Virginia Master Naturalist

Basic Training Course

# Forest Ecology and Management in Virginia

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# An Overview of Forest Ecology and Management in Virginia

## **Objective 1:** Understand the distribution, diversity, and characteristics of the major forest types in Virginia.

The variation of forest types across Virginia reflects the diverse physiography of the state. From the sandy, low-elevation soils of the Coastal Plain to the dry, rocky soils on the southwestern slopes of the Appalachian Mountains, Virginia has one of the most diverse landscapes in the East (Fleming et al. 2006). Most forests in this area have been heavily influenced by anthropogenic disturbances such as fire, logging, farming, and introduced species, all of which have altered composition and structure.

The diverse landscape, disturbances, and natural changes make forest type classification difficult. Forests have been classified according to numerous schemes and varying levels of complexity and scale, each one producing somewhat different results. The classic text on virgin forest classification is Deciduous Forests of Eastern North America written by E. Lucy Braun in 1950. Braun's work resulted in a forest type map depicting the probable locations of historic forest types. Of course, maps of the contemporary forest are rather different since little of the virgin forest is left.

Dyer (2006) revised Braun's maps based on current forest inventory data. The forest types that follow are based on this revised map. Many of the other forest classification schemes are quite acceptable as well. Dyer's classification was chosen for this discussion based on currency, simplicity, and usefulness. Important forest type subgroups, which are not distinguished within Dyer's larger scale classification, have been included as well. The common forest types in Virginia, as they occur from the East Coast to the Alleghany Plateau in western Virginia, are described below.

### Southern Mixed

The southern mixed forest, in the far southeast corner of Virginia, is currently dominated by loblolly pine (historically longleaf pine). Various hardwoods occur as well, including sweet gum, water oak, swamp tupelo, sweet bay, and yellow poplar. Southern mixed forests occur on sandy Coastal Plain soils all along the southeastern coast.

- **Oak-Pine**

  From the Chesapeake Bay and inland, including the Piedmont, oaks become more dominant in the Southern Mixed forest. Planted loblolly pine remains the most dominant species, but shortleaf pine, Virginia pine, and longleaf pine are also important components.

### Pine Plantations

There is debate within some groups over the ecological value of pine plantations. However, studies show that these forests provide critical early successional habitat for many wildlife species and can support a diverse array of understory vegetation (Haywood et al. 2003). Additionally, they provide wood products and fiber to help meet increasing demand while reducing harvesting pressures on natural forests.

In the Coastal Plain and Piedmont areas of Virginia, most plantations are loblolly pine (Figure 1), with some shortleaf pine. In the mountains, both loblolly pine and eastern white pine are planted extensively (Figure 2). Additionally, on forest industry lands, and some private lands in the mountains, a pitch pine-loblolly pine hybrid has been planted (Figure 3). This mix combines the fast growth rates and high-quality timber of loblolly pine with the cold tolerance of pitch pine.

*Figure 1. Landowners examine a loblolly pine plantation in the Appomattox-Buckingham State Forest in Appomattox, Virginia. (Photo by Jennifer Gagnon, Virginia Tech.)*

*Figure 2. An eastern white pine plantation in the Mathews State Forest, Grayson County, Virginia. (Photo by Jennifer Gagnon, Virginia Tech.)*

**Objectives:**

1. Understand the distribution, diversity, and characteristics of the major forest types in Virginia
2. Understand how forest communities function and the factors that affect function
3. Understand the threats relating to forests in Virginia
4. Understand the principles, tools, and methods for management of forests in Virginia
5. Understand the role of Virginia state agencies in managing forests
6. Understand the role of citizens in the stewardship of Virginia forests

*Figure 3. Planted loblolly pine-pitch pine hybrids on private land in Craig County, Virginia. (Photo by Jennifer Gagnon, Virginia Tech.)*

As of 2001, pine plantations accounted for almost two million acres of forestland in Virginia, an increase of 266,200 acres between 1992 and 2001 (Virginia's 7th Forest Survey, www.virginia.gov). This increase is due, in part, to the conversion of abandoned agricultural lands back to forests.

## Mesophytic

Mesophytic refers to a forest composed of species adapted to growing in a moist environment (from the word mesic, meaning moist). This is a diverse forest type and in Virginia, Dyer (2006) breaks this into two areas, the mixed mesophytic and the Appalachian oaks. The Appalachian oak group overlaps the area where the American chestnut once was the dominant species.

The mesophytic forest type consists of over 30 canopy species (Hinkle et al. 1993) with no single dominant species. Major species include sugar maple, American basswood, American chestnut (mainly as stump sprouts in the understory), northern red oak, yellow poplar, white ash, cucumber tree, black gum, black walnut, beech, chestnut oak, yellow buckeye, red maple, white oak, and bitternut hickory.

There are many forest community subgroups within this general forest type. The forest community that occurs in a particular location within the mesophytic forest type is a function of site productivity. The higher the site productivity, the higher the species diversity. The factors that affect site productivity are soil parent material, aspect (direction of the slope), and elevation, all of which affect soil depth, moisture, and nutrient content. For example, on dry, rocky high-elevation southwest facing slopes, productivity is low. Soils are eroded and shallow and do not retain high levels of moisture or nutrients. In these areas, chestnut oak, scarlet oak, sassafras, bear oak, black gum, pitch pine, Table Mountain pine, and Virginia pine are common (Virginia pine is usually found at lower elevations). If these sites are frequently disturbed by fire, pines will be the dominant species (Figure 4).

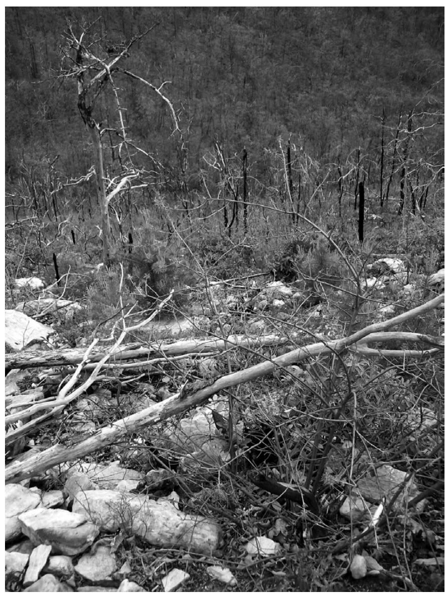

*Figure 4. Recently burned ridgetop in Rockbridge County, Virginia. Wildfire killed the overstory hardwoods and Table Mountain pine (a species with serotinous cones) seeded in prolifically. (Photo by Jennifer Gagnon, Virginia Tech.)*

Sites with intermediate productivity levels – forests at middle and lower elevations on southwesterly facing slopes, on upper slopes and ridgetops on northern and eastern aspects, and in the Appalachian Mountains – are the most common forest communities within the mesophytic forest type. Species found here include white oak, black oak, scarlet oak, chestnut oak, pignut hickory, shagbark hickory, and red maple. Eastern white pine, shortleaf pine, and Virginia pine are also commonly found in this forest type.

Highly productive and diverse forests are located on cool sites with adequate soil moisture and deep soils, most commonly in coves. Species found in this forest type are numerous and include northern red oak, yellow poplar, sugar maple, black cherry, white ash, basswood, American beech, white oak, cucumber tree, and a cadre of less important species. Hemlock and eastern white pine are commonly associated with this forest type as well. The diverse understory vegetation includes dogwood, spicebush, sassafras, hawthornes, eastern hophornbeam, American hornbeam, redbud, serviceberry, sumacs, greater rhododendron, and striped maple (Figure 5).

*Figure 5. A yellow poplar cove in Bedford County, Virginia. (Photo by Jennifer Gagnon, Virginia Tech.)*

## Bottomland Hardwoods

This forest type does not fit neatly into any of Dyer's forest regions. Bottomland hardwoods occur throughout Virginia on rich alluvial soils (flood plains) along streams, in low-lying wet areas, backwater and headwater swamps, and along minor drainages (Fleming et al. 2006). (Figure 6)

*Figure 6. Bottomland hardwood stand along Rock Castle Creek in Floyd County, Virginia. (Photo by Jennifer Gagnon, Virginia Tech.)*

Bottomland hardwood forests have a high diversity of both plant and animal species and are one of the most biologically important habitats in North America (Fleming et al. 2006). The actual species composition of this forest type varies greatly from the oak-gum-cypress swamps of the Coastal Plan (major species include swamp chestnut oak, cherrybark oak, sweet gum, willow oak, overcup oak, Atlantic white cedar, bald cypress, water tupelo, sweet bay, swamp tupelo, and red maple) to the flood-plain forests along the New River (major species include American sycamore, American elm, green ash, hackberry, red maple, and boxelder).

There are approximately 635,000 acres of bottomland hardwood forests in Virginia. Although this is typically a forest type that is threatened by development, in Virginia the acreage increased by 11,200 acres between 1992 and 2001 (Virginia's 7th Forest Survey).

From the discussion above, it becomes apparent that clearly identifying and separating forest types can be complicated and there is a lot of overlap. Sometimes it is sufficient to identify a forest simply as hardwood or pine. However, repeated exposure to the different forest types is the best way to become familiar with the different species groupings.

## **Objective 2:** Understand how forest communities function and the factors that affect function.

A forest community is one dominated by trees (one or more species) growing in a specific area and in association and mutual interaction with one another and with a complex of other plants and animals (Barnes et al. 1998).

### Forest Structure

The structure of a forest community, how the trees are arranged, can be simple, complex, or somewhere in-between. Typically, a forest consists of an overstory (the largest trees which form the main canopy), a midstory (generally a brushy layer comprised of saplings and woody species such as rhododendron) and an understory (which includes herbaceous plants, grasses, and tree seedlings).

Within the overstory, there are different crown classes. A crown class refers to the relative position of an individual tree crown in the main forest canopy.

- **Dominant** trees have large crowns in the upper layer of the canopy; they receive direct sunlight from above and mostly full sunlight from the sides.
- **Codominant** trees have medium-size crowns; they receive full sunlight from above and some sun from the sides.
- **Intermediate** trees have small crowns; although they extend into the canopy, they are shorter than codominants; they receive some direct sunlight from above, but very little from sides.
- **Overtopped** trees have very small crowns that are entirely below the main canopy; they receive no direct sunlight.

These classifications are used frequently in forest management.

Stands can be even-age, two-age, or uneven-age (multi-age). In an even-age stand, most of the trees are approximately the same age. Even-age stands can result from either natural or artificial regeneration. A plantation, where all the trees were planted in a relatively short period of time, is an example of an even-age stand that was artificially regenerated. Areas that have had large-scale beetle or gypsy moth kills will have naturally regenerated even-age forests. In a two-age stand, there are two distinct age classes of trees present, generally an overstory of parent trees and an understory of regeneration. Uneven-age stands have the most complex stand structure and have at least three to four distinct age classes. A forest may begin as even-age, and over time develop into an uneven-age forest because of small-scale disturbances as discussed below. Old-growth forests typically have uneven-age structure.

*Figure 7. Old growth stand of hemlock, yellow poplar, and silver bell in the Great Smokey Mountains National Park, Tennnessee. Note the complex structure of the canopy. (Photo by Jennifer Gagnon, Virginia Tech.)*

### Forest Composition

The composition of a forest community adds to the structural complexity. Some forests communities are monocultures, meaning there is only one dominant tree species in the overstory. An example of a monoculture is a loblolly pine plantation. Although there may be many different species in the understory, the main canopy is almost entirely loblolly pine. The composition of a mixed species canopy is determined by the growth characteristics of the species involved. Shade tolerance is an example of a growth characteristic that affects species composition.

Shade tolerance is the ability of a species to survive and grow under limited light conditions. Some species are very shade intolerant and need high levels of light to thrive. These are generally pioneer or early successional species, which come in after a disturbance. Examples include Virginia pine, black locust, loblolly pine, shortleaf pine, black cherry, yellow poplar, and black walnut. Many of the commercially important species in the Southeastern United States are shade intolerant.

In contrast are the shade-tolerant species, which are able to persist under low light conditions. Tolerant species include eastern hemlock, dogwood, maples and American beech. Some species, however, are intermediately tolerant, and although they can survive in the shade, they respond with rapid growth to increases in light. Examples of intermediately tolerant species include eastern white pine, most oaks, white ash, and hickories.

The composition of a forest community also depends on the location of the forest, availability of a seed source, past management practices, and activity of wildlife, insects and diseases.

### Succession and Disturbances

Forest communities are always changing – even old-growth forests, which are generally considered to be systems in equilibrium, are undergoing succession. Succession is the gradual process of one plant community replacing another one over time (in the absence of major disturbances; Barnes et al. 1998). Disturbances, both natural and man-made, alter successional patterns – generally setting it back to an earlier point in stand development.

Small-scale disturbances, such as individual tree mortality, lightning strikes, and blow downs occur frequently and change forest composition and structure slowly and subtly. Large-scale (stand-replacing) disturbances such as wildfires or extensive windthrow (from hurricanes) occur infrequently but change forest composition and structure drastically and immediately. Native insects can cause large-scale disturbances as well. For example, southern pine beetles can kill thousands of pine trees in a single growing season. Suppression of small-scale disturbances (i.e., small wildfires) may predispose the stand for a much larger disturbance (such as a stand-replacing wildfire) because of fuel build up.

How a disturbance affects a stand depends on the age and species of the stand at the time of the disturbance – larger, older trees are more susceptible to disturbances such as wind damage than younger trees, while younger trees are more susceptible to disturbances such as fire. Some pine species, such as longleaf pine, are more tolerant of fire than others, such as Virginia pine.

### Large-scale disturbances

Hurricanes, ice storms, and intense wildfires are among the more common stand-replacing disturbances in Virginia. These disturbances can kill large acreages of trees, setting succession back to the regeneration stage. After a major disturbance, there are four distinct stages of stand development (succession):

- Stand initiation immediately follows a large-scale disturbance. In this stage, smaller herbaceous plants quickly begin to occupy the growing space and eventually woody stems begin to dominate.
- Stem exclusion occurs when woody stems begin to fully occupy the growing space. Trees begin to compete with each other for limited resources, and weaker trees are suppressed and eventually die.
- Understory re-initiation begins as small-scale disturbances become frequent. The strongest competitors from the stem exclusion stage begin to die. This opens up canopy gaps, in which regeneration of a second cohort of trees begins.
- Complex (old-growth) forests occur when there is a relative balance between new growth production and death and decay (Smith et al. 1997, Barnes et al. 1998).

The age at which a forest reaches any one of these stages depends on the location, site, and species. For instance, in a loblolly pine plantation, the stem exclusion stage may occur at age 5. In an unmanaged hardwood stand, it may not occur until the trees are much older.

### Small-scale disturbances

The creation of canopy gaps by small-scale disturbances plays a major role in altering a forest community structure and composition. Gaps form as individual or small groups of trees die. The microclimate within gaps can be very different from the microclimate under the intact canopy. When a gap forms, there is an increase in the amount of sunlight reaching the forest floor, which encourages the growth of shade intolerant species. In the case of a small gap, however, if the surrounding stand is young and vigorously growing, the crowns of the surrounding trees will take advantage of the opening and expand into the gap, potentially preventing development of shade intolerant species.

Additionally, there may be an increase in soil moisture inside a gap due to a decline in leaf area (hence a decline in rainfall intercepted by leaves). This increased soil moisture can increase the growth of species in the gaps. However, as with crown growth, the root systems of the neighboring trees will also grow into the opening to take advantage of the increased soil moisture. Depending on the size of the gap, other environmental factors may also be altered. In large gaps, summer temperatures may be much higher than in the surrounding forest. Wind and snow patterns can also be affected by gap formation (Smith et al. 1997).

Forest structure and composition are complex and ever changing. Knowledge of the basic terminology and processes helps to describe a forest at a given point in time and to make predictions on how the forest may develop over time. This is useful for forest management planning.

However, not all disturbances are equal. Some disturbances can negatively impact natural forest functions as discussed under Objective 3.

## **Objective 3:** Understand the threats relating to forests in Virginia.

Many of the threats to Virginia's forests are not unique to the Commonwealth. Most forests face the same problems. Some of the biggest threats to forests in Virginia are exotic invasive species, parcelization and fragmentation, and development. These are all anthropogenic threats, and cause permanent changes in forests above and beyond what natural disturbances do.

### Exotic Invasives

Exotic invasive species that become pests are plants, insects, and diseases that thrive and spread vigorously outside their native ranges. Often exotic insects and diseases out-compete native species because they have no natural predators outside of their native habitat. Exotic plant species are often fast growers and can out-compete native vegetation by simply shading it out. This can change the species composition of a forest (from native to non-native), which can alter ecosystem function, change forest structure, decrease productivity, and decrease biodiversity.

While some exotic species were accidentally introduced to the United States, others were intentionally introduced as beneficial species. For example, kudzu was brought to the country and promoted for erosion control, forage, and ornamental uses. Unfortunately, kudzu grows very well in the Southeastern United States and now covers up to seven million acres (O'Britton et al. 2002), displacing many other species.

In general, exotic invasive plant species are prolific seeders and/or root sprouters. For example, a single tree-of-heaven (also known as Ailanthus, paradise tree, and stink tree) can produce over 300,000 seeds in one year, and sprouts prolifically when cut down (Rhoades and Block 2002). Many exotic invasives have light seeds, which are easily disseminated by wind. Additionally, many are adapted to a wide range of site conditions (i.e. soil moisture, light, nutrient availability) and grow rapidly.

The Virginia Department of Conservation and Recreation's (DCR) List of Invasive Alien Plant Species identifies 34 highly invasive plant species (including grasses, shrubs, and trees), and 115 total invasive plant species, many of which are found throughout Virginia. DCR defines highly invasive plant species as those that "exhibit the most invasive tendencies in natural areas and native-plant habitats." Visit www.dcr.virginia.gov for a complete listing of these species.

Exotic invasive insects and diseases have characteristics similar to invasive plant species in that they are able to reproduce rapidly and prolifically. The hemlock wooly adelgid, gypsy moth, and chestnut blight are some examples of exotic invasive insects and diseases that have had (and are having) devastating impacts on Virginia's forests. Photos of all types of invasives are located at www.bugwood.org (Figure 8).

*Figure 8. Eastern hemlock in the understory, Barney's Wall, Giles County, Virginia. (Photo by Jennifer Gagnon, Virginia Tech.)*

### Parcelization and Fragmentation

Parcelization is the process by which land is subdivided into increasingly smaller units. This often occurs when land is passed down through generations. For example, a 100-acre farm belongs to a family with four children. The parents divide the land equally and each child receives 25 acres. Each child then has two children of their own, who receive 12.5 acres each. And so on through the generations. Eventually a large plot of land becomes many small plots.

As long as all the children keep the land as forest, the land is parcelized, but still functions as a forest at the landscape level. Problems occur when adjacent landowners have different ideas about the value of their land. Some may feel the highest and best use of the land is to grow trees; others may feel that the highest and best use is to sell the land to a developer. As individual parcels are converted to non-forest uses, the landscape becomes a matrix of different uses (i.e., a working forest next to a shopping mall). This is fragmentation and it affects the function of the forest at the landscape level.

*An Eastern hemlock killed by the exotic invasive insect, the hemlock wooly adelgid, emerging from a dead American chestnut stump, killed by the exotic invasive disease American chestnut blight. Bottom Creek Gorge, Montgomery County, (Virginia. Photo credit: Jennifer Gagnon, Virginia Tech.)*

Fragmentation limits the type of forest management that can be used. For example, prescribed fire may not be an acceptable management tool in a forest surrounded by residential development due to smoke and safety concerns. Timber harvesting and the noise and machinery associated with it, may be controversial among residents who bought homes overlooking a forest. This takes the work out of a working landscape.

As forests become fragmented and people move out to the urban-wildland interface, there are more encounters between humans and wildlife, which could be dangerous (i.e., bears) or problematic (i.e., deer eating gardens), and more chance of loss of property from a wildfire in the neighboring forest.

### Development

The main outcome of parcelization and fragmentation is an increase in development in formerly rural areas. According to Governor Tim Kaine, at the current rate, Virginia will develop more land in the next 40 years than in the past 400 (VMI, 2006). Aside from the ecological problems this creates, there are also social and economic problems. For instance, development pressures increase the value of forest and farmland, which in turn increases property taxes. This makes it difficult for even the best-intentioned forest landowner to keep growing trees. There are some tools available to help landowners reduce their property taxes; but these aren't available in all parts of Virginia.

Development, of course, leads to the actual loss of forestland. In Virginia, there is a net loss of 26,000 acres of forestland a year – mainly to development. However, the demand for services and products from forests continues to grow.

## **Objective 4:** Understand the principles, tools and methods for management of forests in Virginia.

Silviculture is the art and science of managing a stand of trees to meet specific objectives. It is an art because it is not a one-size-fits-all science. Often times, the answer to the question "How should I manage my forest?" is "It depends." How to best manage a forest depends on what the owner's objectives are. For example, if a landowner's main object is to maximize timber production, the management prescription may be different than if the landowner wants to manage for wildlife. However, management objectives are not always mutually exclusive and many different objectives can be accommodated in a management plan. It also depends on the forest – where it is located, what species are currently on-site, how old the trees are, and past management. This is best done by a professional forester who can use past experience to determine the best plan of action.

Silviculture is also a science. Years of research have been conducted on how to best manage forests, be they naturally regenerated or artificially regenerated stands, pine or hardwood. A sound management plan will be based solidly in the science of silviculture.

A silvicultural system is a plan of action that includes all management activities during the life of a stand, including site preparation, regeneration, intermediate treatments such as thinning, and harvesting. Silvicultural systems differ from simple harvests, in that they plan for the future of the stand – not just for the removal of trees (Johnson and Smith 1998, Smith et al. 1997).

One concept integral to silviculture is rotation age. The rotation age is the optimum age to which trees should be grown – when the tree is considered either economically or biologically mature. Typically, economic maturity occurs much earlier than biological maturity. Rotation age depends on management, the product desired, site productivity, and species. For example, the rotation age of a pine plantation grown for pulpwood may be between 20 and 30 years; in contrast, the rotation age for naturally regenerated hardwoods grown for sawtimber may be 50 years or longer.

Silvicultural systems can be intensive, extensive, or anywhere along the gradient between the two extremes. Intensive management involves high inputs (i.e., fertilization, weed control, release operations, use of genetically improved trees), while extensive management involves very little input (perhaps no active management at all). Intensively managed stands tend to produce large timber quickly, while extensive systems tend to focus on other objectives (e.g. biodiversity).

The following is a discussion of silvicultural systems used in Virginia. Each of these systems can vary in management intensity. To gain a better understanding of these different systems, visit the website www.forestandrange.org. Under the learning options section "A Visual Guide to Timber Harvesting" are 360° photos of forest stands before and after different silvicultural systems have been applied.

## Selection

The selection silvicultural system mimics small-scale disturbances. This name, unfortunately, is very similar to select cut (i.e., diameter-limit cut or high-grade), but in practice is quite different. Selection takes into account the future health and productivity of the forest. Selection systems can either be single-tree or group. In a single-tree selection system, individual trees are removed to create small openings in the canopy. Intermediately shade-tolerant species can naturally regenerate in these openings. In a group selection system, groups of trees are removed to create larger canopy openings and encourage growth of more shade-intolerant species (such as oaks). In both systems, the worst trees are harvested and the best trees are left behind. The goal is to improve the quality of the stand with each successive harvest. Selection silviculture creates uneven-age (multi-age) stands that have at least three different age classes represented (Johnson and Smith 1998, Smith et al. 1997).

## Seed-tree and Shelterwood

Two systems that create even-age stands are shelterwood and seed-tree. These systems involve a series of partial harvests that gradually reduce overstory density. In a shelterwood system, the first harvest is called a preparatory cut and is used to reduce the overstory density, allow more sunlight to reach the forest floor, and remove undesirable species. This gradual reduction in density allows the residual trees to become more wind-firm before the density is further reduced. The second harvest is a seed cut, which allows even more sunlight to reach the forest floor and prepares the seedbed. The overstory trees produce seed to regenerate the forest. In a traditional shelterwood, once regeneration is well established, the overstory trees are removed in a final harvest, the removal cut. However, there are some variations to this method, such as the irregular or modified shelterwood, in which the overstory trees are left on-site. This creates a two-age stand.

In the seed-tree method, usually only two harvests are conducted – the preparatory and seed cut are combined into one harvest and the density of the residual overstory is fairly low (10 to 20 trees per acre). Again, the remaining overstory trees provide seed to naturally regenerate the stand. Once regeneration is established, the seed trees are harvested.

There are several advantages to the seed-tree and shelterwood silvicultural systems. First, relying on natural regeneration is inexpensive. Second, leaving the seed trees on site for several years ensures adequate regeneration, while they continue to grow and increase in value. Finally, many landowners find these systems more aesthetically pleasing, as there are always trees on-site (Johnson and Smith 1998, Smith et al. 1997).

## Clearcut

Clearcuts also create even aged-stands, although not appropriate for all situations, clearcuts have a place in forests where the growth of shade-intolerant species is desired (for example pine or yellow poplar). In order for shade-intolerant seedlings to grow well, they need full sunlight. This can best be achieved by a silvicultural clearcut. Please note, this is not the same thing as a commercial clearcut. In a commercial clearcut, the best trees are taken, and the poorly formed, diseased, and suppressed trees are left on-site. These conditions are not suitable for adequate regeneration of shade-intolerant species due to shade from the residual trees. The remaining overstory trees have little or no value and if left, will develop into a poor-quality stand. In a silvicultural clearcut, all trees, regardless of quality, are removed from the site. This leaves a clean site that is easy to plant, and promotes healthy, robust regeneration of shade-intolerant species.

Clearcuts are also a good option in forests that have been high-graded, like many of the hardwood forests in the Appalachians.

A high-grade is often sold to the landowner as a select or diameter-limit cut. The landowner is told that the biggest and most valuable trees are the oldest trees, and removing them will not only maximize income from the timber sale, but will also free up the young, small trees so they can grow up into big trees. This sounds good in theory, but in reality, size isn't a good indicator of tree age. Two trees can be the exact same age, but due to genetics, disease, or microsite, one tree may be twice the size of the one next to it. Many of the small trees are exactly the same age as the merchantable trees. In a high-graded stand, after the merchantable trees are removed, the remaining forest is composed of poor quality, often diseased and weak trees – an unhealthy forest.

Generally the density of a residual stand after a high-grade is high enough to shade the understory and prevent adequate oak regeneration; the species composition of the forest in mountain coves then moves towards more shade-tolerant species, such as striped maple, red maple, beech, and rhododendron. In the Piedmont, high-graded stands are often comprised of scarlet oak, chestnut oak, red maple, and occasionally Virginia pine. Depending on the management goals, this may or may not be a problem. But if a high-quality, diverse, and healthy forest is the goal, the best way to rehabilitate a high-graded forest is to clearcut and start over. After a silvicultural clearcut, the hardwood stumps will sprout and seeds in the soil will germinate, resulting in a vigorous, healthy stand.

A silvicultural clearcut creates an even-age (one-age) stand, with all trees in the future stand being approximately the same age. Even-age forests can either be naturally regenerated (relying on seedfall from nearby seed trees or stump sprouts) or artificially regenerated (seeds sown or seedlings planted). The method of regeneration used depends on the species, availability of a seed source, size of the clearcut, and management objectives ( Johnson and Smith 1998, Smith et al. 1997).

In the Southeast, regeneration in a clearcut develops rapidly; in a short period of time, many people are not able to identify that the site had been clearcut. Clearcutting is not deforestation – it is replacing an older forest with a younger forest.

## Site Preparation

Site preparation activities occur after a harvest to ready a site for regeneration. These activities include slash removal (by burning, chopping, shearing, or discing on cut over lands), vegetation removal (by burning, applying herbicide, plowing, scalping, or mowing), reduction of soil compaction (by tilling or scalping), and bedding. These activities make the site easier to plant, create a suitable seedbed for natural regeneration, reduce competition for the new trees, increase rooting depth, and control flooding. These practices can increase survival and growth of seedlings.

## Intermediate Treatments

In forests, light, water, and soil nutrients are limited. Trees compete directly with one another for these resources. Intermediate treatments are designed to increase the availability of one or more of these resources to the best trees (i.e., crop trees). The more intensive the management plan, the more intermediate treatments are included. Intermediate treatments are applied to the forest between regeneration and final harvest and include activities such as thinning, crop-tree release, timber-stand improvement (TSI), understory competition control, prescribed fire, and fertilization.

Thinning removes a portion of the overstory trees, freeing up resources for the remaining trees, generally increasing growth. Row thinnings are often used in plantations and are non-selective. That is, every second, third, fourth, or fifth row is systematically harvested. Low thinning (or thinning from below) removes smaller stems, while high thinning (thinning from above) removes co-dominant trees, freeing up the crowns of the dominant trees. Selection thinning (not to be confused with the selection silvicultural system) focuses on removing slow growing, diseased, suppressed, or deformed trees from the canopy. Thinnings are usually conducted in pine forests around age 15 and from age 30 to 40 in hardwood forests. Timber-stand improvement work is similar to a selection thinning, in that poorly formed, diseased trees, or undesirable species are removed, increasing the overall quality of the forest.

Crop-tree release is a type of thinning. The best trees in the stand (in terms of form, species, growth, and health) are identified as the crop trees and remain until the final harvest. Once the crop trees are identified, nearby competitors are removed either by harvesting or herbicide application. This increases the availability of resources for the crop tree. These operations can be labor intensive, time-consuming, and expensive, but can contribute significantly to increases in the volume and value of the final harvest.

Understory vegetation can also be a serious competitor for trees, particularly seedlings. In forests where timber production is the main management objective, understory vegetation is usually minimized in the early years of the stand. Like thinning, understory competition control reallocates resources to the crop trees. This can be accomplished using herbicides or prescribed fire (depending on the species and size of the trees).

Prescribed fire is a useful and inexpensive management tool for pine forests. Longleaf pine forests can be burned at any age. Fire not only reduces understory vegetation, but also prepares a bare mineral soil seedbed, which longleaf pine seeds need for germination. Other species, such as loblolly pine, are susceptible to fire damage until they are old enough to have developed a fire-resistant bark. Table mountain pine is a species with serotinous cones. This means the cones remain closed (and don't drop their seeds) until exposed to extreme heat – such as that generated by a fire. The proliferation of species with serotinous cones is dependant up on fire. The use of prescribed fire is more limited in hardwood forests, as many hardwood species are not fire tolerant.

Intensely managed forests may also be fertilized to increase growth. Generally fertilization in the absence of understory vegetation control can lead to sites that have impenetrable weed growth (e.g., greenbrier and blackberry), so usually fertilization is applied following weed control.

When it comes to managing a forest, doing nothing is always an option (this surprises some folks). Depending on past management, the forest may be growing optimally to meet the landowner's management objectives. A professional forester can make this determination. Professional assistance is readily available for landowners. State agencies have personnel who can work with you to develop realistic goals and management plans (see Objective 5). Additionally, Virginia has a cadre of professional consulting foresters (see www.dof.virginia.gov for a listing), and the forest industry also provides services to landowners.

## **Objective 5:** Understand the role of Virginia state agencies in managing forests.

- **Virginia Cooperative Extension (VCE)** is the community's connection to Virginia's land-grant universities, Virginia Tech and Virginia State University. Their mission is to "improve people's lives by providing research-based educational resources though a network of on-campus and local Extension offices and other educators." In the realm of forestry, VCE provides education through the Virginia Forest Landowner Education Program (VFLEP) and six forestry and natural resource district agents located across Virginia. Together, they provide short courses, workshops, print materials, and training for NIPF landowners and natural resource professionals. Contact Jennifer Gagnon, VFELP Coordinator, at 540/231-6391 or forester@vt.edu for more information. (*www.ext.vt.edu* and *www.cnr.vt.edu/forestupdate*)

- **Virginia Department of Forestry (VDOF)** is Virginia's state forestry agency and its mission is "to protect 15.8 million acres of forest land [sic] from fire, insects, and disease, to manage 17 State Forests and other state lands totaling 47,899 acres for timber, recreation, water, research, wildlife, and biodiversity, and to assist non-industrial private forest landowners through professional forestry advice and technical management programs." Each county in Virginia has an area forester. Area foresters help NIPF landowners determine reasonable management goals and objectives and help prioritize them. They can write a Forest Stewardship Plan, a management plan for the property, as well as assist landowners with insect and disease problems. A wealth of print materials is available as well. VDOF employees assist the VFLEP program and VCE with many of their educational programs, enforce water-quality laws and burn bans, and fight wildfires. (*www.dof.virginia.gov*)

- **The Virginia Department of Game and Inland Fisheries**' mission is: "to manage Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth; to provide opportunity for all to enjoy wildlife, inland fish, boating, and related outdoor recreation; and to promote safety for persons and property in connection with boating, hunting and fishing. VDGIF is responsible for the management of inland fisheries, wildlife, and recreational boating for the Commonwealth of Virginia." DGIF provides numerous educational opportunities for the public and personnel assist with other agencies' programs. The hunting and trapping regulations are published by the DGIF as well. (*www.dgif.virginia.gov*)

- **The Virginia Department of Conservation and Recreation** "works with Virginians to conserve, protect, and enhance their lands and improve the quality of the Chesapeake Bay and our rivers and streams, promotes the stewardship and enjoyment of natural, cultural, and outdoor recreational resources, and insures the safety of Virginia's dams." DCR maintains the Conservation Lands Database, administers Virginia's Natural Heritage Program, and manages Virginia's 34 State Parks. (*www.dcr.virginia.gov*)

- **Virginia Outdoors Foundation** is the state land trust. Its mission is "to promote the preservation of open space lands and to encourage private gifts of money, securities, land, or other property to preserve the natural, scenic, historic, open-space, and recreational areas of the Commonwealth." It holds easements on over 400,000 acres of land in Virginia. There are numerous private land trusts in Virginia as well. (*www.virginiaoutdoorsfoundation.org/*)

## **Objective 6:** Understand the role of citizens in the stewardship of Virginia forests.

There are approximately 25 million acres of land in Virginia; of those, about 16 million are forested. Non-industrial private forest (NIPF) landowners are the largest owners of the forestland in Virginia (10.1 million acres or 66 percent). Because of development, Virginia is losing about 26,000 acres of forestland a year, and pressure for non-industrial private forest landowners (NIPFs) to sell their land to developers for large profits is increasing. For example, land is selling for $10,000 an acre in rural Grayson County in Southwest Virginia; in more urban areas, such as Virginia Beach, land can cost up to $18,000 an acre.

Selling off working rural lands for development leads to fragmentation of the landscape (see Objective 3) and fewer acres devoted to growing trees. However, demand for forest products (this ranges from acorns to pulp to lumber to scenery to carbon sequestration) is continuing to increase. This means landowners who are growing trees must ensure that they are managing their forests in the most beneficial way possible – to maximize production of some of these goods. The importance of the NIPF landowner will only increase as development pressures and other threats increase and the forest base decreases.

Governor Tim Kaine mandated that 400,000 acres of rural lands would be conserved before the end of his term. NIPF landowners can help him reach his goal by utilizing some of the conservation tools that Virginia offers. These include conservation easements, agricultural and forest districts, use value taxation, purchase of development rights programs and bargain sales among others. One of the best actions a NIPF landowner can take is to become educated on forest conservation. Many educational programs are available in Virginia. The Virginia Forest Landowner Education Program, a Virginia Cooperative Extension program, has a short-course series that includes topics on woodland and wildlife management, cost-share assistance, sustainable timber harvesting and marketing, and conservation tools.

For more information on these tools and managing forest sustainably, contact the Virginia Landowner Education Program at *www.cnr.vt.edu/forestupdate*, forester@vt.edu, or 540/231-6391.

Knowledge is power when it comes to conserving forestland.

# Glossary

- **Crown class** – the relative position of a crown within the main forest canopy
- **Diameter limit** – a type of high-grade cut in which all trees above a certain diameter are removed, with no regard for regeneration
- **Disturbance** – an event, either natural or anthropogenic, which alters the natural course of succession (i.e., fire, insect outbreaks)
- **Ecology** – the study of ecosystems
- **Even-age** – a type of stand structure in which all trees are approximately the same age
- **Exotic invasive** – an introduced plant, animal, insect, or disease that reproduces prolifically outside of its native range and can alter ecosystem composition and function
- **Extensive management** – management with low inputs, low capital expenditures; generally results in longer rotation ages
- **Forest** – a collection of stands, often under the same ownership
- **High-grade** – harvesting the largest trees to maximize immediate financial returns with no regard for regeneration or the future health and productivity of the forest
- **Intensive management** – management with high inputs (e.g., fertilization, competition control, use of genetically improved plants); high capital expenditures, shorter rotation ages
- **Mesic** – moist, in the mid-range of the moisture spectrum that can support tree growth
- **Mesophytic** – a forest type comprised of species adapted to growing under moist conditions
- **Rotation age** – the age at which a forest is either economically or biologically mature
- **Seed tree** – a silvicultural system that creates even-age stand structure with two partial harvests – the seed cut reduces overstory density and encourages natural regeneration; the removal cut removes the residual (seed-producing) overstory trees
- **Select cut** – see high-grade
- **Selection** – a silvicultural system that removes individual trees or groups of trees across a stand to create openings in the canopy in which regeneration can develop, creating an uneven-age forest
- **Silvicultural clearcut** – a silvicultural system in which all trees are cleared from a site, allowing shade intolerant species to regenerate, creating an even-age stand
- **Silvicultural systems** – a collection of management activities that includes harvesting, regeneration, and intermediate treatments; takes into consideration the future health and productivity of the forest
- **Silviculture** – the art and science of managing a stand of trees to meet specific management objectives
- **Stand** – a contiguous group of forest trees of the same species, or of similar species groups, growing under similar conditions; the management unit of forests
- **Succession** – the gradual process of one plant community replacing another, over time
- **Sustainable forestry** – managing a forest to meet today's needs without compromising the ability of future generations to meet their needs
- **Two-age** – a type of stand structure that has two distinct age classes of trees – generally an overstory of mature trees and an understory of younger trees
- **Uneven-age** – a type of stand structure in which there are at least three distinct age classes

## Study/Review Questions –Forest Ecology and Management

1. What factors influence the productivity of a soil?
2. What is high-grading and why is it detrimental to the long-term health and productivity of a forest stand?
3. What are the main components of a silvicultural system?
4. Discuss some of the threats to Virginia's forests.
5. What is the difference between parcelization and fragmentation?
6. List three state agencies that help landowners manage their forests sustainably.
7. What role can citizens play in promoting forest stewardship in Virginia?

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# Additional Resources

*NatureServe, www.natureserve.org*

Virginia Forestry Association, www.vaforestry.org

Virginia Forest Landowner Update, *www.cnr.vt.edu/forestupdate*