Forestry Resource Manual

Adapted from North Carolina Envirothon Forestry Resource Manual
Revised July 2018

Delaware Envirothon
Forestry Learning Objectives

Students must be able to…

A. Understand the historical roles of forests in society
1. Know the historical role and importance of forests
2. Explain the various benefits of trees and ecological roles of forests
3. Explain the importance of trees in urban areas and aspects of urban forestry
4. Understand forest land use and ownership in Delaware
5. Know the economic value of forests and the many products they provide

B. Understand and describe the physiology of trees and methods for their identification
1. Know the different parts of a tree and their functions
2. Explain the reproduction of the two main types of trees.
3. Describe the lifecycle of a tree and explain how trees grow
4. Understand the method and terminology required to use a dichotomous tree key
5. Know and identify major tree and shrub species native to Delaware's forests

C. Understand and describe the various characteristics and processes of forest ecology
1. Understand the concept and processes of forest ecology.
2. Identify the abiotic and biotics components of a forest ecosystem
3. Explain the process of photosynthesis and nutrient cycling
4. Understand and illustrate the process and stages of succession
5. Understand the developmental stages, structuring, and types of forests

D. Understand and describe the methods and practices of sustainable forest management
1. Identify and describe the various silvicultural principles and treatments
2. Understand tree harvesting and regeneration methods
3. Describe the various forest management objectives
4. Explain forestry best management practices
5. Explain the forest management cycle and each of its component parts

E. Understand and describe the methods and tools used in a forest inventory
1. Understand the importance of forestry measurements and identify the tools used for each
2. Demonstrate proficiency using various forestry tools and interpreting the collected data
3. Explain plot measurement procedures used in a forest inventory
4. Understand and explain the various objectives for completing a forest inventory
5. Explain what site index means and know to read a site index graph

F. Understand and describe practices involved in the conservation of forest resources
1. Explain the importance of forest health
2. Understand the major issues affecting Delaware's forests
3. Identify Delaware's main forest pests and diseases
4. Understand the programs available aimed at conserving forest resources
5. Explain the various laws and regulations aimed at conserving forest resources

Key Concept 4: Sustainable Forest Management

Approximately 25% of the world's forests are currently managed for wood production. There are two main ways to manage a forest: even-aged management and uneven-aged management.

In even-aged management, the trees are all the same age. Even-aged management is a common practice when a forest is going to be used mainly for commercial forestry. This practice is sometimes called tree farming. In most cases only one or two species of fast growing trees are grown in these areas.

To start an even-aged forest the original forest must first be cleared. This may change the diversity found in an area and changes the type of wildlife habitat. Even-aged stands of forest are more susceptible to disease because all of the trees are the same age and species. In even-aged forest all of the trees are generally clear-cut from time to time. They are then replanted and then cleared again after a set amount of years.

Even-aged management uses the forest mainly for economics (lumber). However, this type of forest farming keeps the stand in an early successional stage. This stage is a preferred area for deer, rabbits, songbirds and quail.

Uneven-aged management involves growing a variety of trees of different ages and species in the same area. It encourages the natural regeneration of the forests. Uneven-aged management focuses on the ecological benefits of the forest such as runoff control, nutrient cycling and removing air pollutants, instead of on the economic benefits. In uneven-aged management, mature and undesirable trees are cut in small patches in ways that benefit the overall health of the forest.

Controlling Infestation by Insects and Disease
The study, detection, and control of pests and diseases are important parts of forest management. Forest entomology is the study of insects that attack forest trees. Forest pathology is the study of diseases that affect forest trees. Both are parts of a successful forest management program to produce marketable timber and lumber. Healthy trees are essential to a profitable harvest.

Integrated Pest Management
Pest management is particularly important in the more vulnerable even-aged stands of pine plantations and Christmas tree farms. Cooperative extension agents and foresters recommend to these owners the use of integrated pest management, or IPM. Integrated pest management is just that, the use of integrated or multiple methods to prevent or manage the problem.

Different methods of control, which take advantage of technology and knowledge of the pest's life cycle and habits, are used alone or in combination with other methods of control.

- Chemical- The use of chemical pesticides to prevent or control infestations.
- Biological – The use of natural predators to control populations, or use of pheromones to disrupt the reproductive cycle of pests.
- Mechanical (physical) – The use of physical methods, such as traps, barriers, destruction of eggs or pupa, or removal of infested trees, to control pest infestations.
- Cultural – Planting multiple varieties rather than one species or species less prone to attack, varying the time of planting and harvesting, and activities to improve the health of existing trees.
- Regulatory – Laws and regulations regarding the transport or inspection of any plant materials, vegetables, or fruits entering areas; and the strict enforcement of those regulations. Some states, such as California, strictly regulate the flow of any plant material into the state, even in an individual's vehicle.

Forestry (Silviculture)
The term silviculture refers to managing a stand of trees for a specific purpose and to meet certain needs of an area or wishes of the individual who owns the stand. To accomplish this, a management plan with management objectives is the first step. Things that may be considered in a forest management plan are wildlife habitat, protection of the watershed, recreational uses, aesthetic value, and the production of timber. Silvicultural techniques vary from one stand to another due to the needs of different stands. Trees are grown as a crop and proper management techniques are necessary to have a good harvest. Some management techniques are listed in the following silviculture practices.

Silvicultural practices include:
- Application of various treatments for clearing forest floor
    - prescribed burns
    - spraying of herbicides and pesticides
    - mechanical clearing of undergrowth
- Intermediate Cutting – the main objectives are:
    - improvement of the stand, removal of inferior trees
    - manipulation or regulation of tree or stand growth
    - early financial return
    - reduction of conditions that favor insect pests or disease
    - creating conditions favorable to reproduction and growth of desirable trees
        - Methods used include:
            - Thinning to improve stand growth by reducing competition
            - Intermediate Cuttings including salvage cutting and pruning
            - Liberation Cuttings
                - freeing desirable saplings from the competition of older, over-topping trees
- Regeneration Methods
    - Clear Cut
    - Seed Tree

    - Shelter wood
    - Group Selection
    - Single Tree Selection
- Planting or Regeneration

Tree Harvest Techniques
There are many techniques that can be used to harvest trees. One step common to all is the building of a road, to get the people or machines in to cut the timber and to get the timber out. The construction of the road can cause many problems. It can increase the erosion and the amount of sediment carried into local streams. It destroys part of the habitat, and creates habitat fragmentation. Habitat fragmentation is the dividing of a habitat into smaller and smaller areas. Logging roads in stands of timber may make the area more vulnerable to disease and/or exotic species. They also open the forest to more use by humans that may lead to destructive fires and other damage.

Erosion can be a major problem. In fact, logging roads in some steep areas in the mountains of North Carolina can cause the loss of up to 200 tons of soil per acre of roadway during the first year after their construction.

A forestry management practice to prevent water pollution by sediment is leaving a **streamside management zones (SMZ)** as a buffer. Management activities are limited in these zones to protect water courses. These areas provide various types of vegetation to trap sediment and pollutants preventing them from entering the streams and rivers.

Harvesting trees can lead to habitat fragmentation.. This creates problems for some species with special needs and for species that require large areas of uninterrupted habitat. Habitat fragmentation may limit a species ability to access to some aspect of their habitat such as food, shelter, or breeding grounds.

Clear-cutting
Clear-cutting is the least expensive method for harvesting trees. It is usually used to harvest even-aged stands. In clear-cutting all the trees are removed from the area in one single cutting. After the trees are cut the area is usually reforested. This can happen one of two ways: 1) naturally by seeds dispersed during the cut or from nearby trees or 2) by foresters putting seeds in the area or planting seedlings grown in a nursery. Like all harvesting methods, it has benefits and drawbacks.

Some of its benefits include: an increase in overall timber yield, trees that are genetically stronger or more well suited to the site may be planted, helps animals needing early successional habitat, requires less skill and planning; simulates natural events like wildfire and tornado damage; and provides timber companies and landowners with the most money in the shortest amount of time. One other positive aspect of clear-cutting is that it requires very little road building.

Some negative aspects of clear-cutting include ugly patches of forest, habitat fragmentation, altered wildlife habitat which benefits early successional species, increased rate of erosion,

and increased amount of sediment in the water causing an overall decrease in the water quality. In some cases, clear-cutting makes surrounding areas more prone to flooding because living trees store water.

A type of clear-cutting is known as **strip cutting.** In strip cutting, a strip of trees the width of one to two times the height of the stand of trees is cut along the contour of the land. The strip is narrow enough so that natural regeneration will happen after a few years. After regeneration has occurred, another narrow strip in the stand is clear-cut and the process cycles through again. Strip cutting allows for a stand to be clear-cut over a few decades. It causes less destruction of habitat for wildlife, lessens the amount of erosion and water pollution, and does not leave a large, ugly scar like regular clear cutting.

A controversial type of clear-cutting is **whole tree harvesting**. The trees are cut at ground level and the wood sold as either timber or chips and then the stumps are removed. The stumps sometimes ground in tub grinders for chips or piled and burned. This method is only used for site preparation for development or construction, and it causes severe ecological damage. No large roots remain to hold the soil in place, greatly increasing erosion. Dead and fallen logs are also removed, causing the loss of many wildlife habitats and decreasing the amount of nutrients returned to the soil and available for use by plants that survive. The forestry practice of *whole tree chipping* uses only the live wood cut off at ground level. It does not remove dead rotten wood or forest litter, thus it does not result in the same environmental damage.

In certain situations clear-cutting may be the best method of tree harvesting. An example would be stands that are full of mature or over mature trees or species that are not desirable. Clear-cutting could then be used to remove those trees and replace them with trees that are better suited to the site, more desirable, and more profitable for the landowner. Leaving stream buffers is key to reducing the ecological effect of removing all the trees in an area.

Single Tree Selection

Unlike clear-cutting, selective cutting involves only removing certain trees from an area. Selective cutting is generally used in uneven-aged stands. It involves cutting individual or small groups of large, mature trees in order to provide better conditions for the remaining trees. It creates small gaps in the canopy that allow for more sunlight to reach the forest floor and thus encourages the growth of other trees. After a few years have passed, more trees can be cut.

Selective cutting is beneficial in many ways, because it allows for the continued growth of the uneven-aged stand. It promotes growth of younger trees while reducing crowding. It encourages the natural re-growth of native plants in the forest. Selective cutting causes less soil erosion and decreases the amount of damage done by wind while providing a more diverse habitat for wildlife.

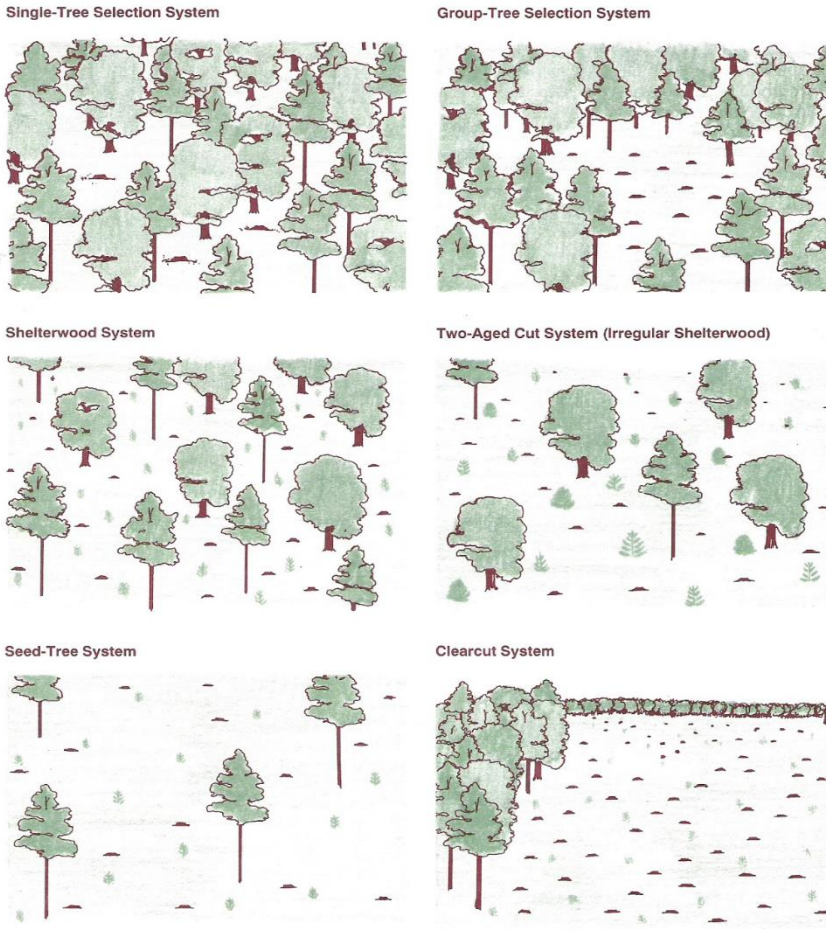
Some negative aspects of selective cutting are: it produces less money than other harvesting methods, it requires planning and skill, it can cause damage to the remaining trees, and it requires more frequent human disturbance.

Shelter-wood cutting is one type of selective cutting. Shelter-wood cutting harvests the mature trees in an area over a period of time in several cuttings. It usually occurs over a period of ten years and consists of two or three cuts spaced at least two years apart. The first cut removes the tallest trees, as well as any smaller trees that are damaged or diseased. The removal of these trees allows for more sunlight to reach the forest floor and thus causes the growth of new seedlings and other plants, as well as improving the health of the forest. A few years later, the second cut is made. By this time, many new trees have begun to grow. More of the canopy trees are harvested during this cut; however, some large trees are left to protect the young trees. Several years later, the final cut is made where all of the remaining mature trees are harvested. The younger trees in the stand are then left to grow as an even-aged stand.

Seed tree cutting is a type of selective cutting. All of the trees are cut except for some good quality, seed bearing trees. These trees are left to reseed and repopulate the area, allowing for natural regeneration to take place. Seed tree cutting is usually used with trees that bear seed often and have the ability to disperse their seeds over a wide area. Foresters leave between four and ten large trees per acre. In most cases these trees are able to repopulate the forest in a reasonable amount of time.

One type of selective cutting, which is not an ecologically good harvesting practice, is **high grading or creaming.** High grading involves removing the best quality trees in a stand, leaving genetically inferior stock to repopulate the area. It is commonly used in areas with a tropical forest. It is no longer a common practice in the U.S.

Selective Cutting usually ends up injuring one-third to two-thirds of the other trees in the forest. Damage can be caused by the equipment used to harvest and remove larger trees or by falling trees. Some of the injured trees are knocked down. Others have branches and/or bark removed. These injuries make the remaining trees more susceptible to insects and diseases.



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Reforestation
Reforestation is the practice of reestablishing trees after a harvest. Today, reforestation has become a fairly common practice. Two methods can be used: planting seedlings or allowing for natural regeneration. Reforestation by planting seedlings is usually done for stands of conifers, while hardwoods are left to natural seed dispersal and sprouting regeneration. Conifer seedlings are planted because they grow quickly and can grow in poorer quality soils. These seedlings come from nursery stock and allow for genetically superior trees to be grown. These seedlings grow faster, have better form, and are more resistant to disease and pests. Reforestation by planting seedlings produces even-aged stands of trees.

Forest Management and the Private land owner
Most of the forested land in North Carolina is privately owned, and it is in the best interest of these landowners to properly manage their forests. Forestland that is privately owned can be managed for any purpose the owner would like. It can be managed for recreation, wildlife, aesthetic value, timber production and sales, or for a variety of purposes.

The recommended first step for managing forest land is consulting with a professional forester. A professional forester will help the owner determine the best way to manage the forest to meet their goals and then develop a management plan.

If the landowner wants to manage the forest for a timber harvest and sale, the following steps should be taken:

- Use a forester - Studies have shown that landowners who use a forester to help plan their harvest get more money for their timber.
- Know what is being sold - Landowners should know the timber that they are selling well. They should know the tree species, amount of timber available, what the cut timber will be used for (pulpwood, saw logs, etc.), and the current market value of the timber. A forester can provide this information.
- Identify the method of timber harvest - there are many ways that the timber can be harvested. The landowner should have basic knowledge about these and, with the help of a forester, determine which method is best for their wants and needs.
- Plan for reforestation - this is a very important step, if the plan is to maintain the land as a forest. The planned type of reforestation may have an impact on the timing of the timber harvest. If the landowner does not plan to reforest the land, then a plan should be developed to control the erosion caused by the method of timber harvest.

Management for Wildlife and/or Recreation
There are several things a landowner may do to manage their land which will increase the amount of wildlife and make it more suitable for recreational uses. Many times, this can be done along with a timber harvest. Some methods to encourage wildlife in an area during and after a harvest are to:

- Leave snags (dead trees that are still standing) and some large den trees for wildlife use.

- Think about managing the forest as a mixed (coniferous and deciduous) forest to increase wildlife.
- Leave a corridor (or uncut strip of trees) connecting cut areas for the use of the wildlife.
- Leave buffer strips along any creeks, rivers, or streams that flow through the area. (This is required by law.)
- Make the boundaries of the timber harvest into an irregular shape. This will increase the overall area of the edge and thus increase the "edge effect" for wildlife.

Protecting Forested Land

There are some practices that can be done to protect the overall value and health of private forestland, no matter what the ultimate management goal is. These practices include:

- Thinning over-crowded stands of both hardwood and softwood trees. This improves the overall health of the stand by encouraging growth, decreasing the risk of insect attacks and disease, and decreasing the amount of competition for sunlight, water, and nutrients from the soil.
- If an insect, such as the southern pine beetle, attacks a tree or small stand of trees, the infested tree(s) should be cut down and completely removed from the area as soon as possible to prevent further infestation.
- Strips of hardwood trees planted in pine forest can act as buffer strips and can be a way to prevent the spread of bark beetle invasions.
- Match the type of soil in an area to the type of tree that will grow well in that soil. Sites planted with trees poorly suited to the soils can be more susceptible to various diseases, such as rusts.
- Conduct prescribed burns every three to five years in stands that are suited for management by fire. This will reduce the danger of a wildfire because it reduces the amount of fuel available. Prescribed burns can also help control some diseases, such as fusiform rust and can benefit wildlife by allowing succulent forbs to grow.

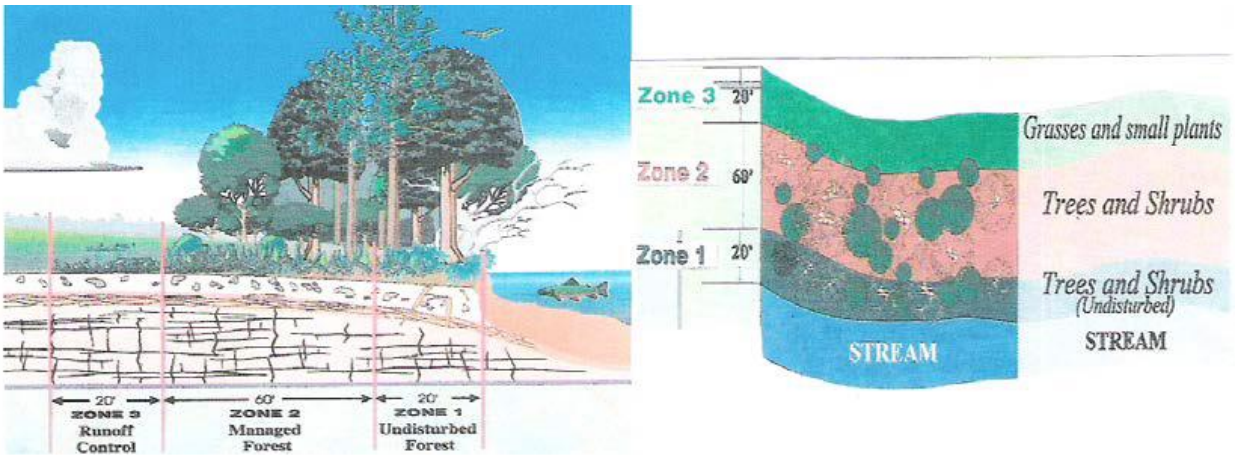
Forestry Best Management Practices

Water resources and the roles of forests in stabilizing soils and protecting watersheds are widely recognized. Any time a forest is disturbed there is potential for increased erosion and harm to water bodies. The use of **best management practices (BMPs)** in forest management helps minimize or eliminate these risks.

Best management practices for forestry include:

- Streamside management zones (SMZs) – Vegetation along streams to slow and spread surface water flow and to trap and filter suspended sediments.
- Road BMPs to protect water quality – water control structures
    - Water turnouts to divert water from road surfaces
    - Crossroad drainage by culvert to transfer water across or under roads
    - Broad-based drainage dips to slow and move water off the road
    - Rolling dips to slow water flow on roads or skid trails
    - Water bars to move water off roads into undisturbed areas

- Planning and use of as few stream crossings as possible, good drainage from crossings diverting water into undisturbed areas, and removal of all temporary stream crossings after harvest
- Planting permanent vegetative cover along roads and all openings created



Minimizing Wildfire Risk

Fire has been a natural part of our forests' history. Lightning ignited fires that burned and were controlled only by nature. Fire resistant species survived in frequently burned areas while others died out. Some of our forests adapted into fire dependent ecosystems, requiring periodic fires to survive.

Fire is beneficial to many wildlife species. It opens up areas of the forest to new growth, increases grazing areas, and starts new succession. The devastating fires that burned Yellowstone National Park are an example. They left ugly views, but park rangers and biologists report that most species, except the moose, have benefited and increased in numbers.

Throughout history, humans have made use of fire and have been a part of the wildfire problem. American Indians used fire to clear land and to improve hunting. Settlers used fire to clear land for settlements and agriculture. Today, careless actions by humans, such as burning trash, discarded cigarettes, and campfires, cause many wildfires.

Wildfires are influenced by three major factors, which determine the risk, spread, and behavior of the fire:

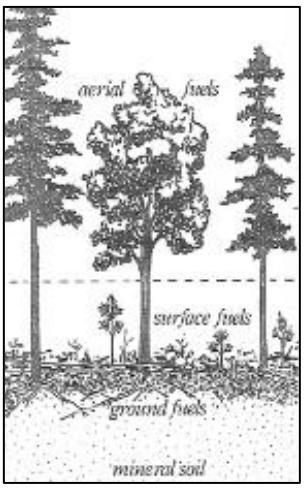
- Weather
- Topography
- Vegetation

Weather

Wind, temperature, rainfall, relative humidity, and stability of the atmosphere impact fire behavior. High or gusty winds, low humidity, drought, and high temperatures lead to rapidly

spreading wildfires. Winds also dry fuels on the forest floor increasing the chance of fires and providing good tinder for any ignited fire.

Topography
Steep slopes increase winds, expose fuels to more drying, and can speed the spread of wildfire. On areas with moderate slopes (40% incline), fire can spread twice as quickly. Fire can spread four times faster on very steep slopes (70% incline). Topography also affects the direction fires spread. Narrow areas create drafts that act like chimneys moving the fire rapidly through an area.

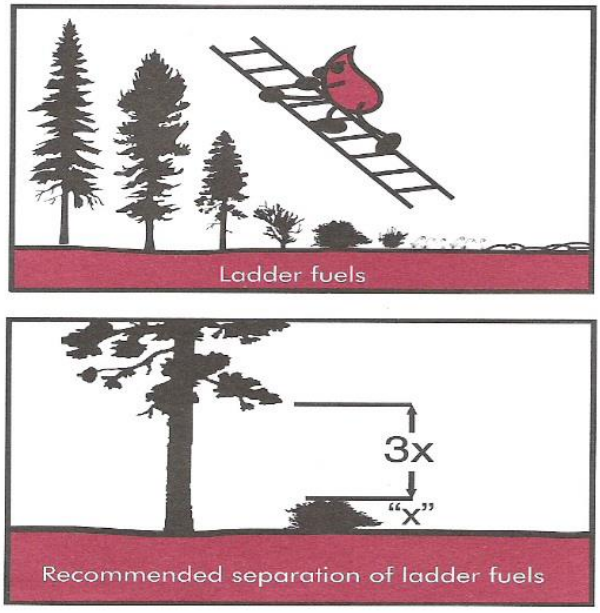


"Wildlife in North Carolina"

Vegetation
Ground fuels are vegetation close to or built up on the forest floor. They include forest litter, such as leaves or pine needles, limbs, downed logs, and low growing plants, such as herbs, grasses, shrubs, and young trees. These fuels are the primary means for the spread of wildfire. The build-up of ground fuels poses a serious threat of wildfire. Fires that begin in forests with a heavy accumulation of fuels spread rapidly and often move up through shrubs, vines, and small trees to the tops, or crowns, of the trees. The fuels that allow the upward spread to the crowns are called **ladder-fuels**, and the resulting crown fires are devastating to the forest.

Wildfires can be classified into several categories:

- Surface – fires that burn the litter on the forest floor: leaves, branches, and other debris.
- Ground – fires that burn close to or beneath the forest floor, burning the organic material on and within the soil, such as peat.
- Crown – fires that burn the tops, or crowns, of trees often destroying the tree, and are difficult to control.



Ladder Fuels and Recommended separation of ladder fuels
N.C. Cooperative Extension Service

While fire is a threat to homes and the timber industry, it is a very effective tool for foresters. A managed fire, or **prescribed fire**, can be used for many purposes. Burns can reduce the risk of wildfire by preventing the buildup of ground fuels. They can be used to kill weakened, diseased, or undesirable trees. Prescribed burns can be used to stimulate regeneration in the forest, maintain a fire dependent ecosystem, and create openings for wildlife habitat. Fire is also used to fight wildfires. Backfires are intentionally set to burn toward the fire, eliminate fuel from its path, and create a firebreak to slow or stop the wildfire.

Management Practices to Minimize Wildfire Risk

- Thinning – The cutting or removal of trees from a stand to control the number, quality, and/or distribution of remaining trees. This lowers wildfire risk by reducing the density of the stand and the woody debris that accumulates on the forest floor.
- Pruning – The removal of low-hanging vegetation to prevent the risk of ladder fuels reaching the crown.
- Fuel Reduction Burning – Prescribed burns to reduce the level of dangerous, combustible fuel buildup on the forest floor. Prescribed burns are typically conducted in pine forests rather than hardwood forests and are low intensity fires causing little damage.
- Firebreaks – The development of a network of firebreaks, natural and man-made to reduce the risk of wildfires spreading. These may also enhance wildlife habitat by providing ecotones and improve access to the property. Firebreaks should be at least 10-12 feet wide. Existing streams, logging roads, skid trails, and cultivated fields serve as firebreaks. Mowing, brush chopping, and disking can also be used to create firebreaks. All overhanging brush and vines should be removed from firebreaks.

Policy

Shortly after the creation of the U.S. Forest Service, devastating fires in the west helped initiate a policy of total fire suppression. In time, the slogan “only you can prevent forest fires” and Smoky the Bear became a highly recognized part of the public awareness campaign for fire prevention. It was later realized that the practice of total suppression may not always be the best management practice. This policy may have added to the intensity and devastation of many wildfires. Today the forest service uses prescribed burns to clear areas of dangerous fuel buildup and allows some wildfires to burn uncontrolled in national parks and wilderness areas. We have come to recognize that fire is a natural, even essential, part of some ecosystems.

Forest Conservation

Almost a quarter of the commercial forests in the United States are found within the 156 national forests. This land is managed by the U.S. Forest Service. Timber companies are allowed to harvest trees, and the Forest Service receives part of the money for its budget from these timber sales. Reforestation of these areas insures the continued supply of timber for the nation and the conservation of our forests for their ecological benefits. The U.S. Forest Service and National Parks Service employ various methods to maintain, protect, and preserve our forest resources for future generations.

Forest Genetics

Tree breeding programs that promote a specific genetic make-up that produces desirable traits have been used for many years. In silviculture, certain practices help to improve the overall genetic makeup of a tract of forestland and thus profitability. These practices are:

1. Taking out undesirable individual trees (poor shape, slow growing, bad form, etc.)
2. Removing diseased trees (taking trees with diseases out of the gene pool)

3. Planting seeds or seedlings from a superior tree with desirable traits (such as faster growing, better form, disease resistance, better quality wood, fewer limbs, insect resistance, etc.)
4. Leaving the best trees as seed trees to restock a newly harvested area
5. Planting the right trees in the right area

Since these practices usually take a long time to see any results, the field of forest genetics has concentrated on increasing the value of the tree as a forest product. The goal is to develop biological improvements in the tree through manipulating the genetic makeup of the seeds/seedlings. Using genetically improved stock to reseed or plant forestland after a harvest will produce a vastly improved forest. For example; taller trees, trees with better forms, faster growing, disease resistant, hardiness against environmental conditions, insect resistant and straighter trees.

An observable trait which can be improved or measured is called a **phenotype.** By studying phenotypes of a tree species, geneticists can discover the **genotype** or combination of genes in a tree cell to manipulate to improve the tree or plant.

The most successful genetic manipulation of forest trees has been in the southern pines. Foresters collect, seeds, twigs, needles and limbs from trees with desirable characteristics to plant or graft to produce trees that have the desired genetic make-up. Seeds are collected from these genetically superior trees and grown into improved seedlings to use for reforestation. These genetically superior or improved seedlings create a straighter, faster growing tree with better form. This shortens the time for the tree to reach maturity and provides for shorter rotations, more wood volume, better wood products, and faster income for the landowner.