to free the favored trees from less desirable individuals of the same age class which overtop them or are likely to do so. A liberation cut is a release treatment in a stand not past the sapling stage to free favored trees from competition of older, overtopping trees. A weeding is a release treatment in a stand not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position. Thus, cleanings, liberation cuts, and weedings take place during successional stages 1 or 2. One effect of all three treatments is to increase, at least temporarily, the amount of light reaching the forest floor. Herbaceous and woody plant production is increased. These treatments may also influence tree species composition.

Thinnings are silvicultural treatments made to reduce stand density primarily to improve growth of residual trees, to enhance forest health, or to recover potential mortality. Thinnings are classed as crown thinning, free thinning, low thinning, mechanical thinning, or selection thinning depending on the criteria for removing or retaining trees. In every case production of herbaceous and woody vegetation on the forest floor increases due to increased light.

Prescribed Fire

Prescribed fire is used for enhancing biological diversity, vegetative composition, and stand structure. A number of rare communities and the rare plant and animal species that inhabit them, benefit from fire. Examples are mountain bog communities, high elevation balds, and high pH mafic habitats. These communities are described in appendix C.

Forest types and plant communities where fire plays a role in community dynamics include: red spruce/Fraser fir (possibly minor effects); yellow birch boulder field forest; high-elevation red oak forest; montane oak-hickory

forest; heath; white pine forest (possibly); chestnut oak forest (possibly); interior upland dry to mesic oak-hickory forest; xeric shortleaf pine; xeric pitch pine-Table Mountain pine ridge forest; xeric Virginia pine ridge forest; heath bald shrub land; grassy bald; Blue Ridge-Piedmont ultramafic barren; Southern Appalachian bog; and longleaf pine.

In the absence of periodic fire, two of the five rare forested communities in the SAA area, mountain longleaf pine woodlands and Table Mountain pine/pitch pine woodlands, are being replaced by hardwoods and loblolly pine. The endangered red-cockaded woodpecker is associated with the mountain longleaf pine woodlands in northeastern Alabama and northwestern Georgia. Table Mountain pine has serotinous cones that open only when exposed to high temperatures from crown fires. Continuing fire exclusion will probably result in continued decline in this ecosystem.

Periodic fire is an important factor in nutrient recycling. Prescribed burning can approximate natural fire regimes and provide a means of restoring fire-dependent and fire-associated vegetation. Some ecological communities such as pine and oak forests may be threatened because of several decades of fire suppression.

Without fire or other vegetative management practices that approximate fire effects, oak dominance may shift dramatically in future years toward shade tolerant and fire intolerant species such as soft maples, white pine, and sourwood. Early successional habitats, which are not abundant in the region and are located primarily on private land, result from even-aged regeneration harvests, group selection harvests, and disturbances such as insects, diseases, and fire.

Prescribed fires are large but infrequent contributors to the total annual amount of particulate matter in localized rural areas. However, in the region as a whole, prescribed fire is a regular, but small, contributor of particulate matter (SAMAB 1996b).

An environmental attitudes survey conducted for the SAA showed that the majority of respondents disagreed with the statement, "Using fire as a management tool in the national forest is a good idea." (SAMAB 1996c). A significant change in public perception may be needed to gain acceptance of this practice in order for managers to be able to use this tool on national forests.

