Indian River Lagoon Envirothon Study Packet

Forestry Section

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INTRODUCTION

Florida's forests cover a vast area of the Sunshine State and almost one half of the state's 35 million acres is in forest. Florida's forests support an industry that generates more than $4.5 billion annually. Many Floridians owe their income and livelihood to Florida's forests and the products they produce. Wood and wood fibers are turned into more than 10,000 useful products that are used in homes, industry, and schools.

Aside from the wood- and fiber-producing aspects, Florida's forests contribute to the health of the state's ecosystems and provide numerous recreational opportunities. Floridians and tourists regularly visit Florida's national, state, and private forests in search of an outdoor experience. Forests offer canoeing, hiking, horseback riding, off-road motorcycling, camping, and many other activities.

Trees around residences, in city parks, and along streets, as well as in rural areas, cleanse the air of pollutants and act as sound barriers along noisy roadways. Trees shield buildings from sun and offer protection from the cold, reducing cooling and heating costs. In Florida's larger cities, urban forests provide an oasis of green in a desert of steel and concrete.

Forestry is defined as the art and science of managing forests and related natural resources to meet the demands of society. Timber production is merged with wildlife management, soil and water conservation, range management, recreational needs, and other simultaneous land uses in today's forestry management. The benefits of forests and trees to the people of Florida are far-reaching and affect almost every aspect of society.

Forest History

Florida's moderate climate provides for subtropical to tropical forests dominated by pines, palms, cypress, and oaks. Mangroves, sea grape, strangler fig, mahoganies, and other trees commonly occurring in the Caribbean islands are found in extreme south Florida.

Spanish explorer Juan Ponce de Leon discovered and named the land that now is Florida. He is credited with sighting it on Easter Sunday, March 27, 1513, a holiday which the Spanish called "Pasqua de Flores," from which Florida gets its name.

Originally, forests covered about four-fifths of Florida's 35 million acres of land. Throughout some 300 years of struggle by England, Spain, and France for dominance in Florida, the forests were left largely intact. During the American Revolutionary War, Florida forests supplied lumber and ***naval stores*** (products derived from the gum of pines) to England.

After Spain sold Florida to the United States in 1819, the demand for forest products slowly increased. By the middle of the 1830s, Pensacola, on the northern Gulf coast, was becoming a shipping point for exporting lumber to other states and the Caribbean islands. This exploitation was limited mainly to the forested areas near rivers where logs could be floated to sawmills.

After the Civil War, forest exploitation began in Florida on a massive scale. Several large influences combined to bring this about. First, the nation's population was growing and moving westward, creating a large need for lumber to build new cities and homes. Second, large, steam-powered logging equipment was developed. With this machinery, timber companies which had logged virgin timber in the Midwest moved into southern states to harvest the pine stands. Third, the naval stores industry in the Carolinas moved west and south to tap Florida's slash and longleaf pines. Finally, railroads pushed into all parts of Florida, which created a fast, efficient means to transport the wood.

After 1870, lumber production climbed rapidly from less than 200 million board feet a year to a six-fold peak of more than 1.2 billion board feet by 1909. It stayed near this peak for 20 years. Naval stores production of north Florida peaked between 1900 and 1910, when up to 1.5 million barrels of ***rosin*** and ***turpentine*** went to market every year.

During those years, the population of Florida rose from 188,000 to around 1,000,000 people. This growth was a direct result of the forest exploitation, and such coastal cities as Jacksonville, Pensacola, Panama City, and Cedar Key grew rapidly as shipping points for forest products.

During the 1930s, lumber production dwindled rapidly as the big companies ran out of readily available virgin timber. Practically all of them followed “cut out and get out” timbering practices that closely resembled mining. A mining approach, although unthinkable today, was understandable for the times because the lumbermen of that day saw virtually inexhaustible stands of virgin trees everywhere.

When trees ran out, the lumber mills closed down and the companies moved to other parts of the nation, leaving the Florida land barren, nonproductive, and almost valueless. Frequent fires kept forests from regenerating. Vast acreages reverted to local governments for non-payment of taxes.

Landowners and far-sighted lumbermen began working in 1923 to bring about improvements in the situation. The Florida Forestry Association was formed in Jacksonville and, in 1927, played a leading role in the establishment (by legislative act) of the Florida Board of Forestry. The state agency was given the responsibility of controlling fires on land of qualifying landowners, developing methods of reestablishing and improving forests, and making forest information available to the general public. By 1930, this agency was expanding its activities in all three areas with active help and support from local governments, the federal government, and landowners.

Two remarkable men deserve special attention for contributions which heavily influenced the direction of southern forestry. One was Austin Cary, a native of Maine who became a forester. From 1917 on, Cary worked in southern states for the U.S. Forest Service, encouraging long-range planning and good management practices. In Florida and elsewhere, he preached planning, ***sustained-yield*** cutting practices, soil conservation, tree planting with superior seedlings, and similar practices to both landowners and industry. By 1930, he was called the “Father of Southern Forestry.”

The other individual whose work was important to Florida was a soft-spoken Georgian native, Charles H. Herty. A professional teacher like Cary, Herty was also a research chemist. He developed a system of collecting rosin from pines in clay or metal cups. It ended the practice of chopping cavities into the living tree trunk to catch the gum, a practice which resulted in extensive damage to the tree. Eventually, the Herty cup replaced the destructive old “chopped box” practice.

But his largest contribution was pioneering methods to show how southern pines could be turned into good white pulp for the newsprint paper industry. This reduced publishers’ dependence on Canadian newsprint and provided a new market for millions of acres of second-growth pine being produced on the land left ravaged by the earlier lumbermen.

In 1936, Herty also discovered a process to produce a wood-***cellulose*** that was excellent for manufacturing ***rayon***. He died in 1938 before his work reached full application, but this chemist established a new papermaking technology that provides one of the largest markets for Florida's timber production today

Several pulp mills presently operate in Florida, most of them owners of vast acreages of forests, which are carefully managed to provide wood to meet demands indefinitely. In addition, these private forests also serve large numbers of people as recreational areas and improve the quality of the environment.

FOREST ECOSYSTEMS

An ***ecosystem*** is all the interacting populations of plant communities, animals, and micro-organisms occupying an area, plus their physical environment. The problem with defining an ecosystem usually comes in trying to decide where one ecosystem ends and another begins. There will always be a certain degree of interaction between adjacent ecosystems; even a forest and a lake exchange frogs, swallows, and autumn leaves.

The selection of the desired or appropriate scale to set the boundaries of an ecosystem is critical. Whether you consider the watershed scale or the individual branch of the tree, both have unique characteristics of habitat, carrying capacity, limiting factors, range of tolerance, and biodiversity.

The essential component of a forest ecosystem is a tree. A tree is a large, woody, perennial plant, usually with a single stem. The classification of trees is primarily based on the sexual structures of plants. For example, pines and cypress are ***gymnosperms*** because they have "naked" seeds that are not enclosed in an ovary. The seeds are borne on cones, thus giving rise to the name conifer. Oaks, hollies, and maples are ***angiosperms*** because their seeds are encapsulated in an ovary. Classification of trees is discussed in greater detail later. The critical adjective in the definition of a tree is woody. It is the essence of what makes a forest. Two characteristics of trees, strength and durability, allow some tree species to be large and long-lived.

Unlike grasslands, forest ecosystems are unique because of their height. This three-dimensional quality or vertical stratification creates the habitat — the environment in which the life needs of the organisms and their community are supplied.

The stratification effect creates overstory, understory, shrub, and herbaceous layers that form microclimate gradients providing niches for many species. Trees leaves are the site of ***photosynthesis***. The food chain begins with trees absorbing carbon dioxide, water, and minerals to be converted to sugar with the by-product of oxygen. The strength of the wood is thus durable over time. In most forests, over 95% of the biomass is in woody tissue. This material is both shelter and food for an array of organisms — woodpeckers, wood ants, centipedes, etc. This wood — live, dead, erect or standing snag — supports a variety of food chains for a series of plants, animals, bacteria, and fungi.

The forest habitat must provide food, water, shelter, and space. The type, amount, and condition of these components determine the carrying capacity of a forest ecosystem. The carrying capacity varies due to certain limiting factors. For example, some of the limiting factors in Florida forests include presence of fire and disturbances — naturally occurring disease or hurricanes, and human-caused like compaction or clear-cutting.

SUCCESSION

All plants and animals live in an environment to which they are specifically adapted. As environmental conditions change, so do the species of animals and plants. The process by which plant communities gradually change over a period of time is called ***succession***. The stages of succession, beginning with bare land, can take many decades to reach the ***climax stage***. When a forest is in the climax stage, succession essentially stops. A climax forest community is stable, contains trees that only perpetuate themselves, and may persist for hundreds of years.

To illustrate the various stages of succession, we will examine the changes that take place following the abandonment of a cultivated field. The first plants to occupy the field are weeds and grasses. These plants are called ***pioneer species***. Within three to five years, a few small pine trees become established. These trees are hardy and are able to withstand full sunlight and effects of the weather. As they colonize the area they begin to provide shade. Pioneer weed and grass species are unable to flourish with additional shade and are gradually replaced with shade-tolerant weeds and grasses.

After 10 to 15 years, shrubs and young trees become the dominant species. Weeds and grasses have been mostly eliminated due to decreasing amounts of sunlight. Eventually, individual trees grow above the shrub level. These trees receive more sunlight and rapidly out-compete shrubby plants. Later, older pines reach sexual maturity and develop cones. Their seeds are spread to other areas of the field. Deer and other wildlife routinely wander throughout the area seeking food and shelter. As pines continue to grow, they shade the forest floor and eventually create suitable conditions for hardwood trees. Young oaks and hickories appear and additional animal species feed on acorns and nuts. This aids in seed dispersal. Assuming fire is absent, hardwood trees continue to develop within the pine forest.

Thirty years passed before the cultivated field turned into a pine-type forest. But in nature, communities are constantly changing.

Hardwoods slowly replace the pines. In time, oaks and hickories may be more numerous than pines. Shade from broad-leafed trees is too much for young pines to survive. In addition, pine seeds released from cones are unable to penetrate the heavy leaf litter on the forest floor and fail to germinate. With successional changes in plant communities, the types of wildlife visiting these communities also changes.

Hardwoods have replaced pines 50 to 75 years later. Animal species once associated with early successional stages are gone. Long-lived hardwoods shade the forest floor and little change is noticeable as these trees continue to create conditions that fulfill their own needs. This area is now considered a climax community and remains in this state until a disturbing force such as fire, hurricane, or human influence causes succession to begin anew. See Figure 4.1.

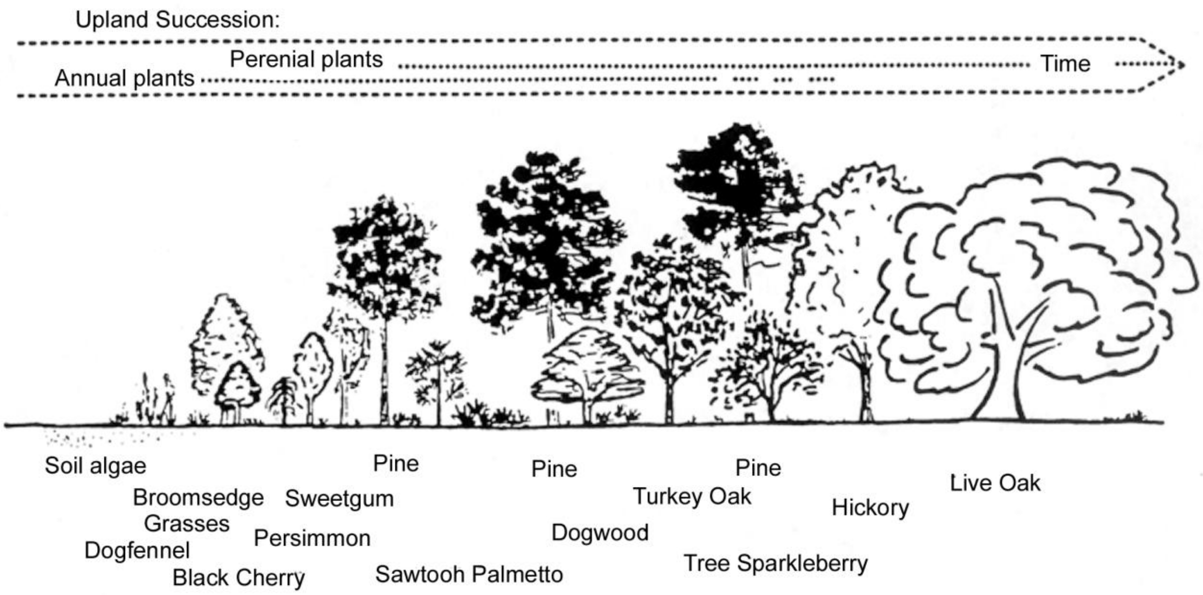


Figure 4.1 Vegetative communities change with time; this change is called succession.

Two other concepts are important in understanding forest ecosystems and their interrelationships to other ecosystems: range of tolerance and biodiversity.

A forest ecosystem has a range of tolerance which consists of the minimum and maximum environmental conditions necessary for an organism to survive. These include climate conditions, soil conditions, fire, and water conditions. These growth factors are discussed later in the text. Within this range of tolerance, certain adaptations are developed over time to help species compete successfully and survive in an ecosystem. An ***adaptation*** is an inherited characteristic of an organism that enables it to function more effectively in its environment. An excellent example of adaptation is the coloring of the pine barrens tree frog against the trunk of a longleaf pine. The frog is almost invisible to the untrained eye.

The differentiation of habitat and the vertical separation that occurs within a forest ecosystem develops a variety of ***niches***, or special places, uniquely suited to a given species. For example, the insect fauna often change dramatically from top to bottom in a forest. These niches give rise to biological diversity. This variety within living things and their habitats is particularly important in Florida. Forest ecosystems destroyed by urbanization due to population growth in Florida are a challenge to be met by the environmental citizens of tomorrow — our Envirothon students of today.

INFLUENCES ON FOREST GROWTH

Florida has wide variations in geology, topography, climate, soils, and vegetation. Each factor influences others and all factors influence the type of tree species that can survive in the area. For instance, geology and topography influence soil characteristics, soil characteristics influence topography and vegetation, and so on.

Topography (or land configuration) in Florida is not rugged, but portions of the state are somewhat rolling. A physical relief map of the state will show the hills of the northern panhandle, the vast flat areas of northeast, central, and south Florida, the sandhills of the central Florida ridge, the lowlands of the Everglades, and the valleys forming the state's major river systems. Soils in Florida vary with topography.

SOIL FACTORS

The major characteristics in discussing soil are texture, fertility, drainage, slope, and acidity. Each of these characteristics should be considered when developing management plans for a particular forest species. For instance, during the late 1950s and early 1960s, thousands of acres in Florida's sandhills were planted in slash pine, a species naturally found in moist areas. Now some of these areas are being converted to longleaf pine; a species better suited to dry soils.

Soil directly affects the tree by anchoring it and by serving as a growth medium. In addition to being a reservoir for moisture, soil provides all the essential elements for tree growth except oxygen and carbon which is supplied by the air. Soil characteristics, such as texture, structure, chemical composition, depth, and position, influence tree growth by affecting the supply of moisture and nutrients available to it.

Soil drainage is influenced by soil texture, elevation, and slope. Poorly drained soils are not usually recommended for pine trees. Trees such as bald cypress may be better suited. Poorly drained areas may also limit heavy equipment access for tree harvesting or site preparation.

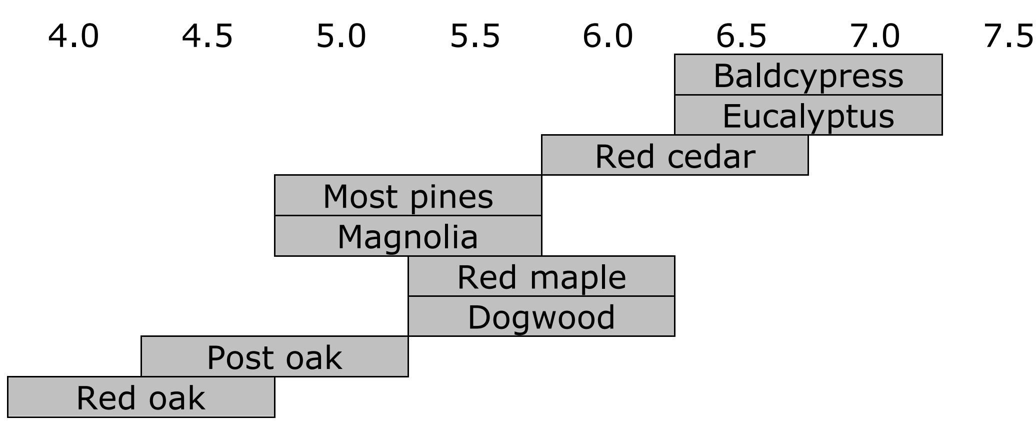
Soil texture describes the distribution of different sized soil particles (sand, silt, clay). Sandy soils are usually dry and support trees that are drought-tolerant. Sand pine and longleaf pine usually dominate these sites. However, sand near the surface does not always indicate dry soil. A ***hardpan*** of clay or limestone rock within six feet of the soil surface can drastically affect tree growing conditions. A hardpan is an impermeable or semi-impermeable layer that can hold water near the soil surface.

The amount of ***organic matter*** found on the surface affects a soil's fertility. This layer contains most nutrients required by trees. If organic matter is removed or washed away, the fertility of the soil drops.

Slope affects the drainage, available moisture, erosion, and nutrient content of forest soils. Water running down a steep slope will erode the soil and wash nutrients from the top of the slope, transporting them to the bottom, where they accumulate. This is why bottomlands are generally more fertile than hilltops.

The soil's ***pH*** is a measure of a soil's alkalinity or acidity. Soils with restricted drainage, such as pine flatwoods, are typically acidic, a result of decaying vegetation in a flooded environment. A low or ***acidic*** pH can restrict a tree's ability to absorb certain soil nutrients such as phosphorus. A high or ***alkaline*** pH can restrict a tree's ability to absorb iron. In some cases, the forester might consider applying soil amendments (sludge, lime, urea, etc.) to the soil in order to raise or lower pH. This practice can be costly and must be carefully considered before implementing.

Table 4.1. Preferred soil pH for various trees (acidity/alkalinity)



How to Examine Forest Soils

Soils are examined to determine which tree species are best suited for particular sites. When a site is selected, it is examined using the following steps:

1. Examine the amount and quality of the organic material on the soil's surface. If there is none, this may indicate the area has been (1) burned and the material removed or (2) the soil has been turned over, filled, or disturbed in some manner.

   When the organic matter in a soil is well decomposed, it usually indicates a moist, fertile site. If there are thick layers of undecomposed forest litter, it usually indicates a drier, less fertile site with some potential for later wildfire losses.

2. Examine the uppermost layer of mineral soil. Squeeze the soil between your fingers and notice the texture. Refer to the soil texture table to determine the effects of the soil texture on soil conditions.

Table 4.2. Surface soil texture

Surface Texture	Water-Holding Capacity	Tree Species to Manage
Sand*	Poor	Longleaf pine, sand pine
Silt	Good to excellent	Slash pine, loblolly pine
Clay	Excellent	Loblolly pine

*Provided that a change in soil structure does not occur within 5 feet

3. Examine the soil color. A rule of thumb is, the darker the soil, the more fertile it will be. Table 4.3 lists the relationship of topsoil conditions to color.

Table 4.3. Topsoil conditions

Color	Topsoil Condition					
	Organic Matter Amount	Erosion Factor	Aeration	Available Nitrogen	Fertility	Tree Species to Manage
Dark (black, brown, grey)	Excellent	Low	Excellent	Excellent	Excellent	Slash pine
Moderately dark	Good	Medium	Good	Good	Good	Slash and, longleaf pine
Light to pale (brown to yellow)	Low	High	Low	Low	Low	Longleaf and sand pine

4. Use the soil augur or sampling tube to examine subsurface conditions and measure the depth at which any of the following occur:
   - Obvious changes in soil texture
   - Mottling, streaking, or flecking by other colors
   - Moisture or saturation of the soil

5. Refer to the tree species selection table (Table 4.4) to determine a recommendation for this particular soil.

Table 4.4. Tree species selection

Depth to a Hard Clay Layer, Clay Mottling, or Evidence of Water	Tree Species to Manage
Less than 6 inches	Cypress
6 inches to 3 feet	Slash pine
3 to 5 feet	Slash pine, longleaf pine
5 to 8 feet	Longleaf pine
Greater than 8 feet	Sand pine

THE TREE

Any discussion of forestry and forests would be incomplete without a look at the major forest component, the tree itself. A ***tree*** is defined as a woody perennial plant with a single trunk, a well-defined crown, and reaching at least 8 feet in height. A shrub is usually less than 8 feet high and may have multiple stems or branches that originate at or near the ground line.

Roots

Roots absorb water, nutrients, and oxygen, all of which the tree must have to carry on its life processes. Roots also help to anchor the tree against wind and water.

Rooting characteristics vary with the species, soil texture, and moisture. Most trees have a main supportive ***taproot*** that penetrates deep into the soil. However, in wetter areas, the taproot may be virtually non-existent, due to the readily available surface moisture and the lack of oxygen in the water-logged soil; this is one reason trees in wet areas are more likely to blow over than trees on drier ground.

Another component of the root system is the ***feeder roots***. These are also known as the surface or lateral roots and generally absorb most of the nutrients and moisture. Feeder roots grow from both the trunk and the taproot and are primarily found within the top few inches of soil. The entire root system generally extends out from the trunk to the outermost reaches of the tree's canopy. This outer perimeter is commonly referred to as the ***drip line***.

Most broadleaf trees have roots with many ***root hairs*** which absorb water and nutrients. Pines, on the other hand, have roots with few root hairs and rely primarily on beneficial fungi called ***mychorrizae*** to assist in water and nutrient absorption.

Tree roots, like other parts of the tree, require oxygen to aid in food absorption, respiration, and growth. When the soil surrounding the tree becomes flooded or extremely compacted, the roots can die from lack of oxygen, resulting in the death of the entire tree. Some trees, such as the baldcypress, tolerate flooding over their roots indefinitely; it is thought that the cypress knees may contribute to this ability.

Trunk

The tree trunk, also called the stem or bole, supports the crown. The trunk allows water and nutrients to go from the roots to the crown and transports food from the trunk crown back to the roots.

The ***xylem*** (zy'-lum) is the woody portion of the tree. It consists of two types of wood, the ***sapwood*** and the ***heartwood***. The sapwood is the living outer portion of the xylem that is the active water- and nutrient-conducting tissue. Water and nutrients absorbed by the roots are transported upward through the tube-like cells of the sapwood to the leaves. Part of the upward movement of the water is due to pressure built up in the roots, part is due to water surface tension, and part is due to capillary action, the same process by which a lamp wick draws kerosene. Part of the energy for water transport is due to the pumping actions of the

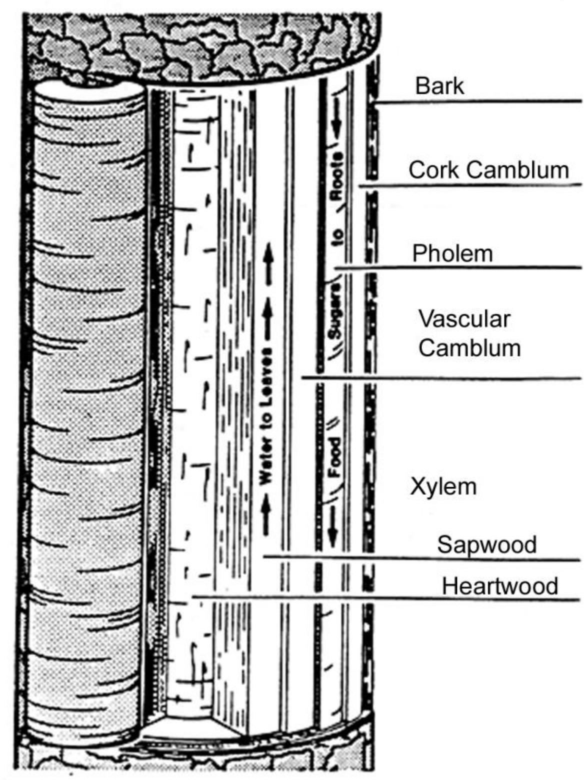


Figure 4.2. The trunk of the tree supports the crown and also transports fluids and nutrients to and from the leaves and the roots.

xylem cells, which are interconnected from root hair to leaf tip. See Figure 4.2.

The heartwood is inactive or dead sapwood and is formed as the tree matures. Heartwood is often darker in color than sapwood due to an accumulation of chemicals and nutrients, and its main function to the rest of the tree is support. The heartwood is often resistant to decay and is usually more valuable than the sapwood. Some tree species, such as pine, have heartwood and sapwood that are sometimes difficult to tell apart.

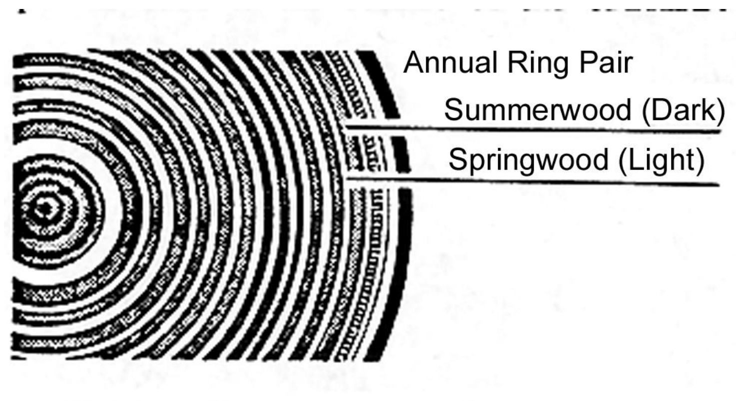


Figure 4.3. Annual rings consist of two separate rings — a light ring and a dark ring, grown each year.

Further examination of the xylem (both heartwood and sapwood) reveals a series of ***annual rings***. As the name suggests, a tree grows new rings each growing season. Each ring consists of a light band and a dark band of distinctly different types of wood. The lighter colored, less-dense wood in the annual ring is called ***springwood*** or ***early wood***. Later in the season, growth slows down, resulting in a darker, more-dense wood called ***summerwood*** or ***late wood***. Foresters determine the tree's age and growth rate by counting and measuring annual rings. A wide annual ring indicates an excellent growth year, while a narrow ring indicates a poor year and may be due to such factors as insects, disease, competition from other trees, or weather conditions. See Figure 4.3.

The annual diameter growth of the tree stem occurs in the ***cambium***, also called the vascular cambium. In this zone, the cambium cells divide and differentiate into xylem cells on the inside of the cambium and ***phloem*** cells to the outside of the cambium.

The phloem (FLOW-em) is the "inner bark" of the tree and contains the tissue that conducts food manufactured in the crown to the rest of the tree. Phloem cells resemble xylem cells, but they do not accumulate as wood. They exist as a narrow band of spongy tissue just inside the bark. If this tissue is completely severed around the entire circumference of the tree, the flow of food to the roots is cut off. The roots soon die, thereby killing the tree. The severing of the phloem tissue around the trunk is called ***girdling***.

Bark

The ***bark*** is the protective, waterproof covering on the outside of the trunk. It consists of dead cells that arise from a separate ***cork cambium***. Some tree species have a highly active cork cambium and are characterized by tight, unbroken bark. An example is the American hornbeam (also called blue beech). Other trees have cork cambiums that do not keep pace with the diameter growth from the vascular cambiums. The result is a deeply fissured or cracked bark, or bark that breaks into plates. Slash pine is a prime example of this type of bark.

Bark prevents the tree from drying out and helps protect it from insects and diseases, freezing, and damage by fire. The thick insulating bark of longleaf pine is one of the reasons for the tree's high resistance to fire.

Crown

The ***crown*** is the site of the active food-making mechanism for the tree. Leaves, which are the tree's food-making factories, are the main component of the crown. The food-making process is called ***photosynthesis***. Photosynthesis is a complex chemical process that converts water, minerals, and carbon dioxide into sugars, which are the tree's food. Carbon dioxide enters the leaf through small openings called ***stomata*** and is used by plants for photosynthesis. Oxygen is emitted into the air as a by-product. This release of oxygen is essential to all animal life.

Photosynthesis requires sunlight to power the photosynthetic process. ***Chlorophyll***, the green substance in the leaves, is a complex cellular material that acts as a catalyst in photosynthesis; that is, it participates in the chemical reaction but is neither changed nor consumed.

Most of the water available to the leaf is released through the stomata to the atmosphere as water vapor. This process is called ***evapotranspiration***. Evaporation of the water cools the leaf's surface and helps to transport water from the roots to the leaves.

An average size oak tree can transpire hundreds of gallons of water per day during the summer months. Imagine the volume of water released to the atmosphere in an oak forest growing 150–200 trees per acre. Evapotranspiration is one of the ways that trees cool the air around them. Trees can control the amount of transpiration by either opening or closing the stomata. Evapotranspiration is critical to the tree's survival during periods of drought.

The crown is also the site of active growth of the tree. Height growth and crown spread occur from the ***terminal bud*** at the tips of the branches. The terminal bud is the tree's only point of elongation above the ground. It comes as a surprise to many people that a nail driven into a tree will be at the same height many years later. In other words, trees do not grow up from the ground, they grow by adding new cells on top of old cells at the branch tips. See Figure 4.4.

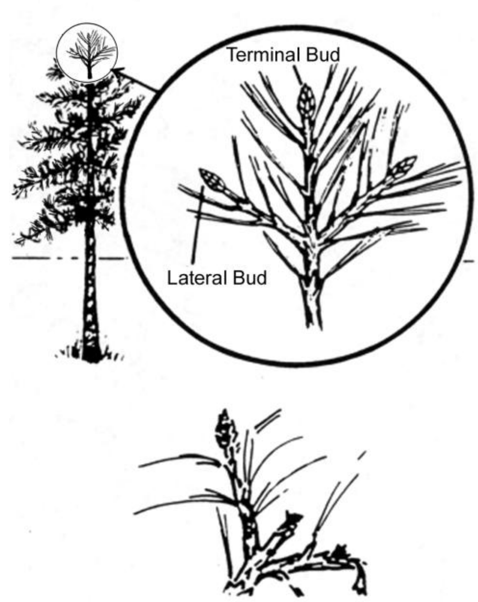


Figure 4.4. The tree grows upward at the terminal bud; if this bud is damaged, a lateral bud grows to take its place.

If the terminal bud is damaged or removed, ***lateral buds*** will grow to replace the terminal bud and become the dominant points of growth. Landscapers and Christmas tree growers take advantage of this characteristic and regularly shear terminal buds, producing a fuller, more pleasing tree.

Tree species, tree age, vigor, and competition are the most important factors in determining the position of tree crowns. The following classifications are commonly used:

- ***Dominant*** — larger trees with crowns forming the upper level of the forest canopy, receiving full sunlight from above and partly from the side
- ***Co-dominant*** — trees with medium-sized crowns, forming the general level of the crown cover or canopy, receiving full sunlight from above but little from the sides
- ***Intermediate*** — shorter, smaller crowned trees just extending into the general canopy level and receiving little direct sunlight from above
- ***Overtopped*** — small trees with crowns below the general canopy level and receiving no direct sunlight

Reproduction

The crown produces flowers, fruits, and seeds, the result of the tree's efforts to propagate. Some trees, such as the magnolia, have both the male and female reproductive organs in the same flower. These trees are said to have ***perfect flowers***. Other trees have male and female structures in different flowers, and these are called ***imperfect flowers***. Trees with imperfect flowers fall into two categories:

1. ***Monoecious*** — trees such as slash pine, with separate male and female flowers on the same tree
2. ***Dioecious*** — species that have only one type of flower on individual trees, either male or female, for example, the American holly — only the female tree bears the bright red berries.

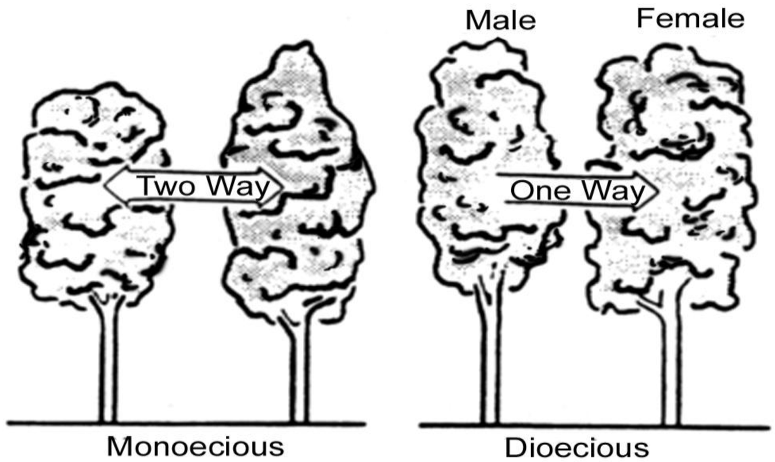


Figure 4.5. Pollination of monoecious and dioecious species

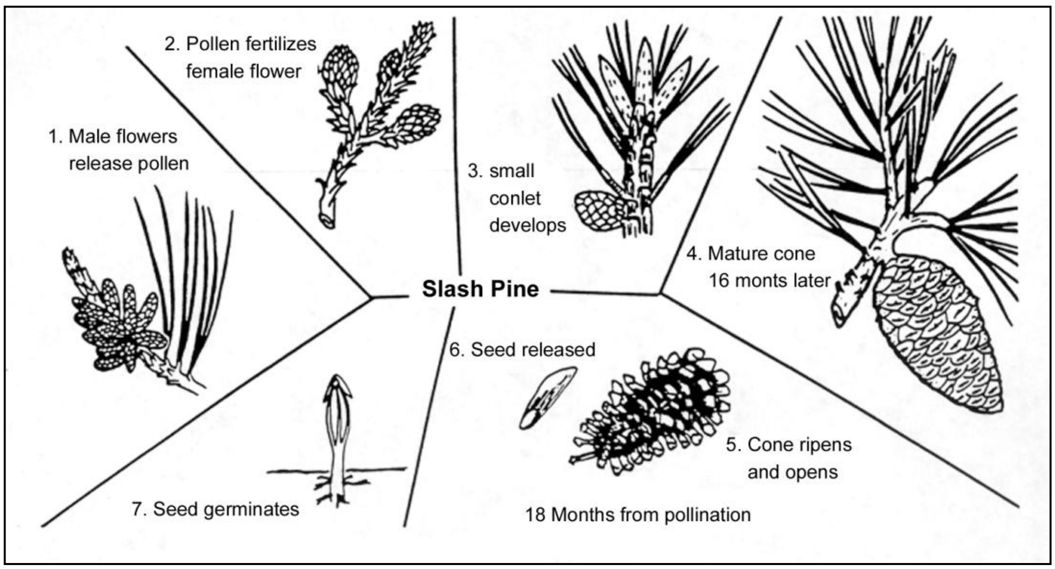


Figure 4.6. Reproductive cycle for slash pine, a monoecious conifer.

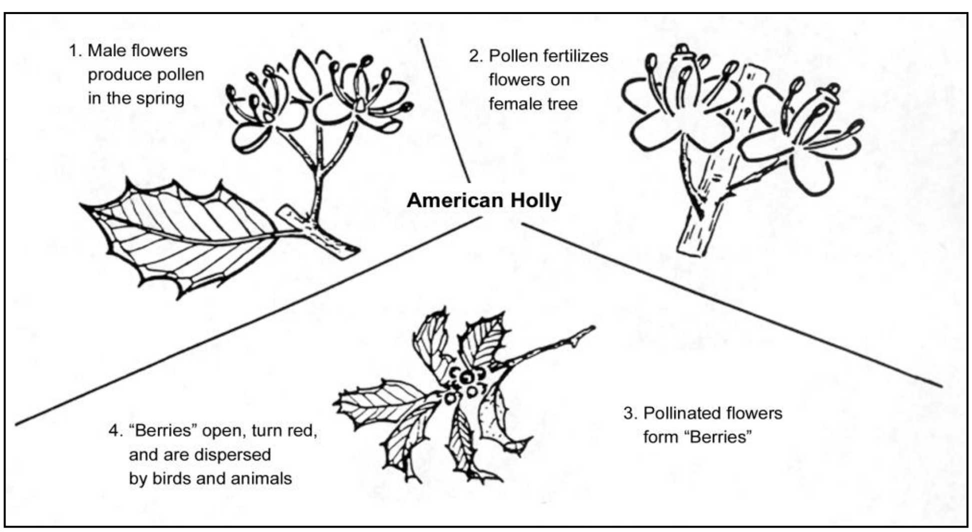


Figure 4.7. Reproductive cycle for American holly, a dioecious hardwood.

Male flowers or flower parts produce ***pollen*** — powdery reproductive particles. The pollen is carried by wind, gravity, rain, insects, or animals to female flowers or flower parts. The female flower or flower parts are fertilized by the pollen to produce a seed or seeds. This mechanism differs between conifers and broadleaf trees, but the end result is the same: the production of a fertile seed. See Figure 4.7.

Most broadleaf trees produce a seed during the same year that the flower is pollinated. Pines take 2 years to develop mature cones, following the fertilization of the female flowers. See Figure 4.6.

Tree seeds, like other seeds, use various means of dispersal. They may be scattered by wind, water, gravity, animals, or man. Sometimes a seed may lie dormant on the ground for several years, waiting for favorable growing conditions. Some seeds require a special event before germination. For example, Southern red cedar seeds require a period of low temperatures before germination is activated. This event is called ***stratification***. Some tree seeds, such as cherry, Dahoon holly and red mulberry must have the fleshy fruit removed before the seed can germinate. This task is accomplished by animals that ingest the berries. The fleshy part is digested and the seed is exposed to acids in the stomach. The seed then passes through the animal and is deposited on the ground. This is known as ***scarification***. Another form of scarification is fire.

Trees may also reproduce without seed. Broadleaf trees, in particular, have the capability to sprout from cut stumps or lateral roots. This type of regeneration is called ***coppice***. The largest organism in the world is a 106-acre aspen tree in southern Utah that reproduced 47,000 clones of itself through coppice regeneration. Pines and other evergreens do not sprout, as a rule. However, there are exceptions, such as shortleaf, Virginia, and pond pines. Willow and cottonwood trees are particularly easy to produce by sprouts or root suckers.

DENDROLOGY

The science of tree identification is called ***dendrology***. This chapter discusses the following items helpful for tree identification: tree groups, tree names, tree characteristics, and dichotomous keys.

Tree Groups

Trees are divided into two main groups, ***angiosperms*** and ***gymnosperms***. Angiosperms are also called hardwoods or broadleaf trees. They typically have broad, flat leaves (See Figure 4.8) that are either simple or compound. Their wood is dense compared to that of gymnosperms. Broadleaf trees generally lose their leaves in the winter, a condition termed ***deciduous***. Examples of angiosperms include live oak, magnolias, maples, ashes, sycamores, and mangroves. Trees may be divided into two main groups, broadleaf and conifer. Other names for broadleaf trees are deciduous, hardwood, and angiosperm. Other names for the conifer are evergreen, softwood, and gymnosperm.

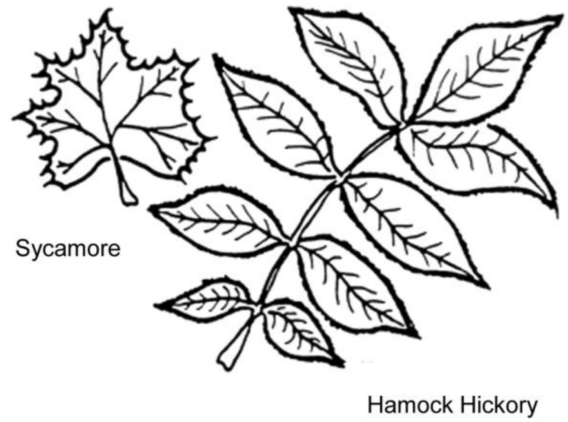


Figure 4.8. Hardwoods typically have broad, deciduous leaves, either simple or compound. They are also called deciduous or broadleaf trees.

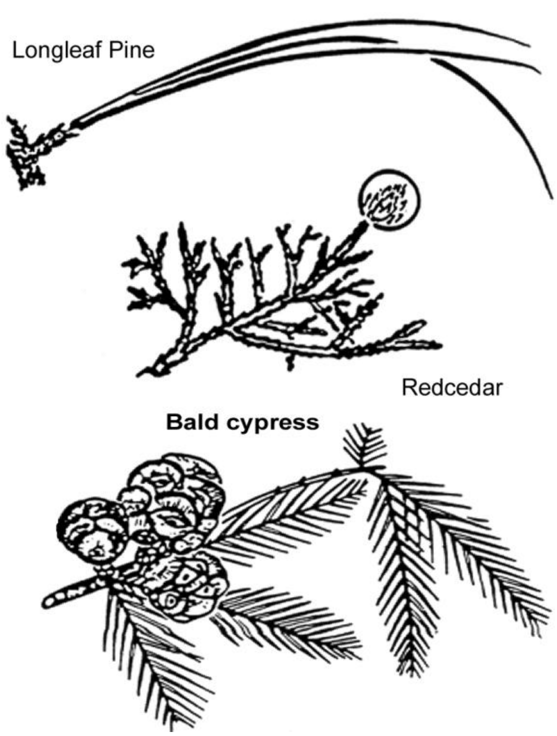


Figure 4.9. Conifers have persistent needles or scale-like leaves and are sometimes called evergreens or softwoods.

Gymnosperms are also called softwoods or conifers. Their leaves are needle-like, scale-like, or feather-like (See Figure 4.9). Unlike angiosperms, they bear cones and have relatively soft wood. Conifers retain their leaves during the winter and are often called **evergreens**. Examples of evergreens in our area include pines, cypress, and red cedar.

Several trees listed in the two groups do not totally conform to these descriptions. For instance, southern magnolia and live oak, considered broadleaf trees, do not lose their leaves in the fall. Baldcypress, considered a conifer, does. Red cedar, a conifer, does not bear cones at all; it bears a fleshy fruit instead. Hardwoods such as cottonwood and willow have wood that is much softer than that of longleaf pine, a softwood tree with rather dense, hard wood.

Palms are not included in these groups of trees. Palms - including our state "tree" the sabal palm - do not have a vascular cambium. They have vascular bundles, tubes that are grouped together and run up the length of the "tree". It is because of this difference that palms are not considered a true "tree".

TREE NAMES

Trees, much like humans, have common names and scientific names. For example, Debbie, Eric, and Becky are common names, but their scientific name is *Homo sapiens*. South Florida slash pine, southern pine, yellow pine, slash pine, and Dade County pine are all common names of one tree whose scientific name is *Pinus elliottii* variety *densa*. Each tree has only one scientific name. Scientific names are frequently used by foresters and biologists to eliminate confusion when speaking about specific trees.

A scientific name consists of two parts, ***genus*** and ***species***. Sand pine's scientific name is *Pinus clausa*. *Pinus* is the genus, *clausa* is the species. Some trees share the same genus such as longleaf pine, *Pinus palustris*, and slash pine, *Pinus elliottii*. Examples of scientific names are given in the dichotomous key at the end of the Forestry Section.

TREE CHARACTERISTICS

When identifying trees, foresters use the tree's characteristics to aid them. Characteristics include: leaves, bark, twigs, flowers, fruits, and tree shape. Leaves are the easiest characteristic to use in tree identification. They can have varying sizes, shapes, margins or leaf edges, orientations on the branch, and simple or compound leaves. Please refer to the Appendix for examples of leaf characteristics.

Conifer leaves vary in shape, but Florida's most important conifers (longleaf, loblolly, slash, and sand pines) all have needles of similar form. Florida's other important conifers, bald cypress and red cedar, are easily distinguished by their leaf shape. Pine needles arise from the branch in little bundles or bunches called ***fascicles***. Needle length and the number of needles per fascicle will distinguish the various pine species.

When identifying hardwoods by their leaves, one must first determine whether the leaf is ***simple*** or ***compound***. Simple leaves are defined as having one leaf per ***petiole***. Whereas a compound leaf will have many ***leaflets*** per petiole. It is important to distinguish leaflets from simple leaves. Beginners make the error of examining leaflets on a compound leaf, mistaking them for a simple leaf. This can be avoided by following the petiole back to the leaf bud. The leaf bud is positioned between the petiole and the twig. Drawings of leafs parts can be found in the appendix.

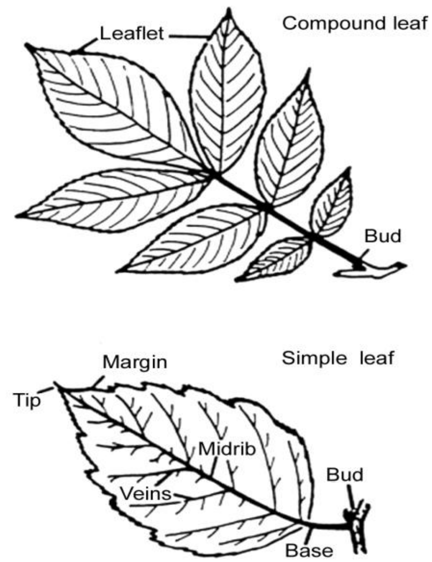
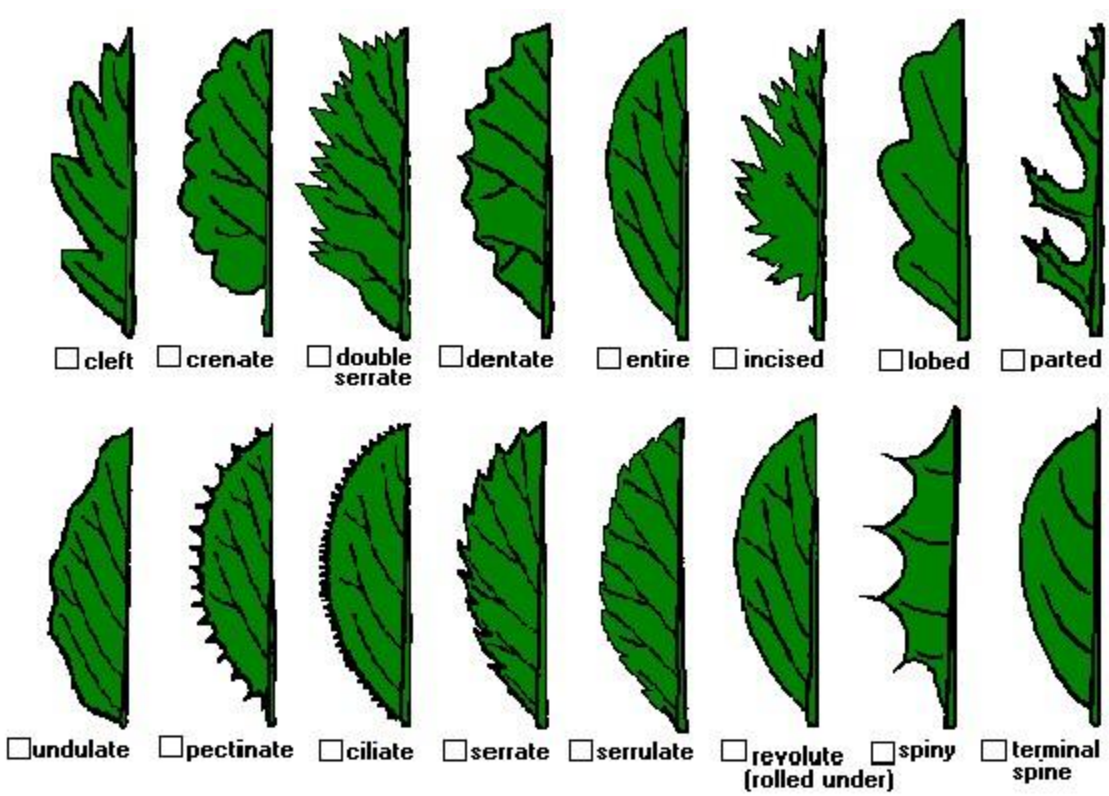


Figure 4.10. Hardwood leaves are either simple or compound.

The ***leaf margin***, or edge of the leaf, is useful in identifying hardwood trees. Examples are shown below:



There are 3 common types of leaf ***orientations***: ***opposite***, ***alternate***, and ***whorled***. Most trees have an alternate leaf orientation. Opposite leaf orientations can be found on maples, ashes, dogwoods (M.A.D.), and mangroves. Catalpa trees have a whorled leaf orientation, but do not occur naturally in our area.

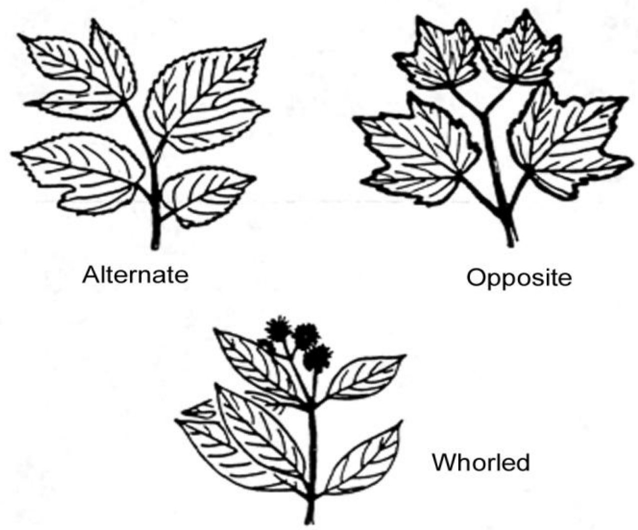


Figure 3.11. Leaf orientations.

Trees may also be identified by observing the site in which they grow. For example, dry, sandy soils are often colonized by longleaf and sand pines. Tidal areas along estuarine waters will contain mangroves. Moist, rich soils may support red bay, live oak, and red mulberry. Be aware that trees planted in landscaped areas may be growing outside of their preferred conditions.

DICHOTOMOUS KEY

A dichotomous key is a chart that botanists and foresters use to identify trees according to a tree's group and characteristics. Here's how the dichotomous key works:

Pretend you are looking at a broadleaf tree whose leaves have U-shaped lobes, toothed leaf margins, and are arranged in an alternate fashion on the twig. What tree is it?

First decide which dichotomous key is the appropriate one to use...conifer or hardwood? Hardwood!!
Next, go to the #1 on the hardwood key...are the leaves and twigs alternate or opposite? Alternate!! Good! Proceed to #3 on the hardwood key.
Are the leaves lobed or unlobed? According to our observation, the leaves are unlobed. The number in the right-hand margin indicates that we must proceed to #4.
The #4 description that matches our described tree is that of the red mulberry, *Morus rubra*.

Below is the dichotomous key that will be handed out at the Envirothon competition. You will be allowed to use this key to identify trees at the Forestry site. This key will not identify all trees in Indian River, Martin, Okeechobee, and St. Lucie counties. This key is intended for use in the Indian River Lagoon Envirothon.

CONIFER KEY

1. Leaves needle-like, in fascicles ________________________________ 2
1. Leaves feather-like or scale-like ________________________________ 4

2. Needles in fascicles of three only.___**LONGLEAF PINE (*Pinus palustris*)**
2. Needles in fascicles of 2, or 2 and 3________________________________3

3. Needles in fascicles of 2; needles 2-3 inches long;
   cones 2-3 inches long___________________**SAND PINE (*Pinus clausa*)**
3. Needles in fascicles of 2 and 3; needles 8-12 inches long;
   cones 3-6 inches long _________________ **SLASH PINE (*Pinus elliottii*)**

4. Needles are feather-like; deciduous; cones are ball-like,
   3/4-1 inch long______________**BALD CYPRESS (*Taxodium distichum*)**
4. Needles are scale-like____5

5. Needles are scale-like in two fashions; the most common is dark green clasping tightly to the stem. The other kind appearing on young stems or vigorous growth is awl-shaped and sharp-pointed; fruit is a small gray-blue berry ______________________________________ **SOUTHERN RED CEDAR (*Juniperous silicicola*)**

HARDWOOD KEY

1. Leaves and twigs are opposite______________________________________2
1. Leaves and twigs are alternate______________________________________3

2. Leaves are compound and 7-12 inches long; 5-7 leaflets per leaf _____________**CAROLINA ASH (*Fraxinus caroliniana*)**
2. Leaves are simple____11

3. Leaves are lobed____ 4
3. Leaves are unlobed____6

4. Lobes on leaves are V-shaped____________________________________5
4. Lobes on leaves are U-shaped, toothed leaf margins____________________________**RED MULBERRY (*Morus rubra*)**

5. Leaves 3-5 lobes, 4-9 inches long and broad, light green and smooth above and paler below ___ **SYCAMORE (*Platanus occidentalis*)**
5. Leaves star-shaped, 5-7 lobes_**SWEET GUM (*Liquidambar stryaciflua*)**

6. Tree is evergreen____7
6. Tree is deciduous____10

7. Leaf margins are entire____8
7. Leaf margins are pointed or toothed_____________________________9

8. Leaves are 3-4 inches long, oblong-lanceolate, apex is acuminate; leaves are edible used in cooking, fruit is a dark blue berry (drupe) ____________________________________**RED BAY (*Persea borbonia*)**
8. Leaves are 2-3 inches long, leathery, oblong-obovate, apex is obtuse (immature leaves may have a toothed margin); fruit is an acorn __________________________________**LIVE OAK (*Quercus virginiana*)**

9. Leaves are 4-6 inches long, finely toothed; fruit is a woody capsule that splits and releases seed ______ **LOBLOLLY BAY (*Gordonia lasianthes*)**
9. Leaves are 1½ - 3 inches long, toothed above the middle toward the apex; fruit is a red berry ____________**DAHOON HOLLY (*Ilex cassine*)**
9. Leaves 2-4 in. long, ½ in. wide, coarsely serrate-toothed; fruit is a 1/8 inch berry covered with a bluish wax ________________________________**WAX MYRTLE (*Myrica cerifera*)**

10. Lvs. are 2-3 in. long; entire leaf margin (immature leaves may have toothed margins); fruit is an acorn _**LAUREL OAK (*Quercus laurifolia*)**
10. Leaves are 2½-5 in. long; entire leaf margin or just a few teeth towards the apex; fruit is a berry___**SUGARBERRY (*Celtis laevigata*)**

11. Leaves have 3 lobes__________________**RED MAPLE (*Acer rubrum*)**
11. Leaves are unlobed____12

12. Leaves dark green on both sides, thick & leathery; proproots extend downward from the trunk; seeds pencil-shaped; ________________________**RED MANGROVE (*Rhizophora mangle*)**
12. Lvs. dark green on top, but distinctively pale and silver-green underneath; leaf surface often coated with salt; lvs. Narrow and oblong____________**BLACK MANGROVE (*Avicennia germinans*)**
12. Leaves are oval & have a small notch at the leaf tip; two small salt glands are visible on either side of the stem below the leaf blade___**WHITE MANGROVE (*Laguncularia racemosa*)**

FOREST COMMUNITY TYPES

The composition of ***forest communities*** depend on soil, climate, and successional stage. When left untouched, forest communities are comprised of multiple species. Sometimes, man's influence can create forest communities dominated by a single species. These communities are called ***monocultures***.

Regional forest communities are identified in Figure 5.1. Keep in mind that these communities contain thousands of microcommunities too small to be shown. Despite differences, these microcommunities all have similarities that fit into a few broad, generalized communities.

COMMUNITY TYPES IN OUR FOUR-COUNTY AREA

Sand Hill Communities

These areas commonly occur in Indian River, St. Lucie, and Martin Counties along the coast. There are patches of sandhill communities near Fort Drum in Okeechobee County. They have extremely dry, sandy soils. Common tree species include sand pine, turkey oak, bluejack oak, longleaf pine, and sand live oak. Sand pine grows extremely fast in these areas and is the best-suited tree for these sites. Sandhill communities also provide habitat for endangered and threatened species such as the scrub jay, gopher tortoise, gopher frog, and the Florida mouse.

Mixed Hardwood-Pine Communities

These communities are located in north and west Florida on the southern coastal plain. As the name suggests, they are a mixture of pine and hardwood trees. Species include longleaf, loblolly, and slash pine, water and laurel oak, mockernut hickory, sweetgum, magnolia, and black cherry. Mixed hardwood-pine communities in west Florida are often converted to southern pines, producing excellent stands of longleaf, slash, and loblolly pine.

Flatwood Communities

The typical species in flatwoods are slash pine with an understory of gallberry and palmetto. Other species include wax myrtle and cabbage palm. This forest community is the most common in our four county area. Longleaf pine exists in drier areas of flatwoods in northern Okeechobee and Indian River counties. Red cockaded woodpecker, indigo snake, and gopher tortoise frequent this habitat. Melaleuca, Australian pine, and Brazilian pepper have invaded many of these areas in South Florida and out-compete native trees.

Hammocks

A ***hammock*** is a slight elevation arising from wetter soil and covered with hardwood trees which may be frequently associated with one or more palm species. Hammocks are usually associated with limestone outcrops. They are most noticeable in the flatwoods or in treeless areas, but are found in swamps. The hammocks are extremely dense and have great diversity in tree species. South Florida hammocks in our area may be dominated by one or more temperate zone species such as live oak, red maple, mulberry, and hackberry.

Cypress Swamps

Cypress swamps may consist of either bald or pond cypress, with few other species present. The cypress community often assumes a dome-shaped appearance when the swamp is in an isolated depression. Cypress swamps not only produce valuable timber, but also are considered water recharge areas.

Cypress may take on a dwarfed or "hatrack" appearance and stand only a few feet high despite many years of age. Such stunting is due to rock formations just below the soil surface which limit growth.

Hardwood Swamps

Hardwood swamps are found on moist to flooded soils near or adjacent to a river or creek. These communities are dependent on periodic flooding. A great diversity of species is found in these areas. Among the species found are baldcypress, loblolly bay, redbay, red maple, sweetbay magnolia, Dahoon holly and Carolina ash. These areas are generally attractive to wildlife.

Mangrove Swamps

Three types of mangroves are prominent in mangrove swamps: red, black, and white. Red mangroves can be identified by prop roots that grow down from larger branches. Black mangroves can be identified by ***pneumatophores*** extending above the soil surface. Pneumatophores are roots, resembling pencils, that project above the soil surface. White mangroves can be found growing upland of red and black mangroves. These areas are common along estuarine shorelines that are sheltered from wave action.

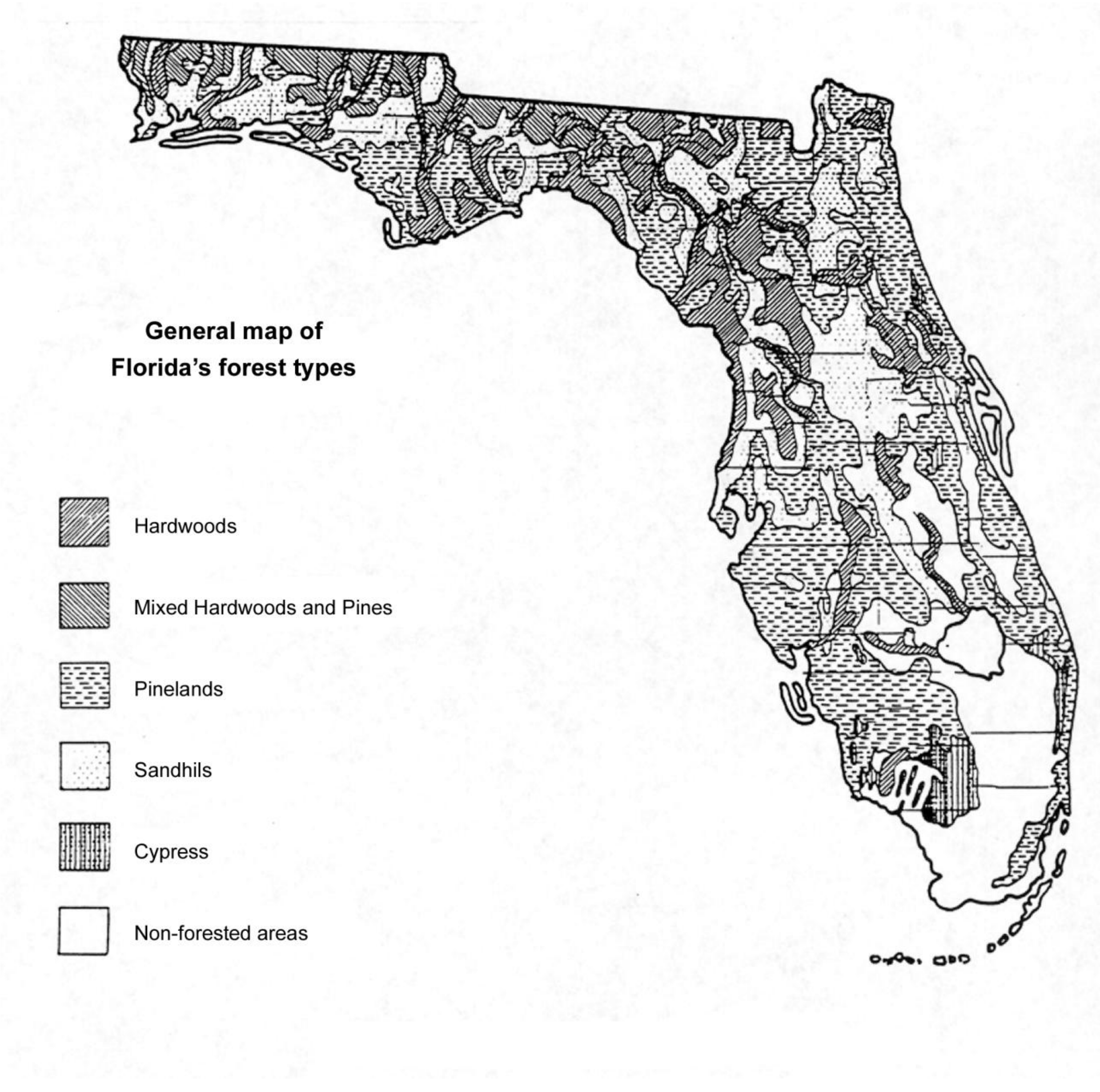


Figure 5.1. Forest types vary with soil features and topography.

PROTECTING THE FOREST

WILDFIRE

Wildfire has always been a natural part of Florida's forests. Over time, Florida's trees and plants have adapted to the presence of frequent fire. Some plants, such as wiregrass, have evolved to require fire as a means to perpetuate itself. On occasion, wildfire can be destructive. It can damage forests, kill timber or retards its growth, reduce soil fertility, cause erosion, pollute air and water, and alter or destroy wildlife habitat. Two main causes of wildfire in Florida are carelessness and arson. Although wildfire can be a problem, properly planned prescribed burns can benefit plant communities that wildfire once served.

Fire Season

Each year there are periods when the danger of forest fire is especially high. These periods are referred to as *fire seasons*. Florida's main fire season occurs January through April, when air humidity is low and flammable forest fuels — especially dead, dry leaves and grasses — are abundant. Human activities in the woods also increase at this time of year, due in part to Florida's hunting season and cooler weather. The larger number of people in the woods increases the chances of a wildfire. The fire season ends when grasses green up in the spring or when summer rain showers begin. In times of drought, however, the fire season may extend through the summer.

Detecting Wildfires

Forest fire lookout stations are strategically located throughout Florida. Most of these towers are spaced on approximately a 16-mile grid, but others are located in remote or heavily forested areas. The system has developed gradually over the years, expanding and adjusting to meet changing conditions. When smoke is spotted, the forest towerman determines its direction from the tower.

Aircraft are used to cover extensive areas not covered by fire lookouts or when visibility has been reduced by haze, fog, or smoke. Air patrols can often spot small fires before the smoke becomes visible to the tower.

Reporting of fires by the public supplements the detection system. Concerned individuals often report small fires via cell phone before they are detected by either aircraft or towers.

Fighting Wildfires (See Figure 6.1.)

Most forest fires are suppressed by indirect attack, which involves removing forest fuels in a strip called a ***fireline*** or ***control line***. In Florida, firelines constructed by tractor-plows are the main means of suppressing fires. Brush, trees, and litter are removed ahead of advancing flames. The fire burns up to the line and stops. However, wind can send burning embers across the line to rekindle the wildfire. The width of the fireline and its distance from the flames are dictated by the weather and fuel conditions. Safety is a most important item to consider in combatting forest fires.

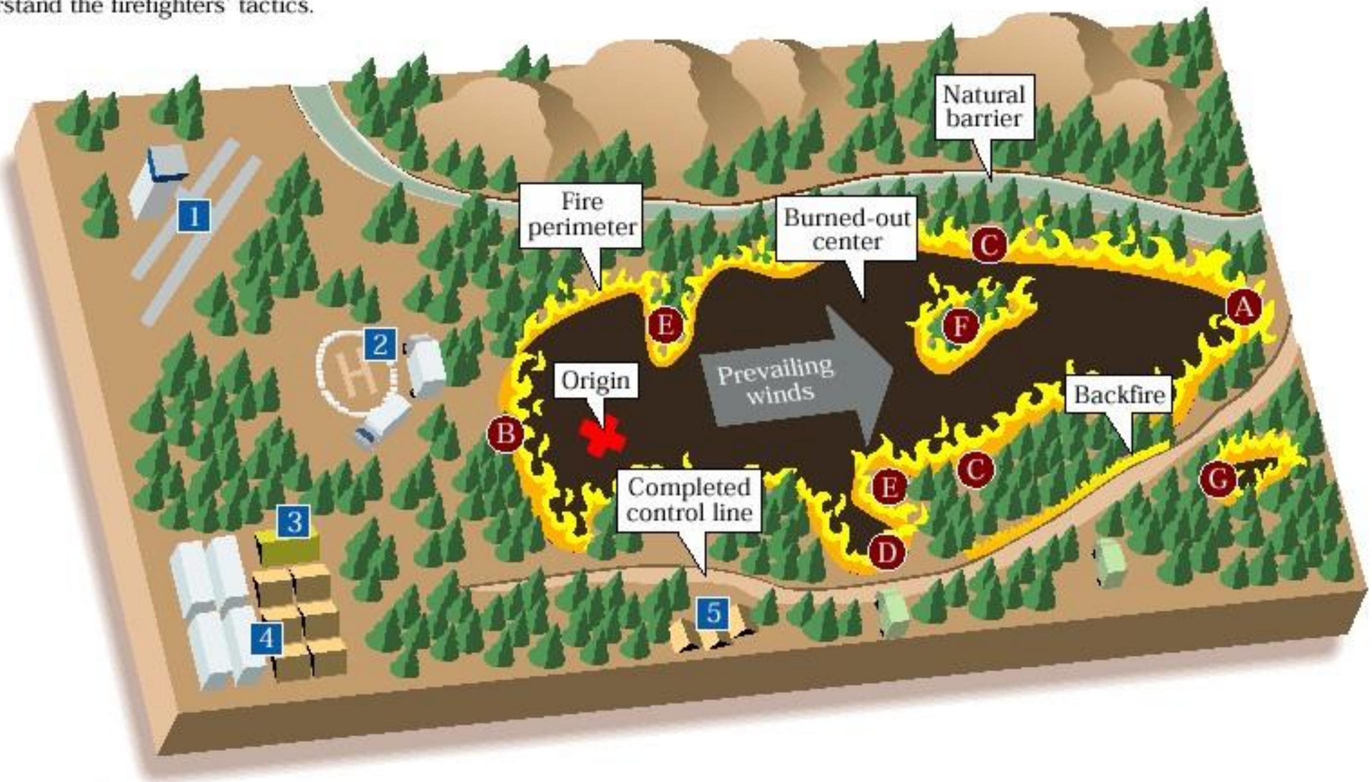
Firefighters will often use ***counterfiring***, which is deliberately setting fire to forest fuels with the intention of stopping a wildfire. Firelines are constructed ahead of the wildfire, then the fuel between the fireline and the advancing flames is burned, widening the fireline and stopping the fire. Counterfiring is not used in extremely heavy fuels, dry leaf litter, or excessively high winds. Under these conditions, counterfiring can compound the fire problem instead of suppressing it.

The use of water to cool and extinguish wildfire is called direct attack. It is usually coupled with indirect attack since limited water availability and difficulties in transporting water through the woods usually make widespread direct attack unfeasible.

Water is also used in the final stages of suppression, or mop-up. Small ***spot-fires***, smoldering stumps, and burning logs are extinguished to prevent rekindling of a wildfire. Water or fire retardant chemicals may be used in either indirect or direct attack when dropped from large aerial tankers. In direct attack, the chemicals or water are dropped directly on the fire. This tactic is usually used on small fires. Indirect attack from aerial drops is similar in its effect to that of firelines. Chemical retardants are dropped in a continuous line across the path of the fire. This technique is used in inaccessible areas, on very hot fires, and to reinforce ground efforts.

Fire basics

Three components are needed to produce a fire: fuel, heat and oxygen. Combined, they're called the "fire triangle." By nature, a triangle needs three sides. Take away one of the sides, and the triangle collapses. The same is true of fire. Take away any of the three components of fire – fuel, heat or oxygen – the fire collapses, meaning that it can't burn. Firefighters try to do just that – remove one of the three essential components of fire. For example, when they dig a line around a fire, fuel is removed. When water is dropped on a fire, it reduces the heat. Retardant blocks the oxygen. If you think of fighting fire in terms of breaking the fire triangle, then it's easier to understand the firefighters' tactics.



Combating the fire

1 Airport
Airtanker bases are at fixed locations throughout the country. Aerial operations can also be run by setting up a portable retardant base.

2 Helicopter base (heliport)
Often dispatched with support personnel and support vehicles, helicopters are used for transport of crews and cargo in addition to dropping water or retardant.

3 Incident command post
Where the incident management team is based.

4 Fire camp
Where firefighters eat and sleep. May include the mess tent, medical and shower trailers, and supply cache.

5 Spike camp
Forward base for firefighters.

Anatomy of the fire

A Head
Often where the fastest rate of spread occurs. The "front" of the fire is the section that burns most intensely and is difficult to control.

B Foot
Opposite of the head, usually nearest to the point of origin.

C Flanks
Sides between the head and rear. If the wind shifts one of the flanks could become the head. Flanks usually burn less intensely than the head.

D Fingers
Shifting winds and changes in topography and fuel can cause points, or fingers, to develop behind the head and along the flanks.

E Pockets
Deep indentations in the fire perimeter of unburned fuel.

F Island
Unburned areas inside the fire perimeter.

G Spot fire
Spotting occurs when the wind or hot air rising from the fire carries embers upward and over to other fuels ahead of the fire, starting a new fire.

Mark Waters/The Arizona Republic

Figure 6.1. Fireline (*completed control line*), Counterfire (*backfire*), and Spotfire (*letter "G"*).

INSECTS AND DISEASES

Insects and diseases that damage and kill trees will always exist in our forests. Under normal circumstances, they are held in check by natural predators, parasites, and ***pathogens*** or environmental conditions, such as temperature or moisture. Occasionally, however, insect and disease populations will increase to the extent that large volumes of timber are killed or damaged in a relatively short period of time.

Insects and diseases are generally unspectacular in the way they attack and kill trees, yet they cause a greater loss of trees than fire.

Since complete eradication of forest pests is impossible, control measures are designed to reduce losses to an acceptable level. Diagnosis of pest problems and application of economical control measures are the responsibility of forest managers, with the help of forest ***entomologists*** and forest ***pathologists***.

Insects and diseases are often closely associated. For example, a disease may be spread by insects which carry fungus spores from tree to tree. Other times, an insect will only attack a tree previously infected by a disease. Whether a tree is damaged by insects or diseases, the result is a slower-growing or dead tree. Trees have their own natural defense mechanisms against insect and disease attacks. It is when a tree is weakened or injured that insects and diseases often find it easy to gain entry. This injury or weakening can be due to

- Fire
- Weather, including wind storms, lightning, floods, drought, or extreme cold
- Pollution
- Grazing damage from too many hogs, cattle, or other animals in an area or the lack of a correct food supply
- Logging damage, construction damage, or damage from heavy equipment
- Soil or site factors
- Poor forest management

Forest Insects

Entomology is the study of insects. An insect is an animal possessing three pairs of legs, antennae, a ***head***, ***thorax*** and ***abdomen***, and usually one or two pairs of wings. These characteristics separate insects from their relatives the spiders, mites, and crustaceans. A wide variety of insects may attack roots, stems, and leaves of both conifers and hardwoods. Usually, however, one insect will damage only one specific part of a tree. This is a key to identifying the insect problem. In addition, one insect species normally infests only one species of tree or one tree species group, such as pines. Dendrology skills, therefore, are also very helpful in identifying an insect problem.

Pine Bark Beetles

Longleaf, slash, loblolly, and other pines that have been weakened by lightning, over-crowding, drought, fire, logging damage, and other stress factors are susceptible to bark beetle attack. Pine bark beetles damage and kill trees by tunneling and feeding in phloem tissue. These tunnels, called ***galleries***, vary in shape depending on the beetle species.

The ***Ips engraver beetles*** are the the most common pine bark beetles in Florida. Three species of these beetles are known to damage pines in the state. One species attacks the upper stem and branches, one species attacks the lower crown and midtrunk, and one species attacks the lower portions of the trunk. In many cases, all three species may be found in the same tree. See Figure 6.2.

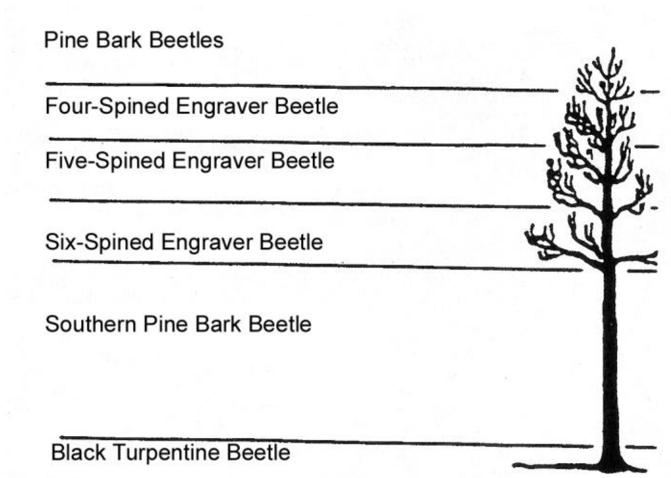


Figure 6.2. Pine bark beetle species can sometimes be identified by the part of the tree attacked.

Adult Ips beetles are brown to black in color and approximately one-quarter inch long. A distinct characteristic of the adults is a scooped-out rear-end, with four to six teeth on the edge of this cavity. Ips beetle attacks may be identified by the presence of dime-sized globs of pitch on the tree bark called ***pitch tubes*** and by Y- or H-shaped galleries beneath the bark. See Figure 6.3.

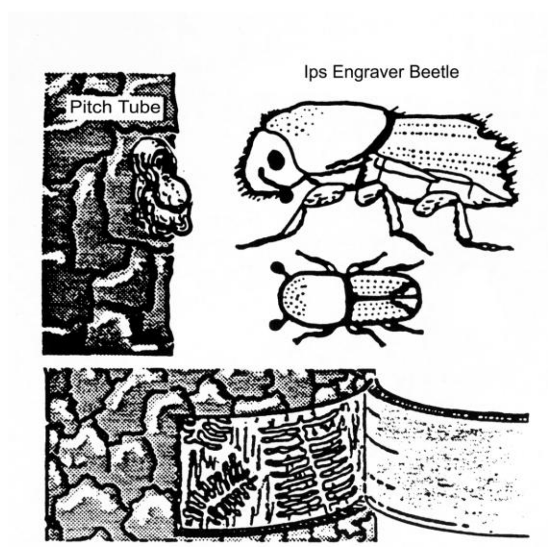


Figure 6.3. Ips engraver beetles are the Number One insect killer of pines in Florida. Ips beetles construct galleries beneath the bark.

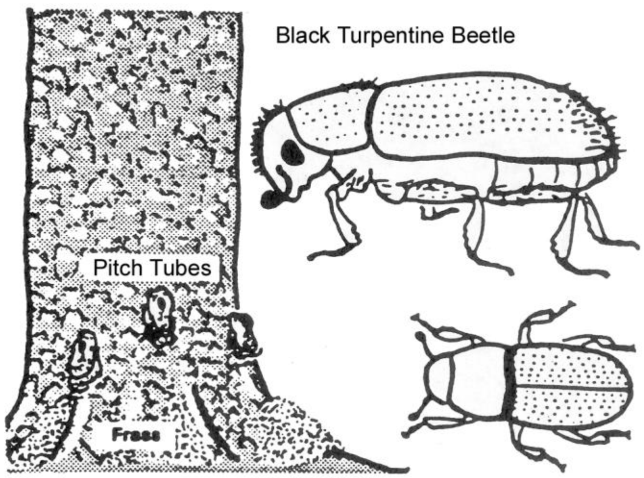


Figure 6.4. The black turpentine beetle makes large pitch tubes at the base of pine trees.

The ***black turpentine beetle*** is larger than the Ips beetle, but it is less prevalent. Adult beetles are brown to black and approximately one-half inch long. Thumb-sized reddish-white pitch tubes and large fan-shaped or D-shaped galleries beneath the bark identify black turpentine beetle attacks. See Figure 6.4.

The best control of pine bark beetles is achieved by maintaining a healthy forest.

Pine Tip Moths

Larvae of the ***pine tip moth*** bore into and kill buds and leaders of young loblolly and shortleaf pines in Florida. This damage usually results in growth loss and deformed trees, and only rarely are trees killed outright. Tip moth damage does not normally occur on trees over 15 feet tall.

Pine tip moths are one-quarter inch long with a one-half inch wingspan. They are copper colored with silvery markings on their wings. See Figure 6.5.

Tip moth infestations can be controlled by planting less-susceptible pine species on appropriate sites and by applying insecticide on high-value shade and Christmas trees.

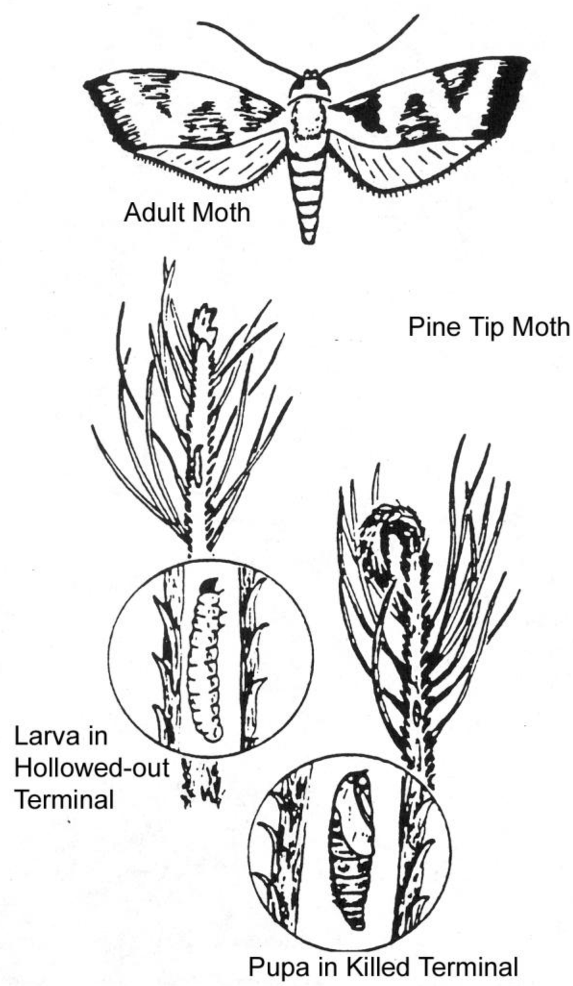


Figure 6.5. Pine tip moths are usually found in young loblolly pine plantations in Florida.

Reproduction Weevils
Reproduction weevils are problems in areas that have been clear-cut and then replanted shortly after the timber harvest. Adult weevils are attracted to fresh-cut stumps to lay eggs and feed on the bark of recently planted seedlings nearby. This feeding girdles the seedlings. Weevil infestations may result in a 50–80% loss in a young pine plantation.

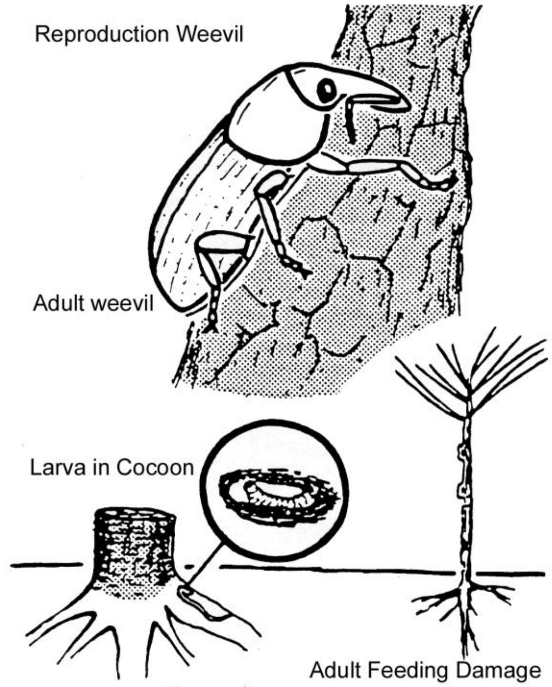


Figure 6.6. Reproduction weevils are problems in areas clear-cut and replanted to pine. Cocoons are made of chewed wood.

Adult weevils are one-quarter to three-eighths inch long and are a grey to brownish color. They possess a pronounced snout or beak, to which bent or jointed antennae are attached. Dead or dying seedlings with patches of bark missing are clues to reproduction weevil attack. See Figure 6.6.

Control can be achieved by delaying replanting a clear-cut area for 9 to 12 months. If this is not feasible, seedlings can be dipped in recommended insecticides prior to planting.

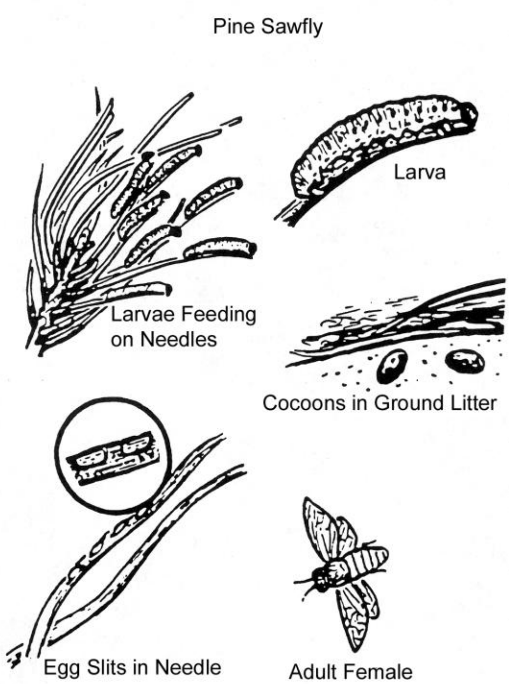


Figure 6.7. Pine sawflies feed on the needles of southern pines.

Pine Sawflies
Eight species of ***pine sawflies*** are known to attack pines in Florida. Pines of all sizes and species may be harmed by one or more of these species of insects. Sawfly larvae feed on the needles. Attacked trees have a bottle-brush appearance, resulting from chewed needles.

Pine sawfly larvae are caterpillar-like and generally have a light green body with black spots or stripes and a red or black head. Adult females are one-half inch long, heavy bodied, and dark colored, and have slender antennae. See Figure 6.7.

Natural enemies normally keep these insects from causing extensive damage, but occasionall, infestations become large enough to warrant an application of insecticides. Promoting tree vigor ensures a pine's ability to produce new needles following an infestation.

Forest Tree Diseases

Forest pathology is the study of forest tree diseases. A ***tree disease*** is a sustained and progressive impairment of the structure or function of any part of a living tree. Diseases can be caused by a wide variety of factors or agents, both living and nonliving. Living agents of diseases are called ***pathogens***. Types of pathogens include fungi, bacteria, viruses, parasitic plants such as mistletoe, and nematodes, which are microscopic worms. Nonliving disease agents include temperature extremes, moisture extremes, soil compaction, nutrient deficiencies, chemicals, and air pollutants.

In order for a tree disease to exist, a pathogen or a nonliving agent must have three elements: a susceptible host, a favorable environment, and time to develop. If any element is missing, the disease cannot exist. A pathogen alone, therefore, is not a disease.

Symptoms of a disease are abnormal characteristics shown by a diseased tree, such as loss of foliage or heavy pitch flow. ***Signs*** of a disease are the physical presence of the disease causal agent, such as mushroom-like fruiting bodies or powdery spores. Observation of these two clues is critical to diagnosing a disease problem.

Roots, stems, and leaves of both conifers and hardwoods can be attacked by any of a number of diseases. Generally, root and stem diseases are much more damaging then foliage diseases, since most trees can tolerate an ocassional defoliation. Root and stem diseases can ***girdle*** a tree or interfere with a tree's water and food transport system and are therefore considered more serious.

Fusiform Rusts

Fusiform rust is the most serious disease of slash and loblolly pines in Florida and is common in pine plantations. Seedlings and saplings are often killed when infested. Larger trees are weakened and disfigured by the disease, resulting in a loss of lumber grade. Larger trees are also susceptible to wind breakage.

The fungus requires two hosts to complete its life cycle — pines and oaks. However, the fungus does not cause significant damage to the oaks. ***Spores*** are produced on the underside of oak leaves in summer, then are carried to the young leaders, needles, or shoots of a pine. The spores may be carried for several miles. If conditions are favorable, the spores germinate. As the disease progresses, pronounced stem or branch ***galls*** or swellings develop.

Figure 6.8. Fusiform rust galls are a common sight in planted pine stands.

These galls may persist for many years and can either girdle the branch or stem or seriously weaken it. In 2 or 3 years, the fungus produces powdery, bright orange spores which are carried by wind to newly emerging oak leaves, completing the life cycle. See Figure 6.8.

Control of the disease can be achieved by planting less-susceptible species on high-hazard rust sites. Fungicides may be applied to nursery trees. Pruning infected branches is effective if the gall is greater than 1 foot from the main stem. Diseased trees are normally removed in thinnings, and young pines are not usually fertilized, which would increase the amount of shoot growth and thus the likelihood of infection.

Pitch Canker

Pitch canker is a major disease of slash pine in Florida. Severe outbreaks of the disease can result in significant crown and stem damage and mortality. Slash pines of all sizes may be affected.

Spores of the fungus are carried by wind or by the deodar weevil. The fungus enters the tree through wounds, including those caused by the feeding of deodar weevils. Infected trees produce flowing gum. Additional symptoms include death of foliage, called flagging, greyish dead needles persisting for over a year, and cankers (depressed areas) in the bark under which the wood becomes discolored and resin soaked. See Figure 6.9.

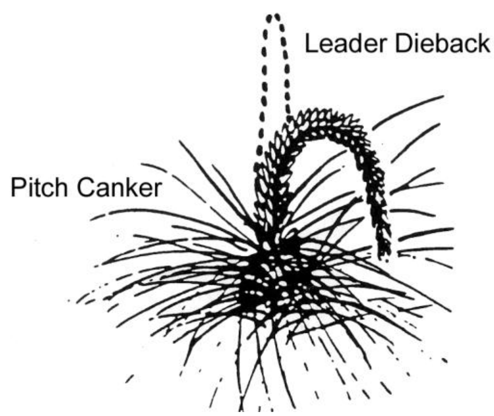


Figure 6.9. Pitch canker is normally found in slash pines in north-central, central, and south Florida.

Seriously infected trees are harvested and plantations are thinned to help control the disease. Care in woods operations needs to be exercised to reduce the incidence of wounding slash pines.

Longleaf Pine ***Brownspot Needle Blight***
Longleaf pine seedlings are susceptible to this disease, which may cause mortality or delay height growth in the stand. Young longleaf pine seedlings less than 3 feet tall are susceptible. Spores of the fungus are carried by wind and rain. Small yellow to brown spots with yellow or purple margins are typical symptoms on infected needles. Eventually, the needles may become brown and die.

Prescribed-burning the seedlings in winter destroys the needles and the fungus. Burning is not used once height growth has commenced. Fungicides are used on nursery grown longleaf pine seedlings to prevent infestations.

Pine Root Rot
Pine Root Rot can cause serious mortality in thinned stands of pine. The fungus colonizes freshly cut stumps, then is transmitted to live trees through root contact and root grafts. Infected trees may show symptoms of gradual crown thinning or windthrow.

At the base of a tree, the fungus produces a large brownish conk or bracket that is white underneath. It may be seen by removing litter and needles from the base of the tree.

Control of root rot is achieved by dusting tops of fresh-cut stumps with Borax to prevent colonization. Restricting thinning operations to summer months also discourages colonization, due to the fact that the stump surfaces are normally too hot to allow germination of the fungal spores.

Other Tree Problems

Chlorosis
Chlorosis refers to the uniform yellowing of the leaves resulting from a decrease in the normal amount of chlorophyll present in the leaves. Chlorosis may develop in the leaves of trees as an indicator of a number of difficulties. Chlorosis has been reported on the heavily shaded branches of some trees due to too little light being present. Some sources of injury which can induce chlorosis include fungi infection, pH, virus problems, physical damage to the root system, insects, low temperatures, toxic substances, excessive soil moisture, and too much or too little nutrient supply.

Leaf Scorch
This is the browning of the edges of the leaves and in the areas between the major veins of the leaves. Leaves develop ***leaf scorch*** when they are unable to obtain adequate amounts of water from the roots of the tree. This may occur due to some interference between the roots and leaves, or some soil condition. Some of the common causes are

- Trees growing in areas where root expansion is limited
- Paving of soil area over the roots of existing trees
- Excavation of large areas close to the tree
- Addition of soil fill material over the existing root system of the tree
- Application of salts or other harmful chemicals to the soil
- Trees growing in shallow soils
- Root or stem diseases or injury

Stress

Stress in trees can be induced by a variety of factors and may be chronic (recurrent or long-lasting) or acute (sudden and intense). Mineral nutrient imbalances and extended droughts are examples of factors inducing chronic stress. Untimely and severe freezes, ***lightning*** damage, floods, and construction damage are examples of acute stress.

Figure 6.10. Lightning strike in Okeechobee County.

Stress on trees can often be a subtle thing. Tree trunks and branches damaged (stressed) by construction activities are usually obvious (breakage and debarking). Stress resulting from soil compaction or air pollution is much more difficult to recognize and define.

Stressed trees are a preferred target of insects and diseases. Insect pests as well as certain tree pathogens (especially fungi) are actually better at recognizing trees under stress than most tree enthusiasts. As a result, stressed trees may go completely unnoticed until they are "suddenly" damaged or killed by insects or diseases.

Prevention of stress by avoiding unnecessary injuries to trees during construction, road building, timber removal, etc., is probably the single most effective method for controlling stress related pests.

HUMAN IMPACTS

Studies have shown that 60% of outdoor recreation participation for day use takes place within a 40-mile radius of an urban area. The overnight and weekend use area extends up to 125 miles from an urban area and accounts for 30% of the recreation visits. Many of Florida's prime recreational sites are located reasonably close to heavily populated areas. As Florida's population and people's time for recreation increase, the impacts on recreational areas increase.

Mechanical Damage

Bark wounds not only interfere with the movement of organic compounds between the top and the roots but also open woods to microorganisms that can cause decay. Bark can be damaged by animals, wind, lightning, sun, ice, cold, fire, cars, lawnmowers, weedeaters, and vandals.

Figure 6.11. Lawnmower & Weedeater damage to red maple in Vero Beach.

Soil Compaction

Compaction is the result of pressure put on the soil through such activities as hiking, horseback riding, and biking. The amount of compaction will vary depending on the soil type, the amount of activity, and type of use. Compaction causes a reduction in water infiltration and aeration. If severe, this can cause injury to or death of vegetation. Studies have found that compaction is greater on slopes than on level sites and that compaction increases from hiker to cyclist to horses.

Soil Grade Changes

Two possible types of grade changes exist — ***fills*** and ***cuts***. Fills and cuts in a recreational setting may be due to the construction of roads or facilities.

In addition to decreasing the soil oxygen content, soil fills also tend to increase the moisture content of the soil, particularly beneath the added fill. Since the roots of a tree remain at the same level in the soil, they are subject to these conditions of reduced oxygen and increased moisture. In most instances, damage and death of the roots occur as a result.

Soil cuts as a whole are probably more damaging to tree vigor than are soil fills. Since the feeder roots of most trees are in the top 12-18 inches of the soil, with the majority of these in the shallower depth, many are lost when even a small amount of the surface soil is removed. Loss of roots and fertile soil will tend to increase the probability of the tree suffering from drought and mineral deficiencies.

Tree Removal

Clear cutting and individual tree removals are made in forests and urban areas. When trees are cut, quick removal of the debris eliminates any potential for insect infestations. Before removing trees, it is wise to consider any insect or disease activity in adjacent areas. For example, reproduction weevils are insects that can cause severe damage or death to newly planted pine seedlings, especially those on sites near recently clear cut sites. Female reproduction weevils lay eggs in the roots of recently cut stumps. The ***larvae*** emerge and overwinter in the sapwood. In the spring, the adults emerge and feed on pine seedlings.

Tree removal can also affect the microclimate around the tree. Small trees, shrubs, and ground cover that require the shade of overhead trees may be stressed by direct sunlight and increased soil temperatures.

Pollutants

Pollutants can range from litter to oil dripping from car engines to air pollution. Many gaseous pollutants exist in our atmosphere. Under widely variable forest conditions, however, only three major pollutants have shown to cause significant foliar injury to forest trees: ozone, sulfur dioxide, and fluoride. Recently, sulfates and nitrates — acid depositions — have been known to cause damage, but direct injury has only occurred where the vegetation is very close to the pollution source.

The accumulation of salts on or within plants often causes severe injury. Injury may occur on plants growing up to tens of miles inland from ocean sources. Uptake occurs through direct foliar application of wind-driven sprays or through root absorption of salts accumulated in soils.

Pesticides

Pesticides are chemicals used to prevent, suppress, or control insect and disease problems. The application of pesticides in a forest setting may be justified when the insect or disease problem is severe or when the value of the trees is especially high. In other cases, however, pesticide applications may not be justified in the forest due to economic considerations, legal restrictions, or biological conditions.

Exotic Species

Numerous trees from the far reaches of the globe have been introduced into Florida, particularly as ornamentals. Some of these exotic trees, such as royal poinciana, floss silk, and fig, grace the lawns of many South Florida residences, while camphor trees, golden rain trees, mimosa, Chinaberry, and tallow trees are popular in North Florida.

Still others, such as eucalyptus species, have been introduced as commercial timber trees, growing to 100 feet tall in 10–15 years.

Some exotics have become nuisances. Two major problem trees are the melaleuca and the Brazilian pepper, which are spreading in the Everglades and adjacent areas in South Florida. Both are growing unchecked by natural enemies and are crowding out native vegetation in those areas.

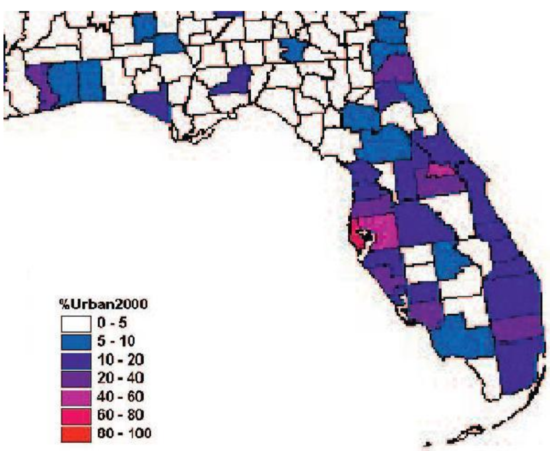
Australian pine is a nuisance tree along many South Florida coastal areas, colonizing beaches and estuaries. This exotic pest is a major problem on barrier islands used by sea turtles for nesting. The extensive shallow root systems prevent the turtles from digging nests in the sand to lay their eggs. These trees also pose a safety hazard during high winds and hurricanes.

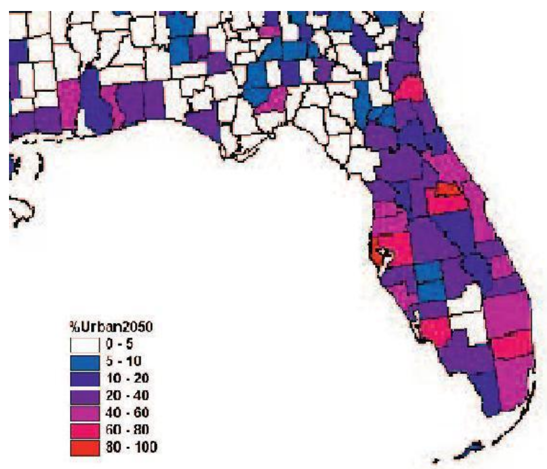
Many other exotic trees have become naturalized, many times forming pure stands. Examples of some are Chinaberry, Chinese tallow, castor bean, and downy-rose myrtle.

URBAN AND COMMUNITY FORESTRY

WHAT IS AN URBAN FOREST?

The community forest is the aggregate of all vegetation and green spaces within communities that provide benefits vital to enriching the quality of life. The trees around our homes, on our streets, in our parking lots, beside our schools, and throughout our parks are part of an urban forest. The urban forest is made up of trees and other vegetation within the built environment. It is highly influenced by people and other factors, such as vehicles, buildings, pavement, utility lines, underground pipes, animals, and other plants. Florida's forests cover 16.2 million acres or 47% of its total land base. These renewable and dynamic resources are undergoing significant pressure from a dramatically increasing Florida population. Since 1987, the forestland base has decreased by 41,500 acres per year, with over 50% of the decrease associated with urban growth. As the area of natural and planted forestland in the state declines, the urban forest increases.





The county map on the left shows the percentage of urbanization as in the year 2000. The map on the right shows the projected urbanization in 2050. Look at the map and find the county where you live. Is your county projected to become more urbanized? Think about how this change is likely to affect the amount of green space in your county.

WHAT IS COMMUNITY FORESTRY?

Simply stated, community forestry is the combination of planning, establishment, management, and research of trees and associated plants (individually, in groups, or under forest conditions) within cities, suburbs, and towns. As cities continue to grow, increasing numbers of people will choose to live, work, and play in community forests, making the field of community forestry critical for healthy and sustainable living.

Properly cared for and well-managed community forests can provide benefits that far exceed their management costs. Community forests can also bring communities of people together and form connections between humans and the urban flora and fauna.

Additionally, community forests are an integral part of large cities, rural areas, streets, backyards, parks, and open spaces. Community forests provide shade, beauty, and habitat for urban wildlife. Properly planted trees and other vegetation can reduce heating and cooling costs, intercept and store rainwater, improve air quality, and increase property values and local tax bases.

URBAN AND COMMUNITY FORESTRY: IMPROVING OUR QUALITY OF LIFE

Urban and community forestry can make a difference in our lives. Each one of us can make a personal contribution. As we develop and apply technologies for a better way of life, often times side effects adversely affect our natural environment. For example, in our urban areas summer temperatures and noise levels are higher than in the surrounding countryside. Air pollution problems are more concentrated, and the landscape is significantly altered, reducing personal health benefits available to us by having access to wooded areas and green open spaces. Trees help solve these problems. Now, 75 per-cent of us live in cities and towns and we can act individually to improve our natural environment through the planting and care of trees on our own streets, and by supporting community-wide forestry programs. Through technology we are learning more about trees and how they benefit mankind, and how we can do a better job of planting and caring for these trees that make up our urban forests.

WHAT DO TREES DO?

Trees are not only beautiful in themselves but add beauty to their surroundings. Trees add color to the urban scene, soften the harsh lines of buildings, screen unsightly views, provide privacy and a sense of solitude and security, while contributing to the general character and sense of place in communities. Beyond aesthetics and emotional well-being, trees perform important functions that protect and enhance city dwellers' health and property. Trees literally clean the air by absorbing air pollutants and releasing oxygen. They reduce storm water runoff and erosion; they temper climate; they can save energy; they create wildlife habitat; they can improve health, serve as screens, and strengthen community. They can even help contribute to a community's economy and way of life

TREES ADD BEAUTY AND IMPROVE PERSONAL HEALTH

Trees are major capital assets in America's cities and towns. Just as streets, sidewalks, sewers, public buildings and recreational facilities are a part of a community's infrastructure, so are publicly owned trees. Trees-and, collectively, the urban forest-are important assets that require care and maintenance the same as other public property. Trees are on the job 24 hours every day working for all of us to improve our environment and quality of life.

Without trees, the city is a sterile landscape of concrete, brick, steel and asphalt. Picture your town without trees. Would it be a place where you would like to live?

Which one of these photographs is the least attractive? Why?

Trees make communities livable for people. Trees add beauty and create an environment beneficial to our mental health. Trees:

- Add natural character to our cities and towns.

- Provide us with colors, flowers, and beautiful shapes, forms and textures.
- Screen harsh scenery.
- Soften and compliment the outline of masonry, metal and glass.

The benefits of cleaner air and water are obvious. But trees also impact deeply on our moods and emotions, providing psychological benefits impossible to measure. A healthy forest growing in places where people live and work is an essential element of the health of the people themselves. Trees:

- Create feelings of relaxation and well-being.
- Provide privacy and a sense of solitude and security.
- Shorten post-operative hospital stays when patients are placed in rooms with a view of trees and open spaces.

A well-managed urban forest contributes to a sense of community pride and ownership.

TREES IMPROVE AIR QUALITY

The health and well-being of our environment are affected by the air that surrounds us. Air pollution such as dust, ash, pollen, smoke and exhaust fumes is the bane of most cities and many towns. At its worst, it can be seen and smelled and even felt. Since the emission of many air pollutants increases with higher temperatures, trees can improve air quality by lowering air temperatures. Trees further their cleansing work by absorbing gaseous pollutants into their leaves and trapping and filtering particulates on and through their leaves, stems, and twigs. Trees have the potential to impact pollutants emitted from power plants by shading buildings and lowering air temperatures in the summer and blocking winds in the winter, which reduces the use of energy for air conditioning and heating. If trees shade a parking lot, they can also reduce pollutants emitted from vehicles.

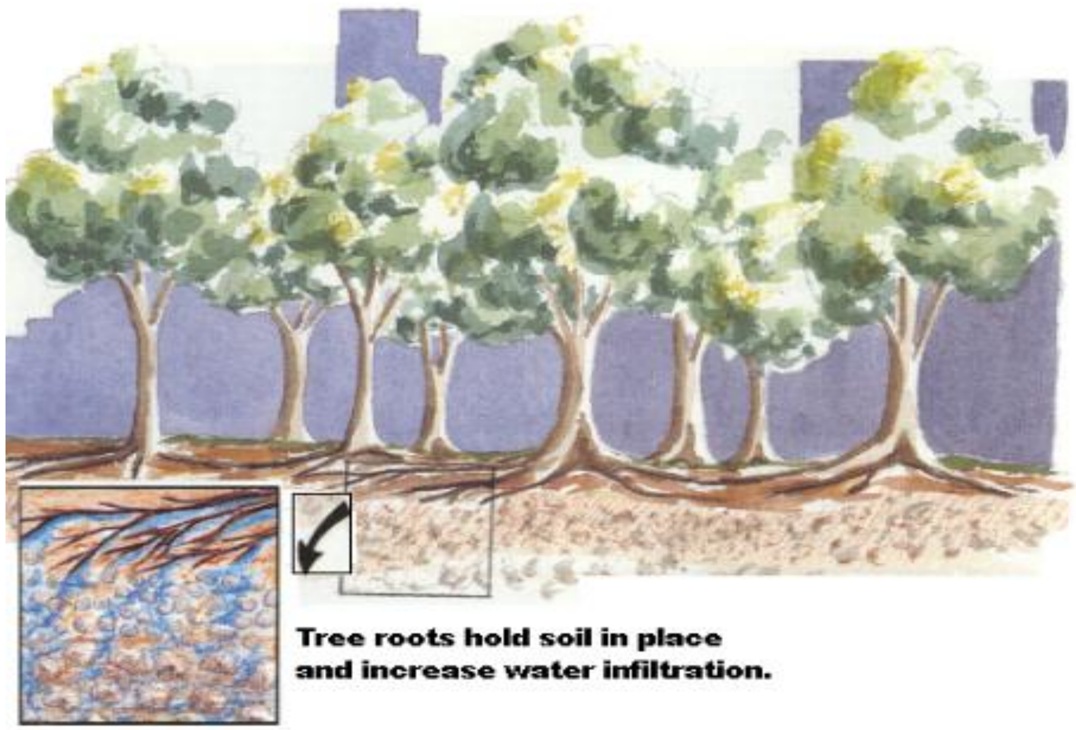
QUICK FACTS:

- Produce enough oxygen on each acre for 18 people every day.
- Absorb enough CO_2, on each acre, over a years time, to equal the amount you produce when you drive your car 26,000 miles.

As ground is cleared for development, the loss of trees in our urban areas not only intensifies the urban "heat-island" effect from loss of shade and evaporation, but we lose a principal absorber of carbon dioxide and trapper of other air pollutants as well.

TREES REDUCE STORM WATER RUNOFF

As towns and cities grow bigger, the amount of impermeable surfaces such as asphalt, paving and roof tiles increases. Water runs off these surfaces very quickly. This results in large volumes of water entering drainage systems very quickly. A lot of money and infrastructure is needed to ensure water can drain away from our streets. Trees can help! Trees influence the flow of water in several ways. Their leafy canopy catches precipitation before it reaches the ground, allowing some of it to gently drip and the rest to evaporate. This interception lessens the force of storms and reduces runoff and erosion. Research indicates that 100 mature trees intercept about 100,000 gallons of rainfall per year in their crowns, reducing runoff and providing cleaner water. Tree roots also hold soil in place and reduce soil erosion caused by wind



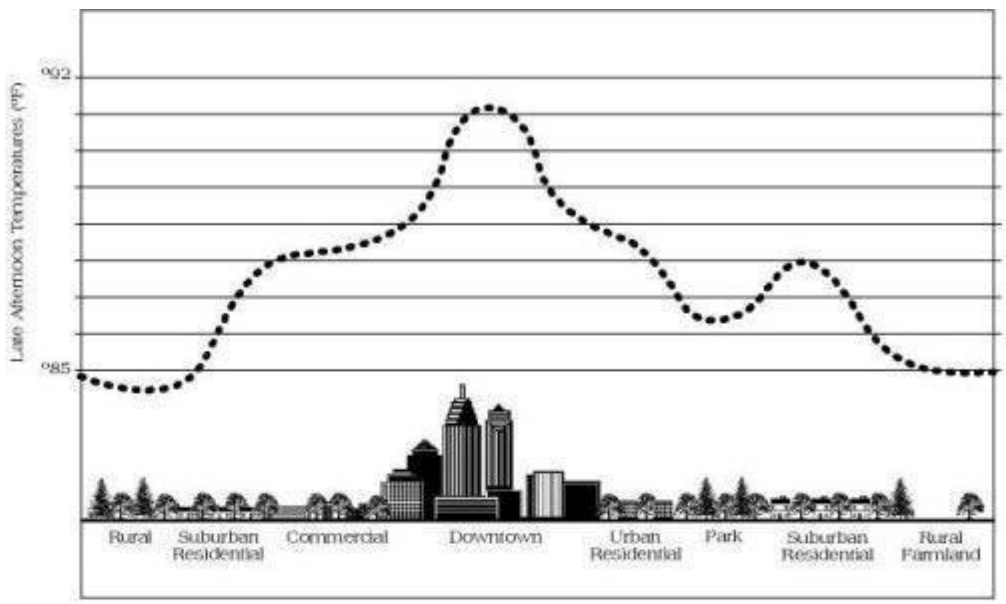
Decaying leaves form an organic layer on the ground that allows water to percolate into the soil, which also reduces runoff and soil erosion. All of this helps reduce flooding in the streets and sedimentation in streams.

A 1996 study by the American Forests found that Fort Lauderdale's urban forest reduced the volume of storm water by as much as 18%.

If some of that water were filtered through the urban forest it could recharge underground aquifers. Thus, towns and cities that remove their trees and fill in their open space will need to construct and maintain a larger storm water drainage system to handle the increased runoff. Maintaining or increasing the urban forest can help communities be more cost effective by conserving water, reducing erosion and flooding, and decreasing chemical pollution which improves quality of water.

TREES MODIFY THE URBAN CLIMATE

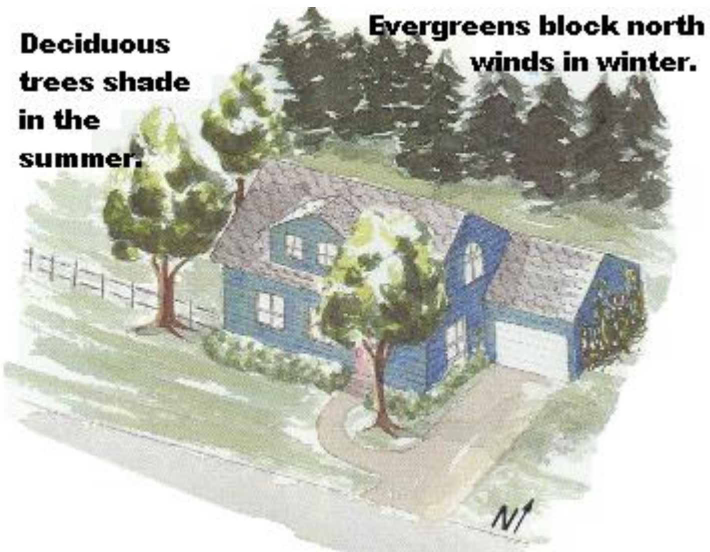
Trees modify local climate, chiefly by lowering air temperature and increasing humidity; they can also influence wind speed and reduce glare. Inner cities are commonly known as "heat islands" because the buildings and pavement absorb solar energy and radiate it back. Trees lining streets or near buildings provide shade that can reduce the heat-island effect, lessening the amount of air conditioning needed. Evaporation of water from trees through the transpiration process also has a cooling effect, especially in hot climates or seasons.



The diagram above demonstrates the "Heat Island " effect. Inner cities retain heat which is radiated back into the surrounding air. This results in a localized increase in air temperature.

A 1996 study sponsored by the American Forests found that over 90 percent of the homes in Dade County, Florida, have air conditioners. In fact, half of all residential energy use was dedicated to powering them. This study estimates that one mature tree in the right location near each home could save Dade County residents over $14.4 million a year in reduced energy bills.

TREES SAVE ENERGY



Strategically placed trees can be as effective as other energy saving home improvements, such as insulation and the installation of weather-tight windows and doors. Trees can help reduce your heating and cooling costs.

Trees save energy through cooling in the hotter months. They provide a windbreak during winter. This results in burning less fossil fuels to generate electricity for cooling and heating.

Three large trees planted correctly around your home can reduce air conditioning costs up to 30 percent. Shade trees offer their best benefits when you:

- Plant deciduous trees, which shed their leaves during winter. These trees provide shade and block heat from the sun during hotter months. By dropping their leaves in the fall they admit sun-light in the colder months.
- Place these trees on the south and west sides of buildings.
- Shade all hard surfaces such as driveways, patios and sidewalks to minimize landscape heat load.

Use evergreens, which retain their leaves/needles year-long, in a planned pattern. They will serve as windbreaks to save from 10 to 50 percent in energy used for heating. Evergreens offer their best benefits when you:

- Place them to intercept and slow winter winds, usually on the north side of your home.

- Do not plant them on the south or west sides of your home, because they block warming sun-light during winter. These trees also provide some shading benefits during summer..

Trees can offer their best shade and air quality benefits in cities by:

- Increasing the number of healthy trees to maximize canopy cover;
- Planting trees in energy conserving locations to reduce cooling and heating cost, thereby decreasing emissions from power plants;
- Planting trees in polluted or in heavily populated areas;
- Choosing trees that have needles or leaves throughout the year, which can potentially remove particulate matter year round.

One of the best ways to affect air pollution is to sustain large healthy trees!

These energy savings, spread over many houses and many neighborhoods, can reduce the demand for power production by utility plants, which in turn reduce the air pollutants produced by these plants.

Click on the link below and do these things:
http://www.arborday.org/trees/benefits.cfm

a) Click on the trees in the picture to investigate the how trees planted around your house can benefit you and your family.

b) Read about the valuable ways that trees benefit the community.

Q: Landscaping can reduce air conditioning costs by up to how much?
A:___________

Q: One acre of forest absorbs how many tons of carbon dioxide?
A:___________

Q: One acre of forest puts out how many tons of oxygen?
A:___________

Activity

In the following exercise you will investigate the urban benefits that two imaginary trees growing in your yard would give. You will examine the differences between the two trees. We will select a Live oak and a Cabbage palm as our two imaginary trees.

STEP 1 **Click here** to visit the National Tree Benefits calculator.

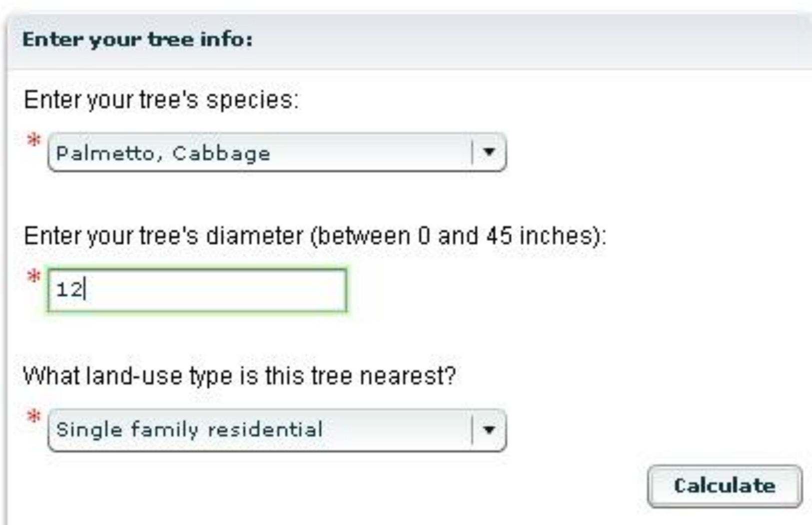
Or go to: http://www.treebenefits.com/calculator

STEP 2 Insert the zip code of where you live in the box on the right hand side. This will determine which climate zone you live in.

STEP 3 Select "Palmetto, cabbage" from the drop-down box. (Another name for this tree is the Sabal Palm, the State tree of Florida.)

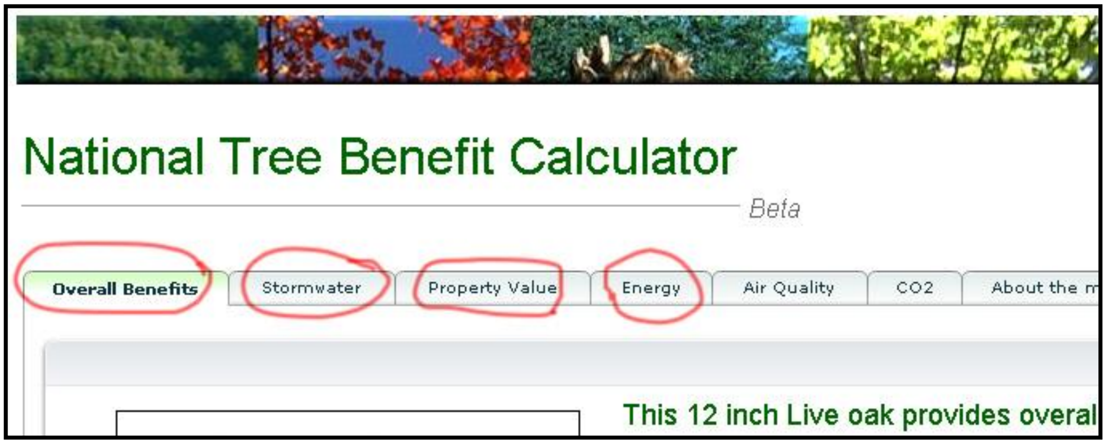
STEP 4 Enter its diameter as 12".

STEP 5 Enter "Single family residential" as the land-use type. The input box should look like the example below:



STEP 6 Click on the "**Calculate**" button. The computer program uses information about the climate where you live and properties of the tree to calculate the benefits given by that tree.

STEP 7 On the website, click on the tabs in the results table for the categories listed in the table below. Write your results in the Results comparison table on the next page.



STEP 8 Repeat the exercise, but chose a **Live oak** with 12” diameter and “Single family residential”

Results comparison table

Tree benefits	Cabbage palm	Live oak
Overall benefits		
Storm water benefits		
Property value		
Energy savings		

STEP 9 Look at the differences in benefits between the Live oak and the Cabbage palm. Can you explain the differences?

Trees improve the economy

Community trees provide subtle but real economic benefits. The value of houses on lots with trees is usually higher than those of comparable houses on lots without trees. Healthy mature trees can add up to 15% to a property value. Studies have shown that shoppers linger longer along a shaded avenue than on one barren of trees. Shaded thoroughfares are not only more physically comfortable but also psychologically more attractive. And an abundance of trees "says something" about a community that makes it more appealing to newcomers as well as residents. In addition to enhancing the home and business environment in an urban area, recreation areas such as parks, greenways, and river corridors that are well stocked with trees tend to keep recreation seekers "at home" rather than driving many miles to find suitable places to play. Here again, less fuel is used and less pollution created. It would be difficult to put a dollar value on such urban playgrounds, but if each visit were valued at only one dollar, the total for the typical city would be in the thousands of dollars per year.

The scope and condition of a community's trees and, collectively, its urban forest, is usually the first impression a community projects to its visitors. Studies have shown that:

- Apartments and offices in wooded areas rent more quickly and have higher occupancy rates and tenants stay longer.
- Businesses leasing office space in wooded developments find their workers are more productive and absenteeism is reduced.
- Streets with little or no shade need to be repaved twice as often as those with tree cover. This means that shade trees save cities money and help make a community look better maintained for longer.

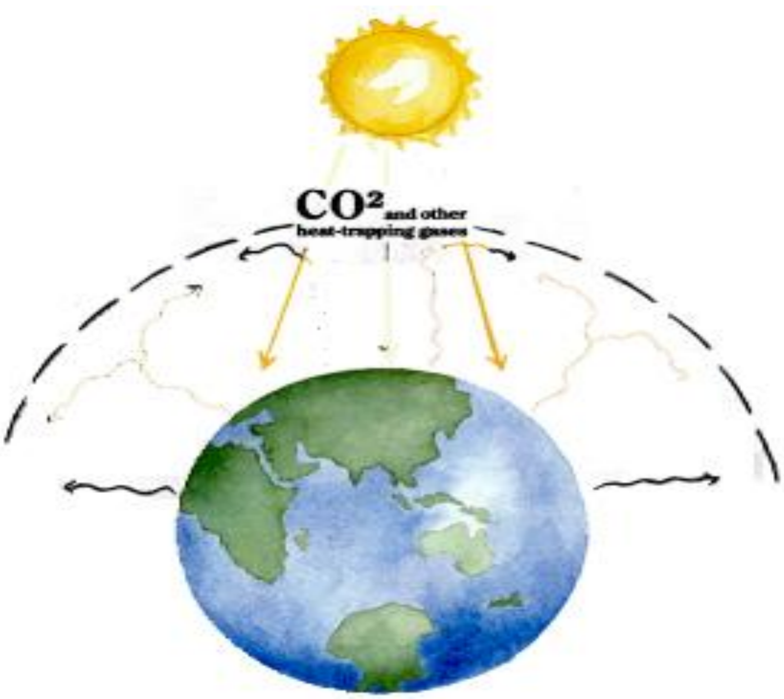
TREES CREATE WILDLIFE HABITAT

Wherever trees are established, wildlife and other plants are sure to follow. Trees and associated plants provide shelter and food for a variety of birds and animals. The presence of trees creates an environment that allows the growth of plants that otherwise would not be there, enhancing the diversity. Again, the monetary value of such diversity is incalculable, but it is well known that residents of and visitors to a community appreciate and enjoy it. Simply put, the presence of trees creates an environment that is much more pleasant for living, working, and playing.

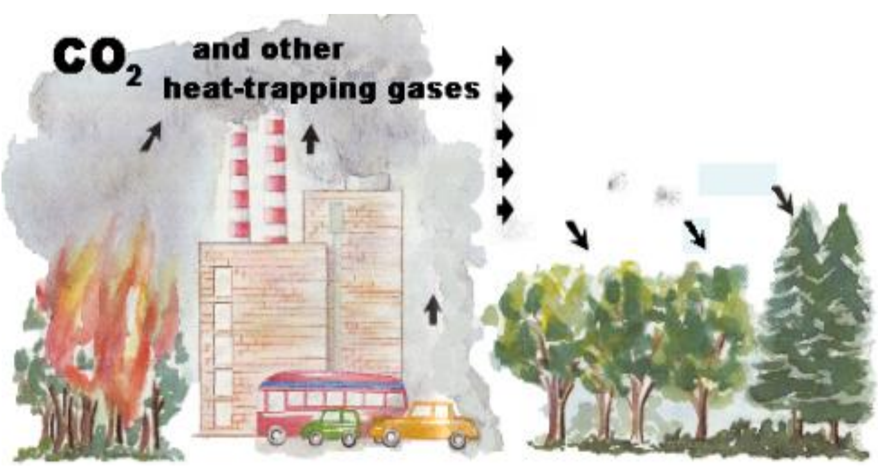
TREES PROVIDE RECREATIONAL OPPORTUNITIES

Many city residents appreciate the recreational benefits urban forests provide. With the growing emphasis on physical fitness, urban forests, parks, and open spaces have become increasingly popular as places to walk, run, bike, and hike. Urban parks are often sites for large community events, such as art and music festivals. Parks are also used for just relaxing and watching the world go by.

TREES FIGHT AGAINST THE GREENHOUSE EFFECT



Heat from Earth is trapped in the atmosphere due to high levels of CO2 and other heat-trapping gases which prohibit it from releasing heat into space-creating a phenomenon known as the "greenhouse effect".



The burning of fossil fuels for energy and large scale forest fires such as in the tropics are major contributors to the buildup of CO_2 in the atmosphere. Managing and protecting forests and planting new trees reduces CO2 levels by storing carbon in their roots and trunk and releasing oxygen into the atmosphere

Trees act as a carbon sink by removing the carbon from CO2 and storing it as cellulose in the trunk while releasing the oxygen back into the air. A healthy tree stores about 13 pounds of carbon annually - or 2.6 tons per acre each year.

Trees also reduce the green-house effect by shading our homes and office buildings. This reduces air conditioning needs up to 30 percent, thereby reducing the amount of fossil fuels burned to produce electricity.

This combination of CO2 removal from the atmosphere, carbon storage in wood, and the cooling effect makes trees a very efficient tool in fighting the greenhouse effect.

TREES SERVE AS SCREENS

Densely planted rows of trees around homes and buildings and along streets and roads can serve as screens to preserve privacy and shut out unwanted or unsightly views. Wide belts of such plantings can also help to muffle sound. With proper design, tree plantings can also re-direct attention away from unsightly areas.

TREES REDUCE NOISE LEVELS

Trees and vegetation can form a barrier that partially deadens the sound from traffic, lawn mowers, and loud neighbors. To be effective, the landscaping should be dense, tall, and wide, and planted close to the source of the noise. Trees also create "background" noise of rustling leaves and wind through the branches that can help muffle other noises.

TREES PROMOTE COMMUNITY

A stronger sense of community, an empowerment of inner-city residents to improve neighborhood conditions, and the promotion of environmental responsibility and ethics can be attributed to involvement in urban forestry efforts. Active involvement in tree planting programs enhances a community’s sense of social identity, self-esteem, and ownership; it teaches residents that they can work together to choose and control the condition of their environment.

Planting programs also project a visible sign of change and provide the impetus for other community renewal and action programs. Several studies show that participation in tree-planting programs influences individuals' perceptions of their community. Conversely, a loss of trees within a community can have significant psychological effect on residents.

URBAN TREE CARE AND MAINTENANCE

Cities and towns make harsh environments for trees, so we must give them special care and protection. Establishing and maintaining community trees and forests can be challenging and costly, but the benefits described here are well worth the time, trouble, and money spent. Trees in urban settings often need to be protected, planted (or transplanted), and tended. This is both an individual and community responsibility.

Right tree right place:

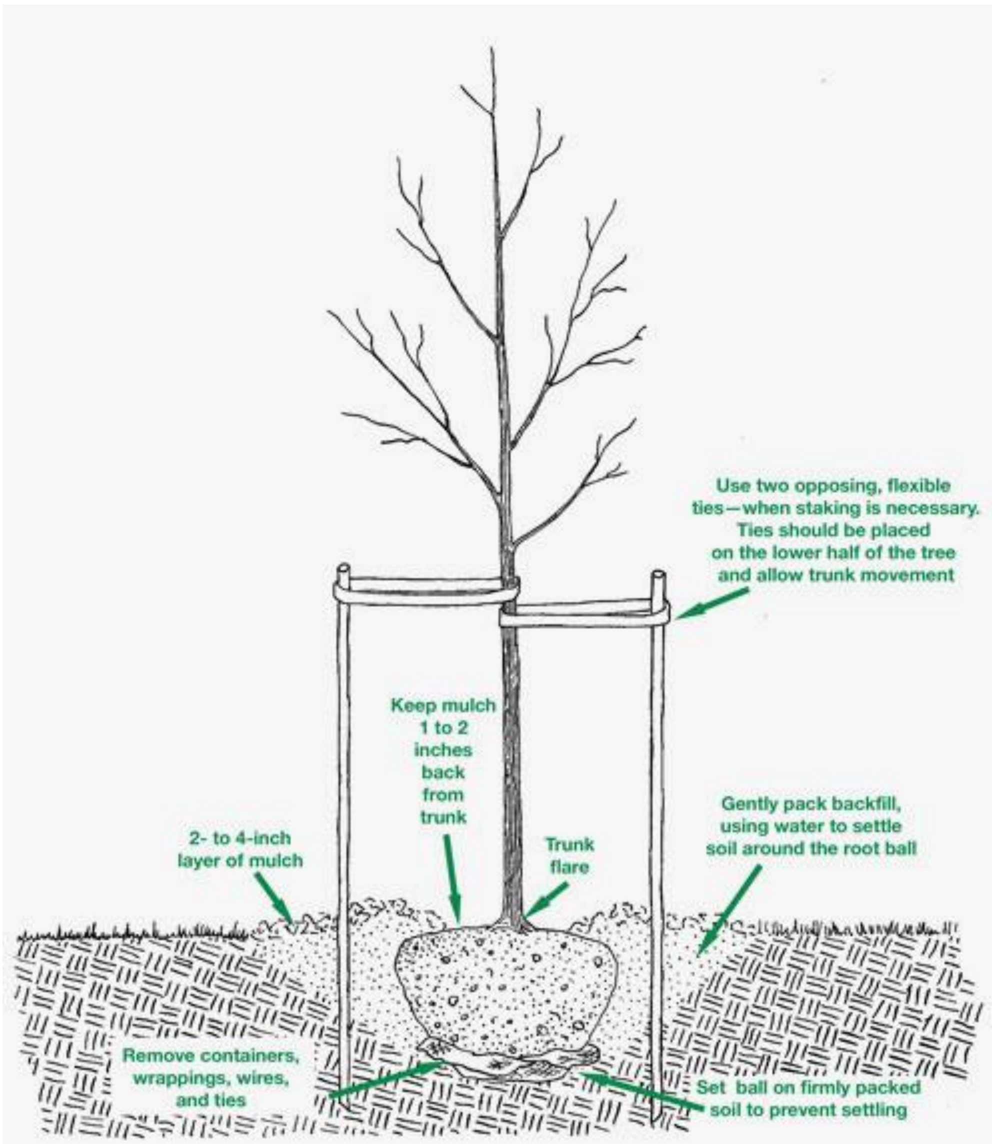
http://www.treesaregood.org/treecare/tree_selection.aspx

http://www.arborday.org/trees/righttreeandplace/quiz.cfm

This tree wasn't given enough room to grow.

Take the online quiz. Don't worry if you get wrong answers. You are not expected to know all the trees mentioned in this quiz.
http://www.arborday.org/trees/righttreeandplace/quiz.cfm

The best ways to plant a new tree:
http://www.treesaregood.org/treecare/tree_planting.aspx



Mulching:
http://www.treesaregood.org/treecare/mulching.aspx

HOW CAN WE MAXIMIZE URBAN FOREST BENEFITS IN FLORIDA?

Urban trees and other vegetation make a daily difference to the quality of life for the 80 percent of the U.S. population who live in urban areas. Despite these benefits, the urban forest also poses risks to residents and property. When exposed to hurricanes and tropical storms, urban trees can lose branches and topple over, bringing down power lines, tearing up water mains, and damaging anything in the way. We can design and maintain urban forests to better withstand high winds, however.

Planting species that have greater wind resistance, pruning them with care, and removing trees with poor wind resistance can help improve the urban forest's capacity in a storm. Planting trees in the best location and providing appropriate water and nutrients are also important.

Wind resistance is a function of tree characteristics such as form, size, trunk, branches and root system, wood density, leaf size, and a few environmental characteristics like depth to water table and surrounding structures. The faster the winds blow, the greater the chance a tree will break or fall. Trees like live oak, magnolia, and cabbage palm tend to do better than red maple, water oak, and queen palm for example, though no tree is absolutely wind proof.

Proper planting plays an important role in maintaining a healthy urban forest. For instance, a tree planted next to a building is left without adequate space for the roots to grow in one direction and is prone to blowing over. The installation of sidewalks or roads may cut roots on one side of a tree, increasing the chance it will topple.

Pruning is also very important to wind resistance. Trees that have been pruned on a regular basis have stronger and fewer branches and are less likely to fall than unpruned trees. Understanding the importance of these characteristics can assist urban dwellers in minimizing property damage and injury from trees falling over during storms.

Thanks to Florida's subtropical climate, our urban forest hosts a rich diversity of trees. While longleaf pine and live oaks are common trees in north Florida's urban areas, palms, cycads, jacarandas, and sea grape are more common in the south. Florida's urban forests can include slash and longleaf pine trees growing on the outskirts of Tallahassee, crape myrtles lining boulevards in Lakeland, live oaks and

Sabal palms in Tampa, or orange and papaya trees growing in Miami backyards.

Florida has seen tremendous changes in a short period of time due to our rapid population growth. Young people can play an important role in helping Florida's urban forests support environmental, social and economic goals in their towns and cities.

Tree quotes

Get inspired! Read some of the tree quotes by famous people.
http://www.treelink.org/linx/Quotesearch.php

Read the factoids about the benefits of trees in the urban environment.
http://www.treelink.org/linx/factoid.php

Now that you have studied how urban trees bring so many benefits to communities, look at the two photographs below and the descriptors that go with them.

Can you think of any other words that describe the communities in the photographs below? Write them down next to the pictures.

Hotter ______________________
More Glare____________________
More Noise____________________
More Water Runoff____________
More Energy Used_____________
Harsh Landscape______________

____

Cooler______________________
Less Glare___________________
Absorbs Noise________________
Less Runoff__________________
Less Energy__________________
More Beautiful________________
____

Where would you rather live?

Community recognition for urban forestry

Tree City USA

A community's urban forest is an extension of its pride and community spirit. TC USA is a state program that recognizes community effort to manage and care for its urban trees. Click on the link to learn about the Tree City Program.
http://www.fl-dof.com/forest_management/cfa_urban_tree_city.html

What four things does a community have to have in place before it can be awarded **Tree City** status?

1____

2____

3____

4____

Arbor Day

PHOTO: Smokey Bear helps with planting a tree on Arbor Day.

Arbor Day is a nationally-celebrated observance that promotes the benefits of trees in the urban environment and encourages tree planting and care. Founded by J. Sterling Morton in Nebraska in 1872, National Arbor Day is celebrated each year on the last Friday in April.
Individual states conduct their own Arbor Day celebrations at various times of the year. Florida has one of the first Arbor Day celebrations in the nation, on the third Friday in January. In 2011, Arbor Day will be celebrated January 21st . Over 100 communities in Florida celebrate Arbor Day, either as a stand-alone event or in conjunction with some other occasion. National Arbor day is on April 22nd 2011.
Click here to learn about how you can celebrate Arbor Day.

http://www.arborday.org/arborday/celebrate.cfm

Click here to learn about the history of Arbor Day

http://www.arborday.org/arborday/history.cfm

CHAMPION TREES OF FLORIDA

The Champion Tree Program was created by the American Forests organization in 1940, to recognize the largest known tree of each species in the United States. American Forests publishes their "National Register of Big Trees" every two years. The new 2010 edition of the Register includes 99 Florida species, many of which are only found in the tropical region of the state. Florida now has the most national champions of any state. The largest National Champion tree in Florida is a native Florida Strangler Fig located in Dade County. This tree measures 360 inches in circumference, stands 63 feet tall, and carries a crown spread of 72 feet.
Florida began keeping a state register, the Florida Champion Tree Register, in 1975 to recognize the largest tree of each species within this state. It now contains hundreds of tree species, including National champions

The Florida Champion Baldcypress is in Big Tree Park, Seminole County. It is named The Senator, although not a national champion, it is the largest native tree in Florida, measuring 425 inches in circumference, 118 feet in height, with a 57 foot crown spread.

The tree used to be 165ft, but in 1925 a hurricane knocked its top off!

A lightning rod has since been installed to protect the tree from further damage.

FORESTRY MANAGEMENT TECHNIQUES

Applying forest management practices to increase forest productivity is called ***silviculture***. Prior to implementing forestry practices, a forester develops a ***forest management plan***. The forest management plan includes:

1. Objectives - Explains the desired outcome
2. Description - Describes plant communities, soil conditions, wetlands on site, and other forest characteristics
3. Plan of Action - Management practices that will occur to reach the objective
4. Maps - Gives the general layout of the site to be forested

The following describes forest management practices utilized in the field of forestry:

TIMBER STAND IMPROVEMENT

Tree farming involves a degree of undesirable tree control to allow for maximum timber production, just as agricultural operations involve weed control for maximum crop growth. In forestry, the weeds may be undesirable tree species or they may be trees of desirable species that are deformed, forked, or less vigorous than the crop trees.

Controlling undesirable trees to remove undesirable competition in the forest is called ***timber stand improvement*** (TSI). There are varying levels and methods of TSI in Florida, and each represents a substantial cost to the landowner. In many cases, the cost of a TSI operation can actually exceed the value of the timber crop.

In Florida, pine trees are the most profitable species to grow and hardwoods are generally viewed as undesirable trees in commercial stands of pine. In the discussion on succession, it was pointed out that hardwoods will crowd out pines without some outside factor, such as fire. If high-quality pine trees are to be grown, some degree of periodic hardwood control will be necessary. Where hardwoods are the crop trees, the undesirable trees might include pines or undesirable hardwoods.

Methods of TSI include thinning, prescribed burning, mechanical treatment, and chemical treatment.

Thinning

A given tract of forestland is capable of growing a limited volume of wood. This wood growth can be scattered among thousands of small trees, or it can be concentrated on a select number of superior trees through ***thinning***. Thinning results in faster growth for the remaining crop of trees, and they reach a marketable size at an earlier age.

Figure 8.1. Thinned pine plantation.

A typical forest that is naturally established contains thousands of young seedlings per acre. As the forest ages, the trees compete with each other for growing space. Faster-growing, superior trees crowd out the less competitive trees, which eventually die. Thinning mimics this natural development process of a forest.

The following are things to consider when determining whether a stand needs thinning:

- Growth rate — Core samples taken from a tree's trunk by an increment borer reveal growth rings in the wood. Declining growth rate over several years ususally indicates the need for thinning or a timber stand improvement operation.
- Tree condition — Tree crowns appear small in size, and they are closely packed together when a stand needs thinning. A rule of thumb to use when examining a stand of southern pine is, if the heights to the first green branches are greater than 60% of the average height of trees in the stand, then that stand needs thinning.

Once it is decided to thin, trees to be removed should include the following:

- Suppressed or dwarfed trees that have been overtopped by superior trees
- Trees with excessive crooks or forks
- Trees severely infested with insects or disease or trees heavily damaged by fire or other causes
- Large, excessively branchy trees called ***wolf trees*** that are shading out or crowding more valuable trees
- Selected trees from densely packed groups

In pine plantations, it is a common practice to remove every fifth row of trees to open up the stand and to allow access for heavy equipment. Trees in the remaining rows are then marked selectively for further thinning.

Precommercial thinning uses the concepts of thinning mentioned previously, except that the trees removed are unmerchantable, and therefore no money is recovered. Precommercial thinning is a labor-intensive and high-cost operation. Its application is usually confined to areas naturally reseeded, where there are too many stems per acre to allow good early growth. It can be accomplished by cutting, mowing, chopping, or herbicide application.

Prescribed Burning

Prescribed burning is the cheapest of these treatments. It is used regularly in stands of longleaf, loblolly, and slash pines to kill encroaching hardwoods. These hardwood trees are particularly sensitive to fires, especially when they are less than 3 inches in diameter. Pine plantations are burned mostly during the winter months due to stable wind conditions, low air temperatures, and favorable humidity. Summer burns may be implemented later in the life of the stand when pines are larger and more fire resistant. Spring and summer burning yields the best hardwood kill, but caution must be exercised to avoid damage to the pines.

State agencies are increasingly using summer prescribed burns. The theory is that summer prescribed burns closely emulate natural burns caused by lightning. It has been discovered that wire grass, an important native grass on drier sites, requires summer burns in order to flower. It is also believed that summer burns increase plant diversity within a forest ecosystem. Later in this chapter, more will be discussed on prescribed burning.

Mechanical Treatment

Mechanical TSI involves either hand labor or machinery such as a heavy disk, double drum chopper, or bush hog. These methods are very expensive. Other drawbacks include restricted equipment, maneuverability in the woods, possible damage to desirable trees in the stand, and unreliable kill of hardwoods, since they sprout back from the cut stumps. Mechanical TSI is being replaced gradually by

Figure 8.2. Double drum chopper.

chemical TSI methods, but is still justified on small tracts of forestland.

Chemical Treatment

Chemical TSI involves the application of plant-killing chemicals called ***herbicides***. Most herbicides used in forestry are designed to kill broadleaf vegetation and can be applied with no effect on existing pine trees. Herbicides can be sprayed onto the leaf, injected into or painted on the trunk, or broadcast as granules on the ground.

A combination of TSI methods can be utilized within the same year. For example, prescribed burning followed by an herbicide application debilitates and kills competition from hardwoods.

TIMBER HARVESTING

Clear-cutting

Clear-cutting is the practice of removing all timber from a stand in one cutting. It is a commonly used method of harvesting timber in Florida because it offers several advantages. It is the most economical method of harvest. It allows replanting of genetically improved trees. It allows the growing of trees that require full sunlight, and it can be used to check forest insects and diseases by removing the infested trees. But clear-cutting also has its drawbacks in that wildlife habitat is damaged or severely altered, soil erosion may be accelerated, and the clear-cut areas are left with a marked, if temporary, appearance of devastation.

Clear-cutting is often the final harvest at the end of a rotation. A rotation is the amount of time for trees to grow from seedling to final harvest. Short pine rotations of 25 years or less are typical for growing ***pulpwood***, while rotations of 30 to 60 years are common for pine for ***sawtimber*** poles, pilings, and plywood peeler logs.

Normally, thinnings are conducted on a planted pine stand at age 12 to 15 years and every 5 years or so thereafter. As trees become more mature, growth slows and fewer thinnings are necessary. At the end of the rotation, the stand is either clear-cut or heavily thinned to promote seed production for ***natural regeneration***.

Select Cutting

Select cutting or selection cuts involve the select removal of timber as single trees, scattered trees or trees in small groups at short intervals.

Successful selection cutting depends upon the ability of reproducing trees to become established and to survive in the openings left by harvested timber.

Seed Tree Cutting

In ***seed tree cutting***, the site is clear cut except for a few desirable "seed" trees. Approximately 10-15 seed trees per acre are left to cast seed over the entire area. The number of seed trees left depends on size, species, site conditions, and seed-bearing characteristics.

Shelterwood cutting

Shelterwood cutting employs the same technique as seed tree cutting except that more seed trees are left per acre (approximately 20-40). All seed trees are harvested once natural regeneration is complete.

Diameter-limit cutting

Diameter-limit cutting, widely used in the past, is no longer recommended. It involves removing trees of a certain diameter and larger. This system has fallen into disuse because it leads to highgrading the stand - removing the best and leaving the poorest trees.

REGENERATION

Regeneration is the establishment or reestablishment of a forest. Management activities for regeneration usually follow a timber harvest or a natural disaster such as fire, hurricane, or insect attack. Regeneration can occur naturally, or it can occur artificially through tree planting or direct seeding.

Natural regeneration occurs from natural seeding or from stump or root sprouts. It has the advantage of low cost. Natural regeneration from seed involves a heavy thinning, called a seed cut, at the end of a rotation. Five to 15 seed-bearing trees per acre are left following this thinning. These trees should be straight, disease-free, and have full crowns for maximum seed production. Seed trees for southern pine natural regeneration should be at least 10 inches in diameter for producing good crops of seed.

In order for the pine seeds to germinate, they need to come in contact with bare mineral soil. Occasionally, harvesting operations associated with the seed-tree cut will sufficiently expose the soil to allow adequate germination, but usually an area will require some sort of site preparation. Normally, burning is sufficient to prepare a seedbed, but other times, disking or chopping will be necessary to remove competing brush and vines or debris from timber harvesting operations.

Once seedlings are established, the mature seed trees are harvested to allow full sunlight for the young trees. This may occur from 1 to 7 years following the seed-tree cut, depending on seed production and the tree species.

Coppicing is natural regeneration through stump sprouts and root suckers. It is used in hardwood regeneration, primarily in northern states. Coppicing cannot be practiced on southern pine stands since these trees do not sprout from cut stumps. Common exotic pest plants that benefit from coppice are Australian pine, Brazilian pepper, rosewood, and Melaleuca.

Artificial regeneration is the most common method of establishing forests in Florida. Planting seedlings is more common, although ***direct seeding*** does take place in isolated locales in the state. Direct seeding involves sowing seeds which usually are treated to repel animals and insects. Seedbed conditions for direct seeding are similar to those in natural regeneration. Some site preparation of seedbeds may be necessary.

More acres of forestland in Florida are established through planting seedlings than by any other method. Planting provides a higher degree of seedling survival, provides control of tree spacing, and allows the use of genetically improved seedlings. The major drawback to seedling planting is the relatively high cost.

Seedlings for planting are grown in state or forest industry nurseries. There are nearly a dozen nurseries in Florida, producing almost 200 million seedlings annually. A two-person crew, a planting machine, and a tractor can plant 5,000 to 6,000 seedlings per day. Hand planting is used on areas too small to justify the use of machinery or in areas where machine planting is impractical due to the terrain. Most hand planting in Florida is acomplished through use of a spadelike tool called a dibble.

When preparing to plant trees, the forester must determine how many trees will be needed per acre. A common spacing for pine seedlings is six feet apart with ten feet between the rows, or a 6' x 10' spacing. This allows 60 square feet for each seedling to grow until the first thinning. There are 43,560 square feet per acre. The forester can now determine how many trees are needed per acre:

(43,560 sq. ft./1 acre) divided by (1 tree/60 sq.ft.) = 726 trees per acre

Consider the following problem:

Ms. Borfitz, a private landowner, wants to plant trees on 80 acres of land. The local forester recommends planting the trees on a 6' x 12' spacing. How many trees will Ms. Borfitz need?

First, each tree will be given 72 square feet to grow; 6' x 12' = **72 sq. ft.**

Second, determine how many trees will be needed *per acre*:
(43,560 sq. ft./1 ac.) divided by (1 tree/**72 sq.ft.**) = **605 trees per acre**

Lastly, multiply the size of the site and the number of trees per acre:
(605 trees/acre) x 80 acres = **48,400 trees!**

Other spacings and trees per acre are shown below:

Table 8.1. Number of tree seedlings planted per acre

Space Between Rows (feet)	Space Between Seedlings in Each Row (feet)						
	4	5	6	7	8	9	10
	Number of Seedlings per Acre						
4	2,722	2,178	1,815	1,556	1,361	1,210	1,089
5		1,742	1,452	1,245	1,089	968	871
6			1,210	1,037	908	870	726
7				889	778	691	622
8					681	695	544
9						538	484
10							436

PRESCRIBED BURNING

One of the cheapest and most effective practices used in the management of pines, except fire-intolerant sand pines, is a well-planned and -executed prescribed burn.

Prescription burning objectives are numerous and varied, such as

- Reducing hazardous fuel buildup
- Improving wildlife habitat
- Controlling undesirable competitive plant species
- Preparing sites for regeneration
- Controlling brownspot disease of longleaf pine
- Improving forage for livestock

Reduction of Fuel Buildup

In Florida, forest fuels such as leaves, grasses, shrubs, and small trees accumulate rapidly in pine stands. These fuels are significant fire hazards to pines, especially during periods of drought. The prescribed burn reduces these fuels by burning them under ideal conditions in a controlled manner. If a wildfire later occurs, the damage is less severe on an area that had previously undergone prescribed burning.

Figure 8.3. Note how this prescribed fire has reduced the height of forest fuels.

Fuel reduction burns are normally conducted during the winter when temperatures are cooler and the pines are dormant. The pine trees themselves should be at least 4 inches in diameter and measure 10–15 feet from the ground to the lowest green branches. Otherwise, the young trees may be severely injured or killed by prescribed fire.

Wildlife Habitat Improvement

Prescribed burning is used to improve timberlands for a variety of preferred wildfire food plants. This includes plants established as a result of seeding on bare soil as well as young succulent hardwood sprouts. Different benefits to wildlife and their habitats come from burning during different seasons. Time is important to benefit specific species.

Figure 8.4. Grass growth is stimulated by fire, which increases forage for this elk in Wyoming

Control of Undesirable Species

The use of fire for TSI has already been mentioned. Spring or summer burns provide the best kill of hardwood competition, but a fuel reduction burn may be needed during the preceding year to prevent heavy damage to the pine trees. Fire is the cheapest method of TSI available, but careful planning is needed to avoid damage to valuable trees.

Site Preparation

Figure 8.5. Note the pine needle-covered soil before the fire, versus the exposed mineral soil after the fire.

Site preparation burns to expose mineral soil or to reduce debris, logging residue, or competing vegetation may be required for planting, direct seeding, or natural regeneration. In open stands, burning is often the only site preparation needed. Burning in early spring prior to seed drop in the fall allows pine seeds to become established in a light grass, which should result in excellent seedling establishment.

Longleaf Pine Brownspot Disease Control

Brownspot is a serious fungus disease of young longleaf pines. The disease can kill or delay height growth in the grass stage of the trees for up to 10 years. Fire burns off infested needles and destroys the fungus. This burning is usually conducted in the winter. The fire does not destroy the tree’s terminal bud which is protected by the cluster of green needles around it. This allows the seedling to survive during prescribed burns.

Figure 8.6. Longleaf pine in the grass stage.

Livestock Forage Improvement

Just as wildlife is benefitted when prescribed burning produces new forage, so too is domesticated livestock. Years ago, cattle ranches made burning the woods an annual practice. Unfortunately, many of those fires were as damaging as wildfires. Today, however, modern burning techniques are used to improve forested rangeland.

Prescribed Burning Techniques

Various firing techniques can be used to accomplish the prescribed burning objectives. Almost all of these techniques incorporate backfiring. A ***backfire*** is started along a prepared firebreak, such as a road or fireline, and allowed to burn *against* the wind. As the backfire moves into the wind, it increases the width of the firebreak by creating a ***blackline***. A blackline is an area that has just burned and prevents the potential start of a wildfire. If embers are carried aloft, they usually fall harmlessly into the blackline. ***Headfires*** are allowed to burn *with* the wind. The major cause of unsuccessful control burns and killing desirable trees is trying to burn too much area too fast. Backfire is the safest, coolest, and slowest method of control burning.

Figure 8.7.

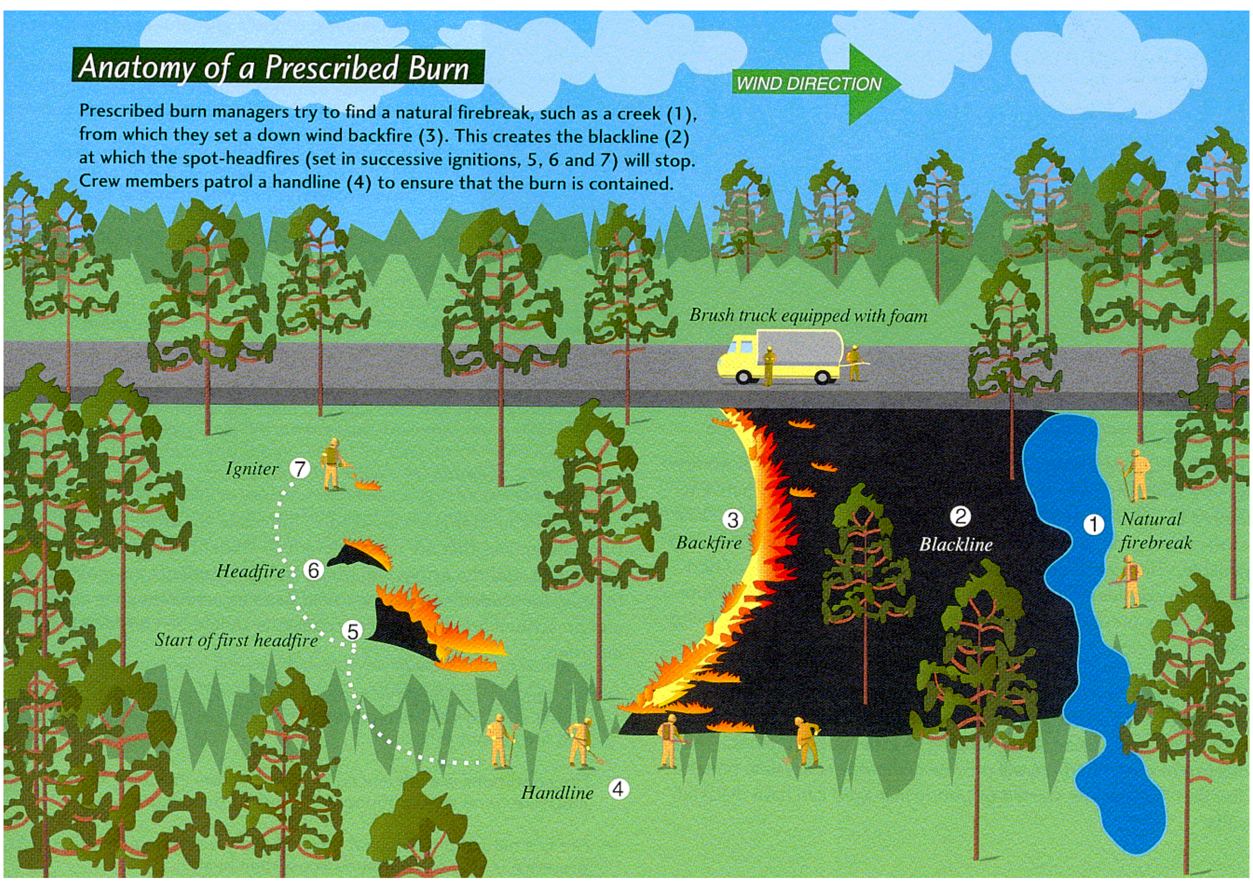


Figure 8.8. A backfire is lit using a drip torch or firepot.

MULTIPLE USE

Managing the forest for more than one purpose is a concept known as ***multiple use management***. The four most common components of multiple use management in our area are: timber harvest, wildlife management, range management, and watershed protection.

TIMBER HARVEST

Timber harvest is a component of multiple use management and, in many cases, ecosystem management. Harvesting trees helps to meet the demand for the more than 5,000 products made from trees. Other benefits or reasons for harvesting trees may include accessibility, insect or disease control, improved forest health, and restoration.

WILDLIFE MANAGEMENT

All animals require food, water, and shelter. With proper forest management, these requirements can be provided for desired species. People involved in wildlife management usually do not deal with the animals directly, but manipulate wildlife populations through the management of their food, water, and shelter. The forest management practices of thinning, clear-cutting, prescribed burning, site preparation, and regeneration are usually beneficial to wildlife, but sometimes the reverse is true. In situations where forestry practices are detrimental to wildlife, valuable wildlife habitat can be set aside as a refuge. This is the simplest form of wildlife management.

Habitat Diversity

Diversity is the key to creating habitat beneficial to a variety of wildlife species. Diverse habitats can be created in many ways. A general rule to keep in mind is that habitats with high diversity contain a large variety of plants. This creates a greater variety of food and shelter, thus making an area more attractive to a greater variety of animals.

Large planted pine acreages provide little in the way of food and shelter for wildlife. In the past, food plots (areas where food crops or plants are specifically grown) were used adjacent to or within pine plantations to attract wildlife. However, research has shown that food plots are often both inadequate and costly. The recommended alternative is to recognize and preserve areas of high quality habitat. For example, oaks and hickories produce acorns and nuts, also referred to as ***mast***. Mast is an excellent food for deer, turkeys, hogs, and squirrels. Other trees and shrubs such as hollies, magnolias, cedars, dogwoods, maples, cherries, elderberries, and palmettos also contribute greatly to food resources.

Figure 9.1. (from l. to r.) Acorns and hickory nuts are excellent mast producers. Berries on this Dahoon holly are a good source of food for birds.

Different tree ages and varying densities within a stand are as important as species selection in creating habitat diversity. Uneven age management provides old trees, which supply den sites and mast for wildlife and young trees, which allow for the growth of valuable food plants. Variation in stand density provides both cover and open areas, therefore increasing habitat diversity.

Figure 9.2. Pines in the forefront give way to hardwood species in the background. This area of transition is the ecotone.

Another way to increase habitat diversity is to provide "edge" between two or more habitat types. The area where two plant communities join together, also known as an ***ecotone***, is very attractive to wildlife. An ecotone includes the best of two worlds where plant species from both communities overlap, thus creating diversity. It is within this diversified zone that a majority of wildlife satisfy their food and shelter requirements. Take, for example, a pine forest merging into a hardwood swamp. Deer, squirrels, rabbits, and turkeys may prefer to feed in the pine forest, yet they derive protection from the dense swamp vegetation. See Figure 8.1.

Succession

Successional stages of a forest are important to wildlife management, providing diversity in tree species, ages, and densities. Different animals prefer different stages of succession. An example is the preference that grey squirrels have for late successional acorn-bearing oak stands. It is unlikely that an abundance of squirrels would be found in a stand of oaks only 2–3 years old. The red-cockaded woodpecker would not normally be found in young pines. Instead, this endangered species is adapted to nesting in old-growth longleaf pines usually infested with red heart fungus. The cutting of mature longleaf pine has eliminated much of the red-cockaded woodpecker's nesting habitat and led to the bird's decline.

Other species of wildlife prefer early stages of succession to meet their food and cover requirements. The bobwhite quail chooses an open grassy situation in which to nest and feed. Some species, such as the white-tailed deer, change their feeding habits from one season to the next. Hardwood trees bearing heavy mast crops make up the major portion of the deer's diet throughout the fall and winter. With the coming of spring, deer shift to other vegetation types such as young grasses, herbs, and woody plants.

Clear-cutting

Large tracts of timber are often clear-cut, leaving limited cover for most wildlife. In this case, man has set back succession. Usually, however, an edge is formed between cleared land and the remaining forest. An ecotone has been created. Within a short time, grasses and other small food plants will begin to grow in the open area, while the forested areas continue to provide cover and shelter. As trees are planted or natural regeneration takes place within the clear-cut area, it gradually becomes more attractive to another species of wildlife.

The shape of a clear-cut area can be designed to maximize the amount of edge, thereby helping to improve the altered habitat for wildlife.

Clear-cutting adjacent to bodies of water can have drastic effects on fish and other aquatic wildlife. Changes in water temperature due to shade removal can result in fish kills. In addition, sediments washed from the clear-cut area can affect water purity. A protective buffer strip of trees should be left to filter sediments as well as to shade the water.

An alternative to clear-cutting and planting trees is natural regeneration from seed trees. From a wildlife standpoint, natural regeneration is more beneficial than clear-cutting. The seed trees left to restock an area supply cover and food for various animals.

Snags

Although foresters are mainly concerned with living trees, dead trees also play a role in a healthy forest. Trees killed by lightning, disease, or insects may stand for a number of years before falling. These dead, yet standing trees, also called ***snags***, provide excellent habitat for woodpeckers, squirrels, owls, and other cavity-dwelling wildlife. One snag tree per acre should be left following a cutting operation to provide perch and nest stands. Once the snag does fall, it continues its usefulness to wildlife. Snakes, rabbits, insects, and plants all utilize the downed timber. Eventually, the tree decomposes and returns to the soil, replacing nutrients it consumed while alive and growing.

Prescribed Burning

Prescribed burning is a management tool used frequently in wildlife management. Prescribed burning, like clear-cutting, sets back succession and creates diversity. Reducing hazardous fuels through controlled burning reduces the chance of wildfire damage to both timber and wildlife. Burning also creates conditions favorable to the production of food plants. A prescribed burn returns nutrients from organic debris to the soil, fertilizing the soil. The ground debris disappears, allowing sunlight to penetrate and stimulate the growth of seed-bearing annuals, perennials, grasses, and other tender plants preferred by most wildlife. Animals are quick to return to burned areas to take advantage of the increase in palatability, quantity, and quality of food.

Game species such as white-tailed deer, turkey, quail, and doves benefit from prescribed burning. The size, frequency, and time of burning are important when considering different wildlife species. Prescribed burns for quail should be conducted every 1 or 2 years to increase the growth of seed-bearing plants. When managing for white-tailed deer, an interval of 2–5 years between burns allows for the production of perennial herbs, forbs, and succulent woody plants which are attractive food items. Turkeys prefer open woods, so hot summer burns that eliminate dense brush are recommended. Hot summer fires also help stimulate acorn production of runner oaks (*Quercus pumila*) in the sandhills. The acorns produced are a valuable wildlife food, but care should be exercised to avoid burning during the nesting season of ground birds. Small unburned patches should be left in the forest when large areas are to be burned. The unburned areas will provide cover for wildlife to feed in the burned areas.

RANGE MANAGEMENT

One of Florida's major industries is livestock, principally cattle production. With land disappearing as a result of increased agriculture, urban development, transportation, and recreation, more emphasis is placed on forested areas to produce both timber and livestock. Range management is the management of forage plants for livestock production.

Pine forests can serve as valuable rangeland. In many cases where timber is considered the primary goal, livestock is also managed to realize two sources of profit rather than one.

Controlling Grazing Pressure

Native grasses are highest in food value during the spring and a few weeks in early fall. During the winter, the value of these grasses declines greatly. Livestock instinctively graze first on plants of high nutrient content and palatability, resulting in the elimination of the favored plant species. Less desirable plants take over, and if they, too, are overgrazed and eliminated, invading weeds and shrubs become established. Extreme over-grazing reduces plant growth to a degree where bare soil and erosion become a problem.

Supplemental feeding and improved feeding conditions are sometimes provided to control grazing pressures, trampling, and possible tree damage. Pellets, grains, hay, and molasses aid in keeping livestock healthy while they feed on the less nutritious winter forage. The use of fencing, salt blocks, distribution of water supplies, mineral supplements, and recently burned areas can help divert livestock from areas that are threatened by overuse. The occasional relocation of these diversion mechanisms will prevent concentrations of livestock and the resultant trampling damage. This helps maintain a healthy range conditon.

Livestock may inflict damage on young trees by eating the leaves. Each kind of range animal may create a different problem. For instance, hogs can damage open range by their excessive rooting and can severely damage pines by feeding on their young, tender roots.

In the South, cattle are still considered the most important range animal. The number of these animals that can effectively graze without causing excessive loss of forage plants is called the ***stocking rate***. Proper stocking rate on a given parcel of land helps to assure the production of healthy animals and the continuation of a healthy range resource. A rule of thumb to use is one animal to 15–18 acres of native range.

Forage Availability

Open forests that let in the sun are critical to adequate forage production. As more trees occupy a site, grasses are shaded out and the quantity and quality of forage decreases. As the forest grows with age and the canopy closes, forage grasses virtually disappear.

In longleaf-slash pine forests, an abundance of forage grasses is normally produced. In pine-hardwood forests, food grasses are less abundant. The forest canopy is more dense, resulting in increased shade and a thicker layer of ground litter. In bottomland forests, the tree cover is even more dense. Smilax vines (green briars) and hardwood sprouts dominate the understory. Hardwood regeneration may be severely damaged by cattle forced to browse on young tree shoots.

The stocking rate is therefore directly influenced by both timber density and timber species. A dense bottomland hardwood stand would have a lower stocking rate than an open longleaf-slash pine stand, since forage production would be minimal.

Tree Spacing and Range Management

Range managers can also increase their returns from timber and cattle by choosing a suitable pine species and by leaving an adequate amount of space between tree rows. Slash pine is generally a preferred species to plant because of its early rapid height growth. Pines should be at least 3–5 feet tall before cattle are allowed to graze within the stand. At that height, physical damage from the livestock is usually minimal. Traditional spacings of 6 feet by 10 feet or 8 feet by 8 feet for pine plantations are commonly used for intensive timber management. Wider spacing of 6 feet by 16 feet or 8 feet by 20 feet is better suited for range management, as additional sunlight is able to reach the forage plants. Spacing is one of the many decisions the landowner will have to make in determining to what degree he wants to mix cattle and timber.

Table 9.1. Number of trees per acre

Space Between Rows (feet)	Space Between Trees (feet)				
	10	12	15	20	25
	Number of Trees per Acre				
6	726	605	484	363	
8	544	454	363	272	
10	436	363	290	218	
12	363	302	242	182	145
15	290	242	194	145	116
20	218	182	145	109	87

A natural pine stand is much the same as a planted pine stand, except that spacing and forage amounts differ. Periodic thinning of timber in both natural and planted stands creates additional openings favorable to forage growth.

FOREST RECREATION

Today, forest recreation is an important part of forest management. Throughout the nation, large increases in the demand for outdoor recreation have occurred. Continued increase in demand is anticipated as more and more people strive to get away from the stresses of city life. Camping, hiking, birding, bicyling, sightseeing, and picnicking are major forest recreation activities. They are enjoyed by people of all ages. The four major categories of ownership of recreational land are private, federal government, state government, and local government. As Florida's population continues to increase, more and more people will continue their interest in outdoor recreation, placing more pressure on public lands.

WATERSHED PROTECTION

The world's water supply moves in a constant cycle. And because of the world's extensive forests, trees play a very important role in the hydrologic cycle. Much of the water which soaks into the soil is used by trees to meet their needs for photosynthesis. Trees exhale moisture the same way people do. This process is called transpiration and occurs mostly during the spring and summer growing seasons when trees are adding large volumes of new growth and are consuming large amounts of water.

Forest soils are usually very stable and generally remain undisturbed for many years. Vegetation continuously supplies organic litter, which slowly decays on the forest floor. Plant roots help to hold the soil in place. Forest soils often act as sponges, holding moisture which is used by plants. When the forest is disturbed, this protective layer of plant litter may be affected and areas of soil exposed to the direct impact of rainfall. In some cases, this leads to soil erosion.

Factors in Erosion

Erosion occurs in three steps:
1. A soil particle is detached.
2. The detached particle is moved or transported.
3. The particle is deposited at some point.

Let's explore each of these three elements more closely.

Detachment — Soil is detached when a raindrop strikes the bare soil surface. Soil particles are most likely to break loose and move with surface water flow when not protected by the organic litter which naturally occurs on the forest floor. Some soil will be exposed as a result of forestry operations, such as harvesting, site preparation, and replanting operations. The detachment process is completed when the soil particle has been dislodged and is ready for transport.

Transport — In order for a soil particle to be transported, water must flow across the soil's surface with enough force to carry the detached soil particle. Water normally does not flow over the surface of a forested site, but when soil compaction occurs and the litter layer is removed, as with a road system, the soil's infiltration rate is lowered considerably and significant surface flow may occur. Forest roads with a long, steep grade will exhibit both increased runoff volume and increased velocity. As a result, there is an increased capacity for sediment transport.

Deposition — Once set in motion, the moving sediment will continue to travel until the carrying mechanism (water) is either slowed or stopped. If the water flow isn't diverted along the way, the sediment load will be carried to a stream or lake and be deposited there.

Detachment, transportation, and deposition are the three elements that form the erosion process. Reducing any one of these three elements will reduce the degree of erosion.

Controlling Forestland Erosion

Similar types of silvicultural treatment on different sites may produce different amounts of sediment. Anticipated problem areas need to receive careful consideration by the land manager or landowner. Essentially, there are three primary factors influencing how much sediment will reach the water body: (1) proximity to a waterway, (2) steepness of the terrain, and (3) lack of vegetation.

When correctly applied, forestry operations are relatively minor causes of erosion. Estimates indicate that only 4% of the total sediment produced in the United States is attributable to forestland. This is particularly impressive considering that one third of the country is forested.

Tree harvesting itself does not cause significant soil disturbance, but problems may develop when logs are skidded on steep slopes with erodible soils. Roads can be a significant contributor of sediment if proper location and construction are not considered. Heavily traveled haul roads become very compacted and prevent infiltration from occuring. The effect of rainfall can be quite significant, and erosion is likely to occur.

To reduce the problem of surface erosion, various construction techniques can be applied during road layout and building. One successful method is the use of broadbased dips (shallow humps in the road producing a rolling effect) to break the slope length. On less-traveled roads and fire lanes, water bars can divert surface water onto adjacent vegetative areas at selected intervals. Roadside ditches should include periodic turnouts to divert water into the woods in the same manner.

Site preparation (chopping, burning, and bulldozing) can also be a source of sediment pollution. The land manager or landowner should use less intensive methods which leave more surface litter in place to reduce the potential of erosion. Mechanical site preparation should not be used on land areas adjacent to streams and water bodies.

A vegetative buffer strip will help protect the stream from sediment problems in the fragile streamside area. This preserves water quality, maintains the efficiency of the stream to move water, and retains valuable topsoil on the site, which is necessary for quality plant growth. This strip is called the ***streamside management zone*** and is a very important factor which all land managers should include on sensitive areas adjacent to water bodies. See Figure 9.3.

Mechanized tree planting is by far the most common form of regeneration. When planting mechanically, the rows of trees should follow the contour of the land to minimize a potential erosion. This practice of planting with the contour can readily be seen on most agricultural fields and aids in reducing surface flow during rainfall. On some sites, hand planting of trees is still the best method to get the trees established. This technique, which has less potential for erosion because of the minimal degree of soil disturbance, should be considered on potentially erodible sites and sites where a mechanical planter cannot be used because of topography or wet conditions.

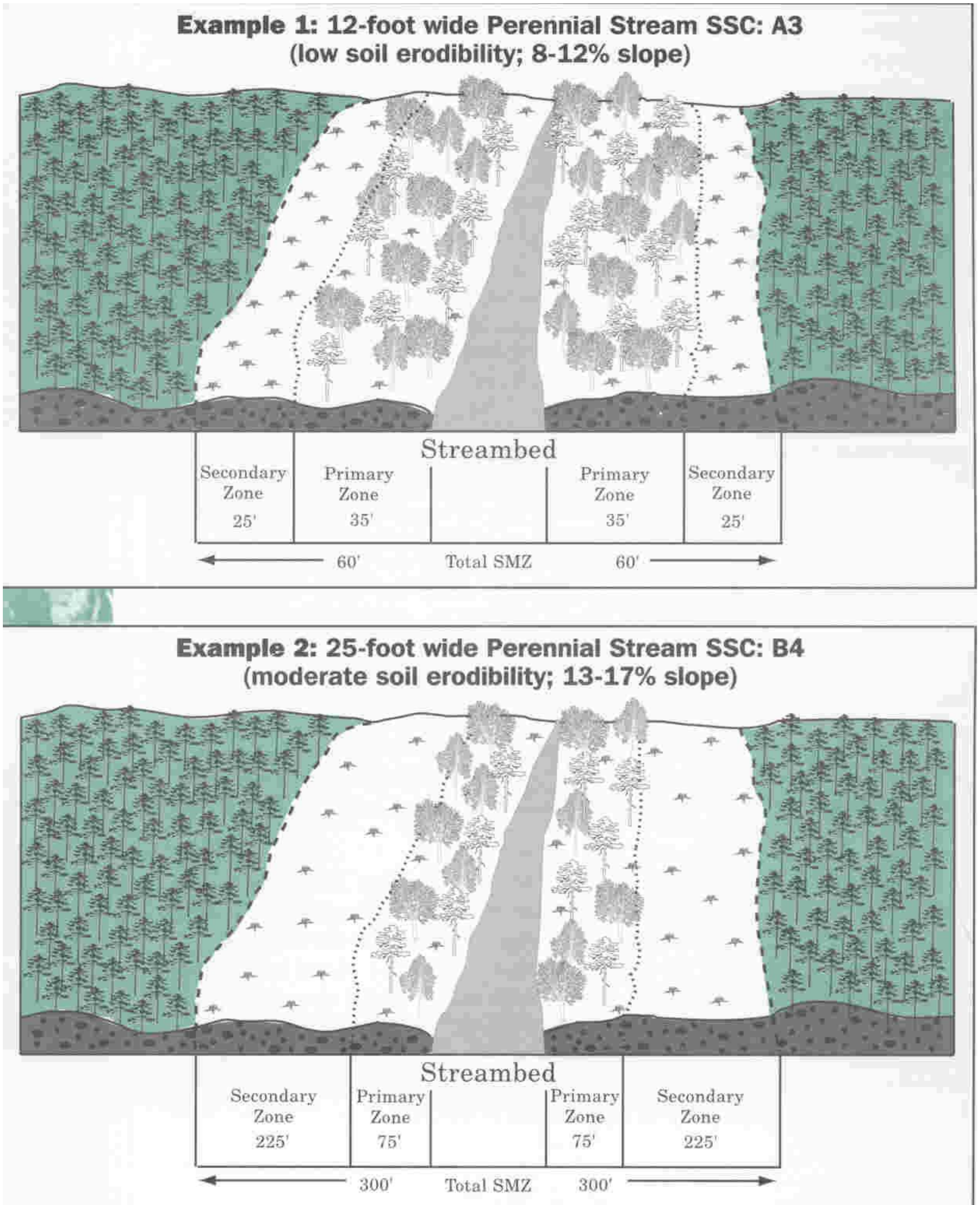


Figure 9.3. Streamside management zones, or SMZ's, are utilized during timber harvest operations to protect water quality from soil erosion.

<u>FOREST MEASUREMENTS & TOOLS</u>

INTRODUCTION AND OBJECTIVES

Forestry is a science based on measurements. In this section you will learn to use the same instruments and collect the same data that professional foresters use to learn and manage forest resources.

At the end of this chapter, you should:

- Demonstrate proficiency in pacing to measure distances and determine how many paces you have in a chain (66 ft.).
- Demonstrate proficiency in the use of the Biltmore Stick and Wedge Prism.
- Conduct a sample plot as part of a forest inventory using forestry instruments.
- Apply data to specific charts and tables to determine forest growth conditions.

PACING

The most basic forest measurement is pacing or counting your number of steps to determine how far you've traveled in the woods. A compass helps you determine which direction you are walking, but pacing allows you to determine distance.

In forestry the standard unit of distance measurement is the ***<u>chain</u>*** or ***<u>Gunter's chain</u>***, which equals 66 feet. Years ago surveyors literally dragged a 66-foot-long chain around with them to measure properties, which were measured in chains and links. It may seem like an awkward number to use, but the number 66 divides evenly into 5,280, which is the number of feet in a mile. There are exactly 80 chains in a mile. In addition, if you have an area of 10 square chains, you have exactly an acre. These numbers are easy to remember.

Today, foresters measure chains by knowing how many ***<u>paces</u>*** they take in 66 feet. A pace is equal to two steps. To determine your pace, measure out 66 feet using a 100-foot measuring tape, and count every other step (for example, every time your left foot hits the ground). People range between 10-17 paces per chain.

CHAIN FACTS:

- 1 pace = 2 relaxed steps
- 1 chain = 66 feet.
- 80 chains = 1 mile
- 10 square chains = 1 acre
- Several forestry tools are calibrated to be accurate from a distance of one chain.

TREE MEASUREMENT

Trees are measured to determine the volume and growth of both the individual tree and the entire forest stand. Measurements taken from trees form the data on which forestry policies are based. Decisions such as cutting schedules, thinning, and regeneration are dependent on tree measurements. Tree measurements also determine timber value and are used in predicting the future conditions of forested areas.

Diameter

Fig. 10.1. Diameter is measured 4.5 feet above ground.

Diameter is always measured outside the bark at 4.5 feet above the ground. This is called ***Diameter Breast Height***, or ***DBH*** (Figure 10.1).

Diameter measurements are used to determine the type of product for which a tree may be used. Minimum diameters vary from product to product and from mill to mill, but some general rules apply in Florida for pulpwood and sawtimber. ***Pulpwood*** is timber suitable for chipping and processing into pulp and paper products. ***Sawtimber*** is suitable for lumber production.

Minimum dbh for pine pulpwood is 4.6 inches. Trees with smaller dbh are usually considered too small for pulpwood. Minimum dbh for pine sawtimber is 9.6 inches. See Figure 10.2.

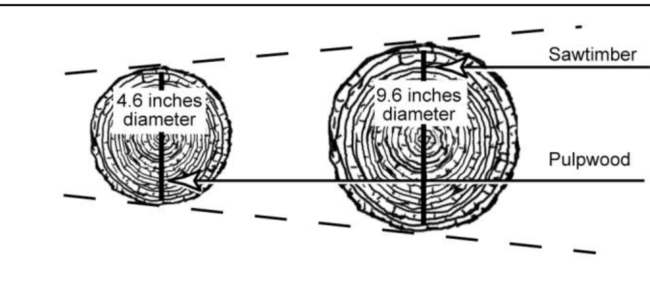


Figure 10.2. .Minimum DBH for product types.

Diameter is measured with a variety of instruments. The most frequently used tool is the logger's tape, which is calibrated to determine diameter by measuring girth (Figures 10.1 and 10.3). Diameters may also be measured using a tree scale or ***Biltmore stick*** (Appendix A explains how to make your own Biltmore stick). Diameters are usually tallied to the nearest inch. See Figure 10.4.

Figure 10.3 Logger's Tape

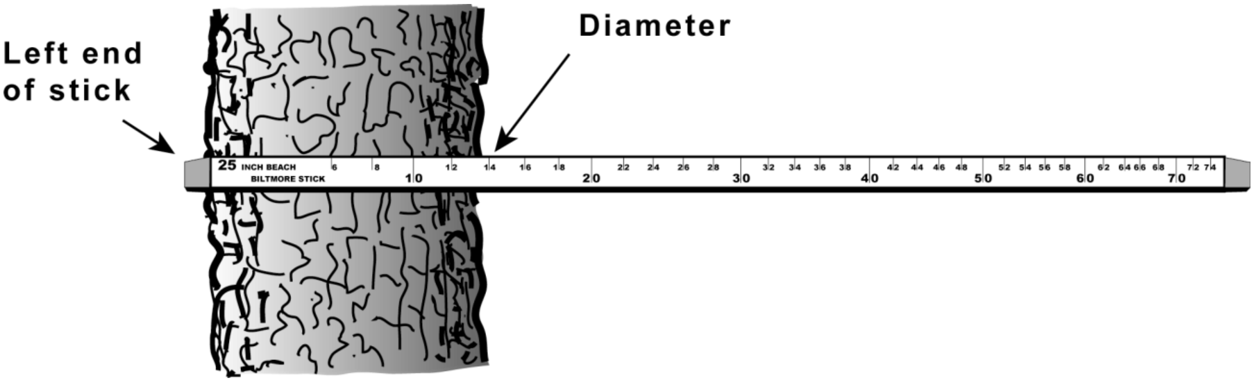


Figure 10.4. The Biltmore stick is a simple tool for reading tree diameters.

How to use measure diameter using the Biltmore stick:

1. Holding the Biltmore Stick against the tree, stand 25 inches from the tree. Almost all Biltmore sticks are 25 inches in length which will help you determine how far away to stand. If you have a homemade Biltmore stick, stand the distance away from the tree for which you made calculations. For example, if the markings on your stick are taken from the calculations for a 21-inch stick; stand 21 inches from the tree.
2. Hold the Biltmore stick at DBH.
3. Using only one eye, line the left end of the Biltmore Stick with the left edge of the tree.
4. Line the right edge of the tree with the corresponding number on the Biltmore Stick. This is your first diameter measurement.
5. Move perpendicular to your first measurement and take a second diameter reading. (A second measurement is necessary since trees are not perfectly round!)
6. Take the average of your two measurements and *voila'*; you have your diameter.

Height

Foresters use tree heights to determine growth, site productivity, tree and stand volumes, and tree vigor. A distinction is made here between total tree height and ***merchantable height***. Merchantable height is the upper limit of usable wood for a given product on a tree stem. See Figure 10.5.

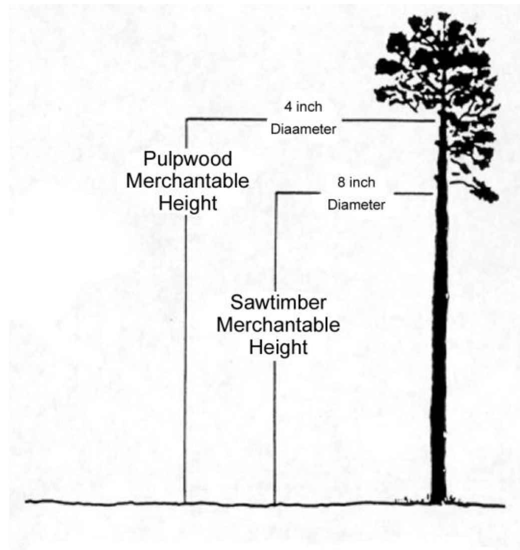


Figure 10.5. Merchantable height is dependent on the desired forest product and tree taper.

To determine the volume of a tree, we must first know how many ***logs*** or ***sticks*** are in the tree.

- A log is a unit of measurement equalling 16 feet. Merchantable height for sawtimber is measured in logs and is measured from the stump of the tree to an 8-inch diameter top.
- For pulpwood, we measure the number of 5-1/4 foot sticks from the base of the tree to a 4-inch diameter top. **NOTE: There are roughly 3 sticks per log

The insturment used to measure logs and sticks is the ***Merritt Hypsometer***, which can be found on one side of the Biltmore Stick. Here's how you use the Merritt Hypsometer:

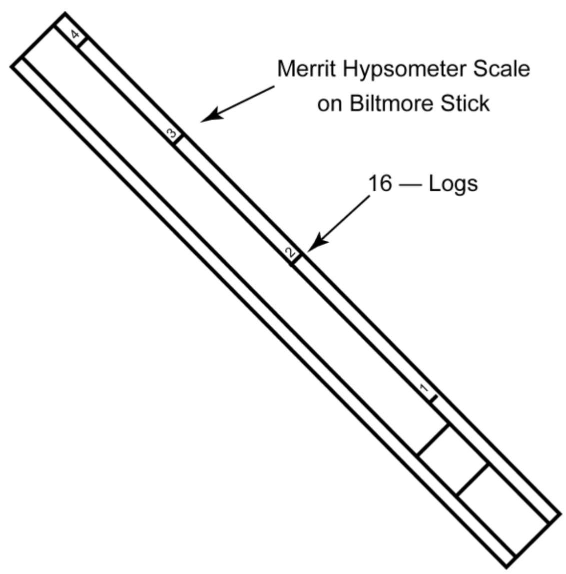


Figure 10.6. The Merritt hypsometer on a Biltmore stick can be used to measure merchantable height of pine sawtimber, as well as pulpwood.

1. Standing one chain away from the tree, hold the stick upright 25 inches away from your eye with the Merritt Hypsometer side of the stick facing you. **Note; if you made a 21-inch Biltmore Stick, hold the Biltmore Stick 21 inches away from your eye.
2. With the butt of the stick aligned with the base of the tree, count the number of 16-foot logs by matching the graduations on the stick to the trunk of the tree until you reach an 8-inch top or the first major defect in the tree. A defect may be a large branch, a bend in

the trunk, or a hollow cavity that would cause that part of the tree to be unusable at the sawmill. Measure to the nearest half-log (for example: 1-1/2 or 3-1/2 logs is OK).

3. For pulpwood, measure to a 4-inch top, defects are less critical because the tree will be ground up into chips, not sawn into lumber. Don't forget to convert merchantable height into 5-1/4 foot sticks!

Volume

With diameter and merchantable height measurements in hand, the forester is able to determine timber volumes by referring to tree volume tables. Volume tables vary by product, species, geographic location, date, and user preference. The Florida Division of Forestry's county foresters use the Hawes pulpwood volume tables for pine pulpwood and the Mesavage and Girard Scribner 78 Form Class volume tables for pine sawtimber. Pulpwood volume tables give tree volumes in terms of cubic feet of solid wood.

Pulpwood is bought and sold on the basis of a ***cord***. A cord of wood is a stack of wood that measures 4 feet high, 8 feet wide, and 4 feet long and contains 128 cubic feet. However, the 128-cubic foot stack also includes air space and bark, so the conversion factor of 90 cubic feet of solid wood per cord is used for standing timber.

Sawtimber volume tables yield tree volumes in board feet. A board foot is a piece of lumber that is 12 inches wide, 12 inches long, and 1 inch thick. Sawtimber tables take saw kerf into account. ***Kerf*** is the amount of wood removed as sawdust in the sawing operation. Generally, 1 cubic foot of wood will yield approximately 6 board feet of lumber after removal of slabs, bark, and sawdust. Sawtimber is sold on the basis of 1,000 board feet (MBF). ***MBF*** is *Millen* Board Feet, not million. Millen is Greek for one thousand.

Listed below are volume tables and sample problems for both pulpwood and sawtimber. You must not memorize volume tables, but you must know how to work these tables for the contest.

Table 10.1 Pulpwood Volume Table. Volume is measured in cubic feet.

	Number of 5-1/4 foot sticks						
DBH	**4**	**5**	**6**	**7**	**8**	**9**	**10**
5"	2.0	2.5	-	-	-	-	-
6"	2.8	3.6	4.2	4.9	-	-	-
7"	3.7	4.7	5.6	6.5	7.4	-	-
8"	4.8	6.0	7.2	8.5	9.5	10.8	-
9"	5.9	7.4	8.9	10.4	11.9	13.4	14.9
10"	7.1	8.9	10.6	12.5	14.3	16.1	17.8
11"	8.5	10.6	12.7	14.8	16.9	19.0	21.2

Table 10.2 Sawtimber Volume Table. Volume is measured in Board Feet.

	Number of Usable 16-foot logs						
DBH	1	1-1/2	2	2-1/2	3	3-1/2	4
10"	28	36	44	48	52	-	-
11"	38	49	60	67	74	-	-
12"	47	61	75	85	95	100	106
13"	58	76	94	107	120	128	136
14"	69	92	114	130	146	156	166
15"	82	109	136	157	178	192	206
16"	95	127	159	185	211	229	247
17"	109	146	184	215	246	268	289
18"	123	166	209	244	280	306	331
19"	140	190	240	281	322	352	382
20"	157	214	270	317	364	398	432
21"	176	240	304	358	411	450	490
22"	194	266	338	398	458	504	549
23"	214	294	374	441	508	558	607
24"	234	322	409	484	558	611	665

To compute pulp or wood volume, simply measure the tree's DBH, find it on the table, then line it up with its corresponding height.

Example #1. A tree has a 5.7" DBH with 39' of merchantable height. What is this tree's volume? Answer: 6-in. DBH, 7 sticks; **4.9 cubic feet**

Example #2. A tree has an 8.9" DBH with a merchantable height of 51'. What is this tree's volume? Answer: 9-in. DBH, 9 sticks; **13.4 cubic feet**

Example #3 A tree has a 12.1" DBH with 33' of merchantable height. What is this tree's volume? Answer: 12-in. DBH, 2 logs; **75 board feet**

Example #4. A tree has an 22.6" DBH with a merchantable height of 55'. What is this tree's volume? Answer: 23-in. DBH, 3 logs; **508 board feet**

Example #5. How many cords are found within a load of 5490 cubic feet of pulpwood? Answer: 5690 cu.ft. / 1 cord per 90 cu.ft. = **61 cords**

Example #6. How many MBF are found in a load of sawtimber containing 895,430 BF? Answer: **895 MBF**

Growth Measurements

Tree growth is often measured to predict future forest characteristics and to determine effects of certain forestry management practices on growth rates. Growth can be measured in any of a number of ways, one of which is determining height growth. Total tree height is measured prior to the growth season and is measured again after the growing season. A drawback to this method is the time period required to complete the growing season.

An easier and quicker method of determining growth is to measure diameter growth using an ***increment borer***, which extracts a small core of wood from the tree at dbh. The forester can then count the annual rings in the core to determine growth and also the age of the tree. The increment borer enables the forester to measure growth and predict future volumes of the forest without cutting the tree down to count the rings.

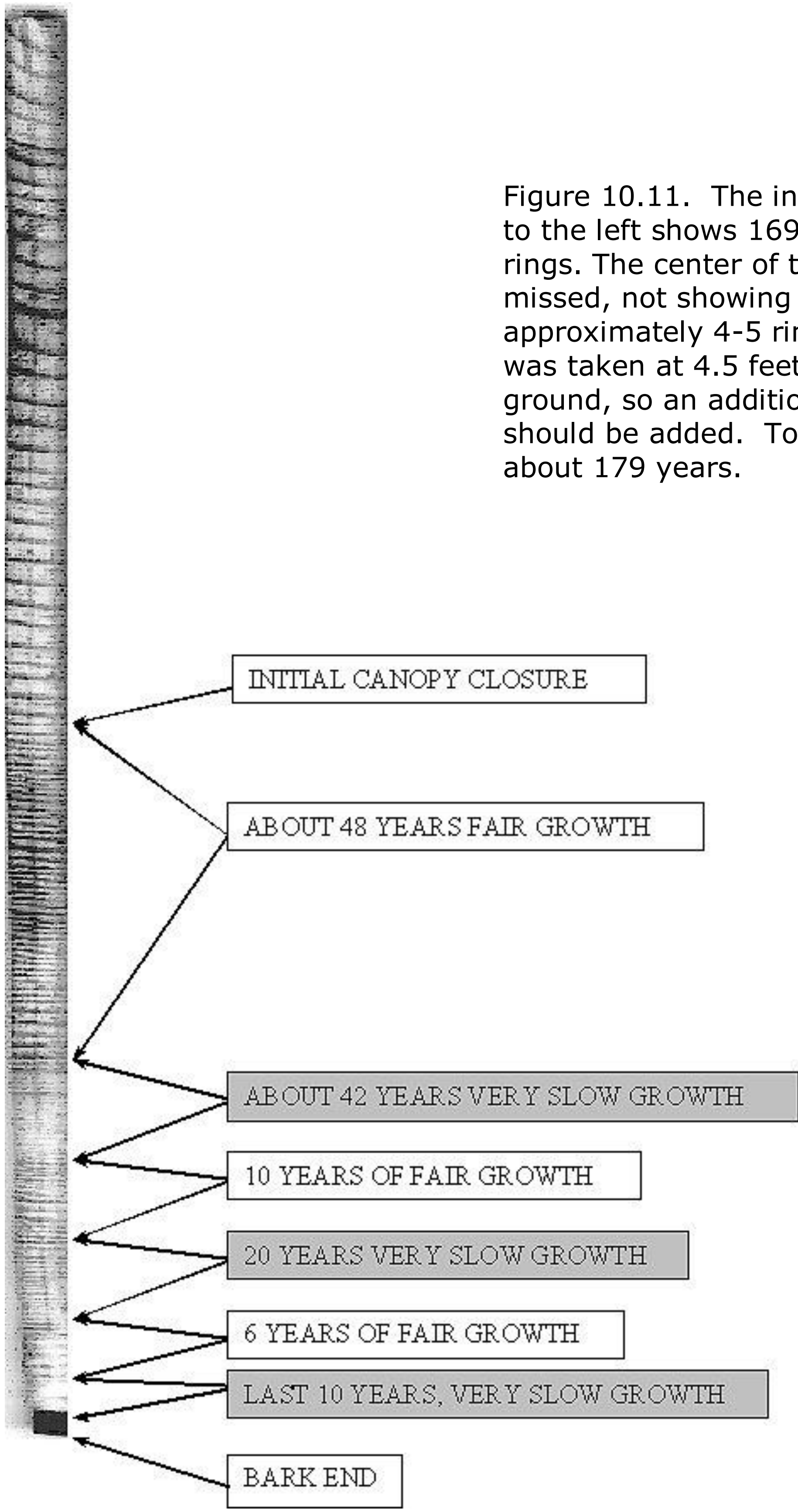
Fig. 10.7 Increment borer (blue handle with hollow, threaded bit).

Fig. 10.8 The forester inserts the increment borer by turning the threaded tip into the tree.

Fig. 10.9 The core extractor is inserted into the hollow increment borer.

Fig. 10.10 The core is removed. Growth rings can be counted and observed for growth patterns.

Figure 10.11. The increment core to the left shows 169 annual rings. The center of the tree was missed, not showing approximately 4-5 rings. The core was taken at 4.5 feet from the ground, so an additional 5 years should be added. Total age is about 179 years.



MAPS

Maps are used in forestry to locate land boundaries, determine timber types, calculate areas, locate wildfires, and help keep a person unfamiliar with an area from getting lost.

Two of the more common maps used in Florida forestry are the U.S. Geological Survey topographic ("topo") quadrangle maps and the Florida Department of Transportation county highway maps. Topo maps are highly detailed, showing locations of structures, trails, and depressions as well as ground elevations and land contours. The county highway maps are useful for establishing property boundaries and land locations.

Legal Descriptions

Distances between two points can be determined through the proper use of the map scale. For purposes of standardizing property lines throughout the state, Florida is divided into blocks, called ***townships***, measuring 6 miles by 6 miles (Fig. 10.12). The sides of the townships running east and west are called ***township lines***. Those running north and south are called ***range lines***. The numbering system for the whole state begins from a concrete monument called the ***Prime Meridian*** marker near the state Capitol in Tallahassee. The numbers grow larger as distance from the Prime Meridian marker increases. Each township line also is designated either north or south and each range number as east or west, depending upon the direction from the Prime Meridian marker.

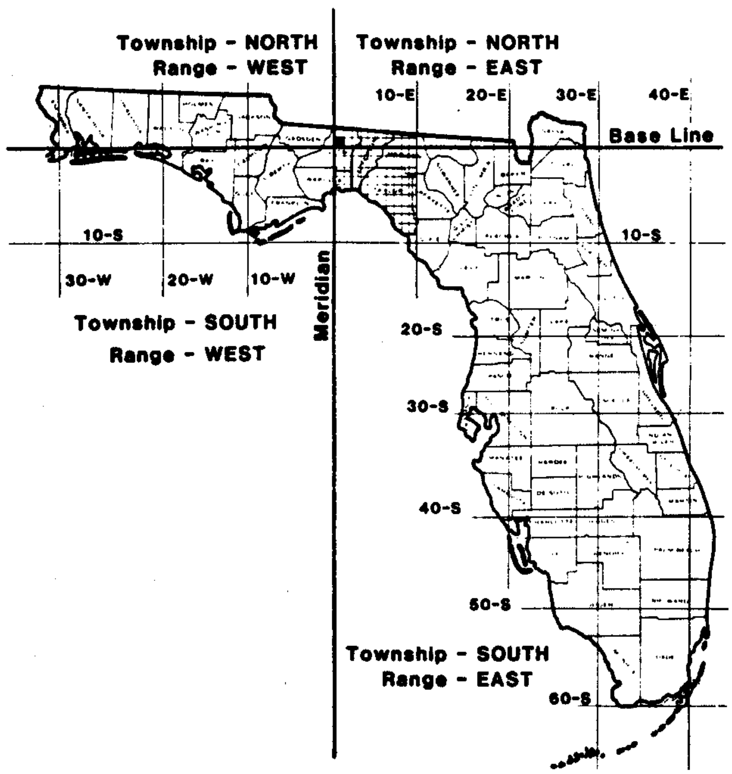


Figure 10.12 Florida is divided into townships. Range lines run N-S; Township lines run E-W.

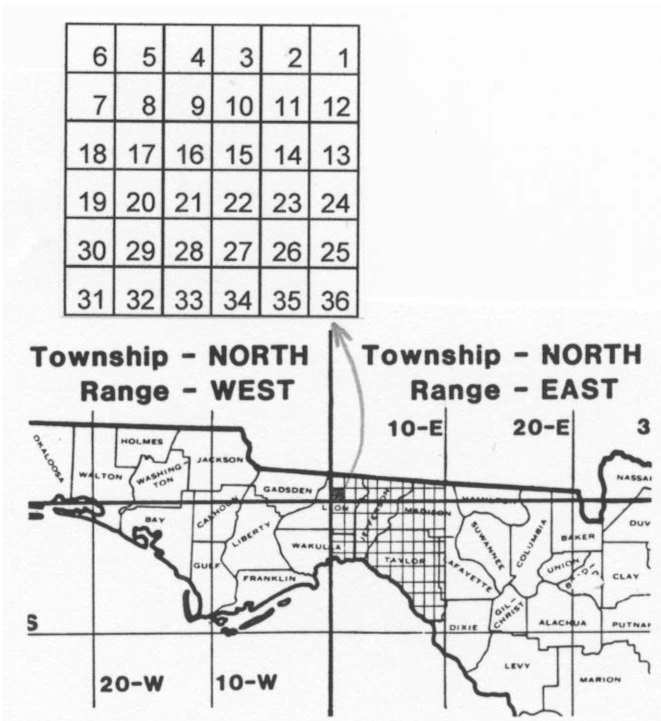


Figure 10.13. There are 36 sections in each Township.

Each township is divided into 36 ***sections***, each of which is 1 mile square (640 acres). Sections are numbered from east to west, top to bottom. Legal descriptions indicate section first, then township, then range. This is called the "***S-T-R***" of the property. For example Section 1, Township 10 S, Range 10 E.

Sections can be further divided into quarters and again into quarters (Figure 10.14). During the Indian River Lagoon Envirothon, you may be asked to identify the S-T-R for a location on a map.

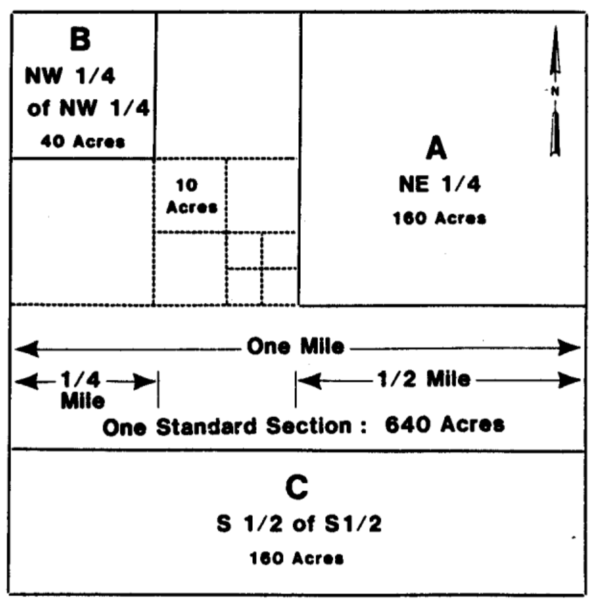


Figure 10.14. One standard section is 640 acres and is one mile square.

Land Area Calculations

It is important to know the size of the parcel when making land management decisions. Knowing the parcel size will determine the number of trees that will be needed for planting, the number of people required for a prescribed burn, or the cost of site preparation.

There 43,560 square feet in an acre. By measuring the dimensions of a parcel of land, either on foot, with a map or with an aerial photo, the acreage can be calculated utilizing geometry.

Example #1: Calculate the acres in Figure 10.15

2000 ft. x 2000 ft. = 4,000,000 sq. ft.

4,000,000 sq. ft. / (43,560 sq. ft./1 acre) =

91.8 acres

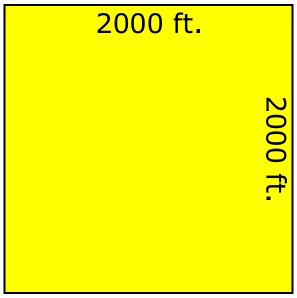


Figure 10.15

An alternative method of area calculation would be to measure the number of chains. On foot, it would be difficult to use a measuring tape to measure 2000ft. Pacing the number of chains is a quicker and easier method. In the above example, figure 10.15 is approximately
30 chains by 30 chains (2000ft / 66ft = 30.30).
The area of the parcel of land is 30 x 30 = 900 square chains.
Remember, there are 10 square chains in 1 acre. (*see* chain facts: page 84)
The number of acres is therefore 900 / 10 = **90 acres**. This is a good working approximation to the accurate answer, 91.8 acres. As you can see, using chains also makes the math a little easier!

Example #2: Calculate the acres in Figure 10.16

Area of the square: 2000 ft. x 2000 ft. = 4,000,000 sq. ft.

Area of the triangle: (1000 ft. x 2000 ft.)/2 = 1,000,000 sq. ft.

(4,000,000 sq. ft. + 1,000,000 sq. ft.)/(43,560 sq. ft./1 ac.) =
114.8 acres

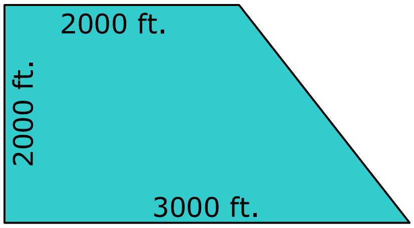


Figure 10.16

Assume that there are approximately: 15 chains in 1000ft, 30 chains in 2000ft and 45 chains in 3000ft.
Use the alternative method as in Example #1 to calculate the number of chains in Figure 10.16.
The approximate answer is 112.5 acres

SITE INDEX (S.I.)

Site index indicates the productive capacity of an area of forestland for a specific tree species. There are many ways to determine this productive capacity, but the most common is to measure the relationship between tree height and tree age.

To determine the site index, the heights of several dominant and co-dominant trees are measured. The age of these trees is found by taking a core sample and counting the growth rings.

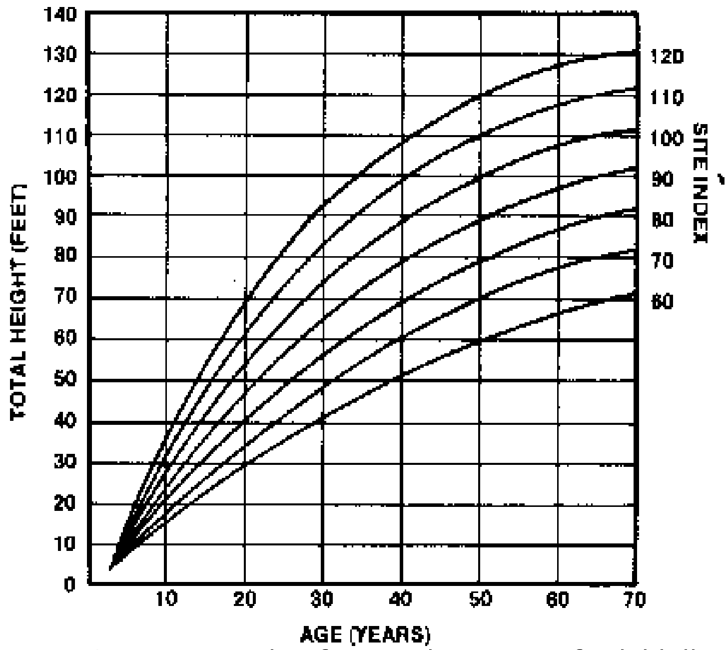


Figure 10.17. Example of site index curves for loblolly pine in Virginia, South Carolina, & North Carolina.

The average age (in years) is located on the *x*-axis and the average height (in feet) is located on the *y*-axis. Where these lines intersect on the site curve is the site index. Site index curves showing average height of various ages have been prepared for different species, by region.

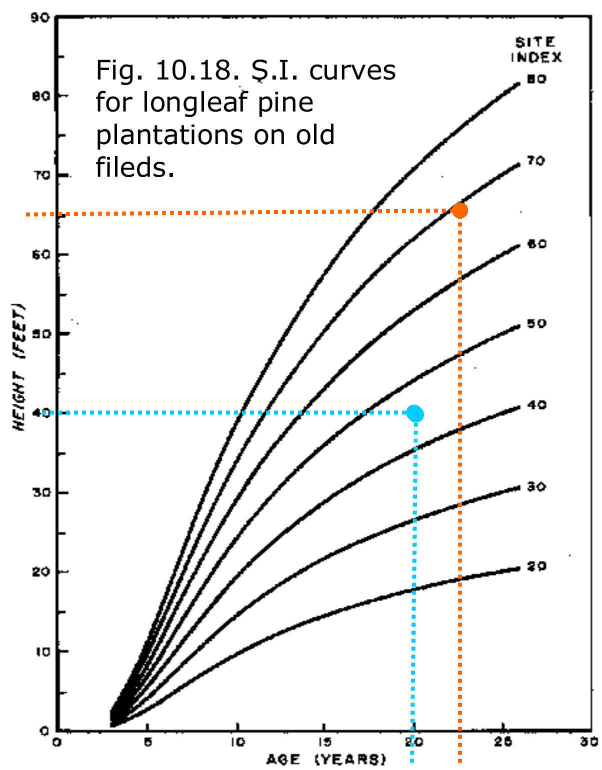


Fig. 10.18. S.I. curves for longleaf pine plantations on old fileds.

Example of how to use a site index curve:

What is the S.I. for longleaf pine whose height is 65 feet and age is 23 years? Answer **69**.

What is the S.I. for longleaf pine whose height is 40 feet and age is 20 years? Answer **45-46**.

WEDGE PRISM

Once you've learned how to take measurements on individual trees, we will now look at the characteristics of the forest community. One important measurement is determining the ***basal area*** , or level of tree stocking on a particular site. Basal area is the measurement of the cross-sectional area of a given tree stem (or trunk) expressed in square feet at DBH. The basal area of a forest stand is the sum of the basal areas of individual trees, and is expressed in square feet per acre. The basal area of all trees in an area describes how much area is occupied by those trees.

Foresters use simple yet innovative instrument to determine the basal area on a specific site of a sample point. The ***wedge prism*** is a small piece of glass that has been ground to refract light rays at a specific offset angle, which creates an "optical illusion" (Figure 10.19). Each tree that is measured or *tallied* is equal to 10 square feet of basal area, so we are using a wedge prism that has a basal area factor of 10 (BAF=10).

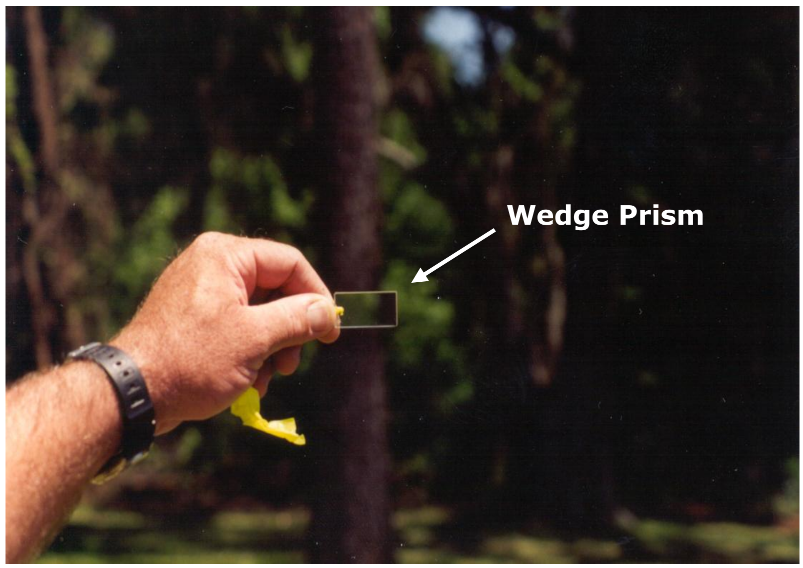


Figure 10.19

Foresters can determine the amount of basal area in a forest by measuring the trees in parts of the forest called plots. When a forester measures these plots, it is assumed that these small areas of the forest are representative of the entire forest. When using the wedge prism, it is very important to remember that the instrument must always be held directly above the "plot center" for accuracy.

The optical illusion the wedge prism creates appears to "offset" a portion of the tree's stem or trunk when viewed, preferably at DBH. If the offset portion appears to connect with the main stem of the tree, you tally that tree as "in" or "countable." If the offset portion appears completely removed from the main stem of the tree, do not tally that tree because it is considered "out" or "not countable." For trees that appear to be borderline or on the edge, simply count the first borderline tree then tally every other borderline tree after that. See Figure 10.20.

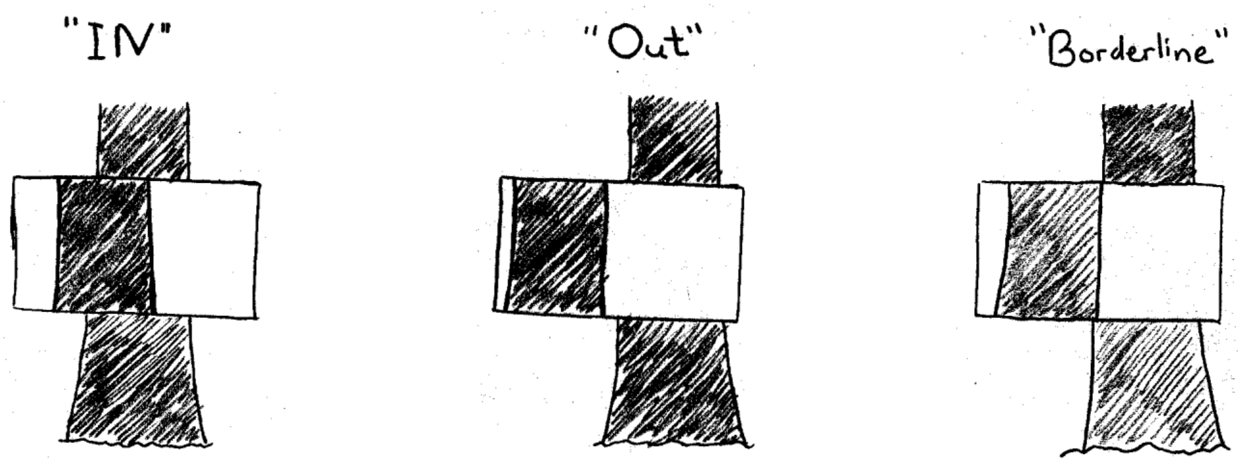


Figure 10.20 This is what trees will look like when viewed through a wedge prism. Remember, view all trees at DBH. Tally the first borderline tree in your sample plot, then tally every other borderline tree after that.

After determining the number of "in" or countable trees, as well as every other "borderline" tree, multiply that number by 10 to determine your basal area (because you are using a 10 BAF prism). For example, if you have 8 "in" trees, your basal area is 80, or you have 80 square feet of basal area per acre. If you were using a wedge prism with a BAF of 5, your basal area would be 40.

APPENDIX A—HOW TO MAKE A BILTMORE STICK

Biltmore sticks will be provided during the day of the competition. Homemade Biltmore sticks may be used at the Regional Contest ONLY and are subject to inspection prior to their use during the Forestry segment. Homemade Biltmore sticks may be disallowed at the discretion of the Forestry official in charge at the event.

Let common sense be your guide if using a homemade Biltmore stick. In other words, don’t draw or write anything on the Biltmore sticks that may look like an aid to you or your team.

Listed below is the table with the formulas for 21”, 23”, and 25” sticks. Industrial-sized paint stirring sticks make great Biltmore sticks. You may be able acquire them at any store that sells paint.

Instructions:

Diameter Increments - On one side of your blank stick, measure the distance from the end of the stick to the point where you will make your first mark for “diameter 4”. For example, if you have a 23” blank stick, measure 3.4 inches from the end of the stick and make a mark. The second mark you’ll make is 4.5 inches from the end of the stick, and so on…

Hypsometer Increments – Using the table marked “Height” and the other side of your stick, make your first measurement from the end of the stick to the point where you will make your first mark for “16”. For example, if you have a 21” stick, measure 5.1 inches from the end of the stick and make a mark. This mark will indicate the first 16 feet on your tree. The second mark is located 10.2 inches from the end of the stick, and so on…

Diameter and Hypsometer Increments for a Biltmore Stick

Diameter	25" Stick	23" Stick	21" Stick
4	3.7	3.7	3.7
5	4.6	4.5	4.5
6	5.4	5.3	5.3
7	6.2	6.1	6.1
8	7.0	6.9	6.8
9	7.7	7.6	7.5
10	8.5	8.3	8.2
11	9.2	9.0	8.9
12	9.9	9.7	9.6
13	10.5	10.4	10.2
14	11.2	11.0	10.8
15	11.9	11.7	11.5
16	12.5	12.3	12.1
17	13.1	12.9	12.6
18	13.7	13.5	13.2
19	14.3	14.1	13.8
20	14.9	14.6	14.3
21	15.5	15.2	14.8
22	16.0	15.7	15.4
23	16.6	16.3	15.9
24	17.1	16.8	16.4
25	17.7	17.3	16.9
26	18.2	17.8	17.4
27	18.7	18.3	17.9
28	19.2	18.8	18.3
29	19.7	19.3	18.8
30	20.2	19.8	19.3
31	20.7	20.2	19.7
32	21.2	20.7	20.1
33	21.7	21.1	20.6
34	22.1	21.6	21.0
35	22.6	22.0	
36	23.0	22.5	
37	23.5		
38	23.9		
39	24.4		
40	24.8		

Height	25" Stick	23" Stick	21" Stick
16	6.1	5.6	5.1
32	12.1	11.2	10.2
48	18.2	16.7	15.3
64	24.2	22.3	20.4

Hypsometer (Height) Increment =
(Biltmore Length x Log Length) / 66 ft.

Diameter Increment = SQRT [(a (d*d)) / a+d]
a = fixed distance from eye to stick; e.g. 25"
d = any selected tree diameter

APPENDIX B—GLOSSARY

Abdomen. The hindmost of the three main body divisions of an insect.

Acidic. Soil with a pH of less than 7.0.

Adaption. An adjustment to a specified use or situation.

Alkaline. Soil with a pH of more than 7.0.

Alternate. An unpaired leaf arrangement. Alternate leaves are located singley on a stem.

Angiosperm. Plants with seeds born in an ovary.

Annual ring. One year's wood growth, as viewed in the cross section of a tree trunk.

Artificial regeneration. The practice of planting seedlings or direct seeding for reestablishing a forest.

Backfire. A slow-moving fire that burns into the wind.

Bark. Protective covering over branches and stem that arises from the cork cambium.

Basal Area. The cross-sectional area of the tree 4.5 feet above the ground.

Biltmore Stick. A yardstick-like device for estimating tree diameter and merchantable height.

Blackline. An area where forest fuels between the main fire and a fireline are burned out.

Board Foot. A unit of volume measurement for sawtimber equal to a board that is 12" x 12" x 1".

Cambium. See *cork cambium, vascular cambium*.

Canopy Analysis. The determination of percent canopy cover over a selected area by use of aerial photos.

Cellulose. The material in a wood cell wall that is extracted in the papermaking process.

Chain. See Gunther's chain.

Chlorophyll. The green substance in plants which acts as a catalyst in the photosynthesis process.

Chlorosis. The uniform yellowing of the leaves resulting from a decrease in the normal amount of chlorophyll present in the leaves.

Clear Cut. The practice of removing all timber from a stand in one cutting.

Climax stage. A relatively stable stage of succession. Plant communities remain in the climax stage until some disturbance begins succession anew.

Co-dominant. A tree with its crown in the upper level of the canopy of surrounding trees, and receiving direct sunlight from above and comparatively little sunlight from the sides.

Compaction. Solidly united or packed together. This refers to compacted soils which are poorly drained and contain little oxygen.

Compound. A tree leaf that contains more than one leaflet per petiole.

Control Line (fireline). A strip of ground where all flammable forest fuels have been removed to suppress a wildfire.

Coppice (coppicing). Relying on stump sprouts or root suckers for regeneration.

Cord. A stack of wood 4'x 4'x 8', or a unit of volume measurement equal to 90 cubic feet of solid wood.

Cork cambium. The zone of bark development. Cells in the cork cambium divide to become bark.

Counterfiring. Deliberately setting fire to forest fuels with the intention of stopping a wildfire.

Crown. The above ground portion of the tree excluding the trunk.

Cut(s). A land grade change in which soil is removed.

Deciduous. Trees or shrubs that shed all of their leaves each year.

Dendrology. The science of tree identification.

Diameter Breast Hieght (DBH). The diameter of a tree measured at a point 4.5 feet above the soil surface.

Diameter Limit Cut. The practice ofremoving trees of a certain diameter and larger.

Dioecious. Trees that have male and female flowers on separate trees. (See *monecious*.)

Direct Seeding. The application of spreading tree seed in an area pre-pared for tree planting.

Dominant. The tallest, broadest trees of a forest that get the most sunlight.

Drip line. The outermost edge of a tree crown.

Earlywood (springwood). The wood (xylem) that develops in the spring during periods of rapid growth. It is the lighter colored band of an annual ring.

Ecosystem. A system of interrelated organisms and their physical-chemical environment.

Ecotone. Edge area between two vegetation types.

Entomologist. A person who studies insects.

Entomology. The study of insects.

Evapotranspiration. The process by which a tree releases water vapor to the atmosphere.

Evergreen. Green all year, not shedding all of its leaves at one time.

Fasicles. The bundles of two or more needles on pine twigs.

Feeder roots. Roots at or near the soil surface, located from taproot outward to the drip line. These roots absorb the bulk of the water and nutrients required by the tree.

Fill(s). A land grade change in which soil is added.

Fireline (control line). A strip of ground where all flammable forest fuels have been removed to suppress a wildfire.

Flatwoods. Flat, wet, sandy forestlands with soils of low pH, typically occupied by slash pine, saw palmetto, and gallberry.

Forest Community. A group of tree species that occur together in a particular habitat. Many forest communities may exist within an ecosystem.

Forest Management Plan. A written document containing a description of the forest and a plan of action to be implemented.

Forest Pathology. The study of forest tree diseases.

Forestry. The art and science of managing forests and related natural resources to meet the demands of society.

Gall. A swelling of plant tissues frequently caused by insects.

Gallery (galleries). Tunnels excavated under tree bark, by bark beetles, for the purpose of egg-laying.

Genus. A group of species having similar fundamental traits.

Girdling. The practice of severing phloem tissue around a tree's circumference to cut the supply of food to the roots and kill the tree.

Grass stage. The early life stage of longleaf or South Florida slash pine. The seedling resembles a clump of grass and develops an extensive root system prior to initiating height growth 3–7 years following germination.

Gunther's Chain (chain). A unit of length equal to 66 feet.

Gymnosperm. Plants with seeds born exposed (not in an ovary).

Hammock. A slight elevation arising from wet soils occupied by one or more species of hardwood trees.

Hardpan. A compacted, impermeable layer of soil.

Head. The most rapidly spreading portion of a fire's perimeter, usually to the leeward side (with the wind) or upslope.

Headfire. A fire , or portion of the fire, that burns *with* the wind.

Heartwood. Dead or inactive xylem, located in the center of the tree, often of a different color than the sapwood.

Herbaceous. Having little or no woody tissue.

Herbicides. Plant-killing chemicals.

Imperfect Flower. A flower with one type of sexual structure only.

Increment Borer. A device used to extract small cores from a tree trunk for examination of annual rings.

Insect. An invertebrate animal having three distinct body segments, three pairs of legs, and, generally, one or two pairs of wings.

Intermediate. Trees that receive some sunlight from above, but none from the sides because of competition from the dominant and co-dominant trees.

Kerf. The amount of wood removed as sawdust in the sawing operation.

Larvae. The immature life stage of an insect.

Latewood (summerwood). The wood that develops in summer during periods of slower growth. It is the dark-colored band of an annual ring.

Lateral Bud. Bud located to the sides of the stem below the terminal bud. If the terminal bud is damaged, the lateral bud grows to replace it as the site of shoot elongation.

Leaf Margin. The edge of a leaf.

Leaf Scorch. The browning of leaf edges and the areas between major veins of the leaves.

Leaflet. One leaf of a compound leaf.

Log. A sawtimber-size tree whose merchantable wood is cut into 16 foot lengths.

Mast. The flowers, fruits,or seeds of plants, especially of trees and shrubs, that are eaten by animals.

Merchantable Height. The smallest diameter of usable wood on a standing tree trunk.

Merritt Hypsometer. A device found on the Biltmore stick that measures merchantable tree height.

Millen Board Feet (MBF). One thousand board feet.

Monoculture. A single tree specie that occurs together in a particular habitat.

Monoecious. Trees with both male and female flowers on the same tree. (See *dioecious*.)

Multiple-Use Management. Managing forestland for more than one purpose. For example, managing for both timber and wildlife.

Mychorrizae. Beneficial fungi that aid a root to absorb water and nutrients.

Naval Stores. Products such as turpentine and rosin derived from the gum, or resin, of pines.

Natural Regeneration. The practice of relying on seed produced and disseminated from standing trees, on stump sprouts, for regeneration.

Niche. The unique environment or set of ecological conditions in which a specific plant or animal species occurs, and the function the organism serves within that ecosystem.

Opposite. A paired leaf arrangement. A part directly across anotheras paired leaves on a stem.

Orientation. The arrangement of leaves, twigs, and buds on a branch.

Organic Matter. Non-living, decomposed organic material.

Overtopped. Trees that are growing beneath the canopy of other trees, and which receive little or no direct sunlight.

Pace. Two normal, relaxed steps.

Pathogen. A living disease-causing agent.

Pathologist. A person who studies diseases.

Pathology. The study of diseases.

Perfect flower. A flower with both male and female sexual structures.

Pesticide(s). A general group of pest-killing chemicals. This grouping can include herbicides, insecticides, nematicides, rodenticides, etc.

Petiole. The stem-like part of the leaf.

pH. A measure of soil acidity or alkalinity. The pH scale runs from 1 to 14, with 1 being extremely acid, 7 being neutral, and 14 being extremely basic.

Phloem. Tissue which conducts food manufactured in the crown to the rest of the tree. It is formed on the outward side of the vascular cambium. (See also *xylem*.)

Photosynthesis. The food-making process in all green plants. Carbon dioxide and water are combined to form sugars and oxygen gas.

Pioneer Species. The first plants to become established on bare land.

Pitch Tube. Hardened resin with a tube-like or balled form on the outside bark of pine trees infested with bark beetles.

Pneumatophore. Black mangrove root structures that grow vertically from the soil surface and provide air to undreground and underwater roots.

Pollen. A plant's powdery, male reproductive particles.

Prescribed Burning.

Precommercial Thinning. A non-merchantable, partial harvest of timber designed to control the density of a timber stand.

Prime Meridian. A concrete marker near Tallahassee where the Township numbering system for the state begins.

Pulpwood. Standing timber or cut roundwood, suitable for converting to paper.

Range Lines. Parallel lines 6 miles apart running north-south that are numbered to denote east-west locations of townships.

Rayon. A textile fiber made from a cellulose solution.

Regeneration. The re-establishment of a forest through planting, seeding, or natural processes.

Root Hairs. Minute projections of tree roots that absorb the bulk of nutrients and water required by the tree.

Rosin. The hard resin left after the distillation of crude turpentine. It is rubbed on violin bows and used in making varnish.

S-T-R. The abbreviation for section, township, and range.

Sapwood. Active xylem tissue; the layer of wood that transports water and nutrients from roots to crown.

Sawtimber. Trees suitable for the production of lumber.

Scarification. The treatment of seeds that make them permeable to water and gases. This usually done by mechanical abrasion or by soaking seeds briefly in strong acid or other chemical solution.

Section. A land unit of one square mile (640 acres).

Seed Tree Cut. The practice of removing all timber from a stand except for a 10-15 desirable "seed" trees.

Select Cut. The select removal of timber as single trees, scattered trees or trees in small groups at short intervals.

Shelterwood Cut. The practice of removing all timber from a stand except for a 20-40 desirable "seed" trees.

Sign. Physical evidence of a pathogen or disease-causing agent.

Silviculture. The science of producing and tending a forest.

Simple. A tree leaf that contains one leaf per petiole

Site Index. The productive capacity of an area of forestland for a specific tree species.

Slope. An upward or downward incline.

Snags. Standing dead trees.

Soil texture. The proportional distribution of different size mineral particles in a soil.

Species. The asexual reproductive unit of ferns, lower plants, and fungi.

Spore. The asexual reproductive unit of ferns, lower plants, and fungi.

Spot Fire. Fire set outside the perimeter of the main fire by flying, or rolling, sparks or embers.

Springwood (early wood). The wood (xylem) that develops in the spring during periods of rapid growth. It is the lighter colored band of an annual ring.

Stick. A pulpwood tree whose merchantable wood is cut into 5.25 foot lengths.

Stocking rate. The number of livestock animals per acre of forest rangeland.

Stomata. Microscopic pores on the underside of leaves that release water vapor from the tree and take in carbon dioxide.

Stratification. Treatment to seeds to break dormancy and promote germination. This is usually accomplished by exposing seeds to moisture at near freezing temperatures for a specified time.

Streamside Management Zone. A buffer strip of vegetation left adjacent to a body of water to protect it from degradation from timber harvest or reforestation.

Street Tree Survey. An inventory of trees growing along public rights-of-way.

Succession. The process by which plant communities evolve over a period of time.

Summerwood (late wood). The wood that develops in summer during periods of slower growth. It is the dark-colored band of an annual ring.

Sustained Yield. The principle of managing land in a manner that provides the same amount of product at the time of harvest to perpetuity.

Symptom. Characteristic exhibited by a disease host, indicative of a disease; response of a tree to disease.

Taproot. The main supportive root of a tree's root system. It serves as support for the rest of the tree and also aids in water and nutrient absorption.

Terminal Bud. The bud located at the end of a branch that is the site of shoot elongation.

Thinning. A partial harvest of timber designed to control the density of a timber stand.

Thorax. The body region behind the head on an insect which bears legs and wings.

Timber cruising. Measuring trees in the forest to determine their volumes.

Timber Stand Improvement (TSI). The practice of removing undesirable trees from a stand.

Township. A land unit of 36 square miles containing 36 sections.

Township Line. Parallel lines 6 miles apart and running east-west that are numbered to denote north-south locations of townships.

Tree. A woody perennial plant, with a single stem and a well defined crown, that grows at least 8 feet in height.

Tree Disease. A sustained, progressive impairment of the structure or function of any part of a living tree.

Turpentine. A colorless, volatile oil distilled from a substance extracted from various coniferous trees.

Urban forestry. The practice of managing trees and other resources to improve the urban environment.

Vascular cambium. The zone of xylem and phloem development where cells divide and differentiate into either xylem cells on the inside of this zone or phloem cells to the outside.

Wedge Prism. A glass instrument that foresters use to determine the basal area on a specific site of a sample point.

Whorled. An arrangement where three or more leaves or flowers are located at the same point.

Wolf trees. Large, bushy trees that suppress younger, more desirable trees in a stand.

Xylem. Woody tissue which transports water and nutrients from the roots to the crown consisting of millions of tubelike cells. It is formed on the inward side of the vascular cambium. (See *phloem*.)

APPENDIX C—FORESTRY UNITS OF MEASURE

Tree Volume

1 cord = 90 cubic feet of solid wood
1 cord = a stack of wood 4 feet x 4 feet x 8 feet
1 board foot = a piece of wood 12 inches x 12 inches x 1 inch
1000 board foot = 1 MBF

Land Measurement

1 pace = 2 relaxed steps
1 acre = 43,560 square feet
1 chain = 66 feet
80 chains = 1 mile = 5,280 feet

1 section = 640 acres = 1 square mile
1 township = 36 square miles
1 township has 36 sections in it.