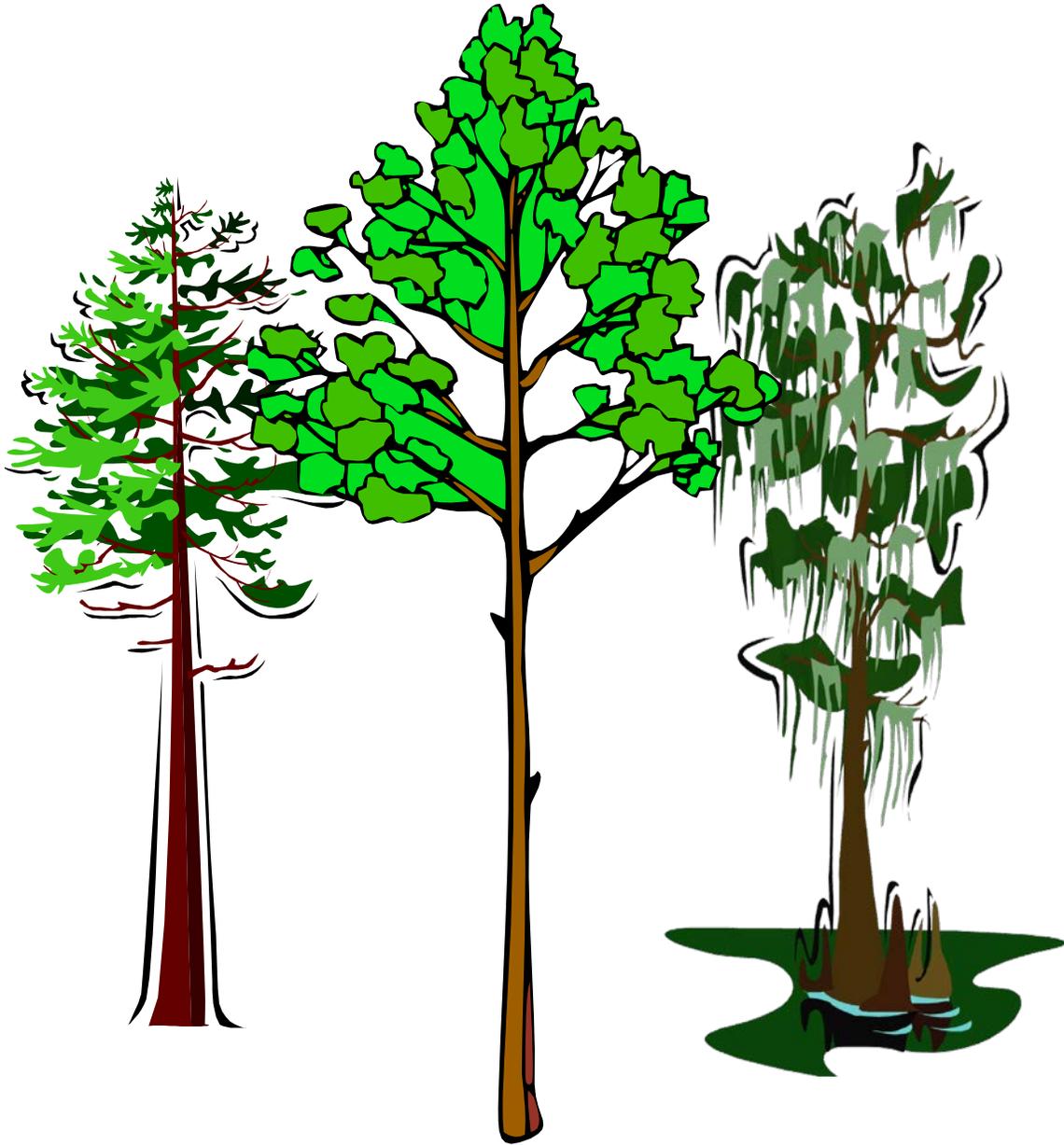


INTRODUCTION TO FORESTRY IN FLORIDA



NICOLE "NIKKI" FRIED, COMMISSIONER



DEPARTMENT OF AGRICULTURE & CONSUMER SERVICES

Introduction to Forestry in Florida



Florida Forest Service

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www.FDACS.gov/FLForestService

FOREWORD

The forest needs of Florida's citizens are much greater than many realize, often impacting our lives in ways that we may not always see. It is estimated that the average person utilizes 40 products a day that are derived from the forest. This not only includes the obvious products such as lumber and paper, but items such as toothpaste, ice cream, film, cellophane, tape, adhesives, and enhancements for many of the foods we eat and drink. There are well over 5,000 different products that come from forests. Of course, there are many other benefits we derive from forests, such as clean air, clean water, recreation and an enhanced environment.

Currently the forest industry is the leading agricultural industry in Florida and second only to tourism in total impact on the state's economy. The timber industry also provides numerous jobs and outdoor recreation opportunities for millions of visitors each year.

Forestry is about balancing the ecological, social and economic needs of our state. Educating our citizens about proper forest management practices will help ensure that forests will be healthy and that the forest industry remains a viable commodity for future generations.



Jim Karels
State Forester, Florida Forest Service

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This document is also available on the world wide web at:

<http://www.FDACS.gov/Divisions-Offices/Florida-Forest-Service/Education/For-Kids-and-Parents/Future-Farmers-of-America-Forestry-Contests>

Revised 2012

Throughout this manual are words that are bolded and set in italics. The definitions of these words can be found in the glossary.

Part One: Introduction

Introduction

Almost 1/3 of the world's total land area is covered by forests!

Florida's forests cover a large area of the Sunshine State. Almost one half of the state's 35.7 million acres is forested. This is more than the total amount of area that makes up New Hampshire, Vermont, and Massachusetts combined! Florida's forests support an industry that creates more than 5,000 everyday items, has a \$16.6 billion impact on the State's economy, and supports more than 133,000 jobs. The state also gains from the ecological services that forests perform. Forests purify our water and air, create wildlife habitat, give us natural beauty, and provide recreation opportunities. In fact, a year 2000 study showed that four million people visit Florida's forests each year primarily for observing wildlife. An additional 234,000 people visited forests to hunt. They contribute around six billion dollars to the economy every year, and support almost 65,000 jobs doing so. The added worth of water and air purification, biking, hiking, camping, horseback riding, fishing and other forest services to Florida's economy are huge!



Trees around residences, in city parks, along city streets, and in rural areas clean the air of pollutants. Trees also act as sound barriers along noisy roads, reduce heating and cooling costs of buildings, and provide us with aesthetic beauty.

Forestry is the science, art, and practice of managing and using trees, forests, and their associated resources for human benefit. The benefits of trees to the people of Florida are more than we might ever know. Through the study and practice of forestry, we can better understand the usefulness of forests to people and to Earth's ecology.

Our demand for lumber or paper production results in a need for forests that is obvious to us. Other reasons that we need forests are not as obvious to many people, such as the need for

wildlife preservation or natural beauty. Many forest landowners use *forest management practices* that fulfill each of these needs to get what we need.

The following sections of this book should teach you about Florida's forestry history, common trees of Florida, what forests provide for us, how to manage these forests sustainably, and how to use forest measurement skills.

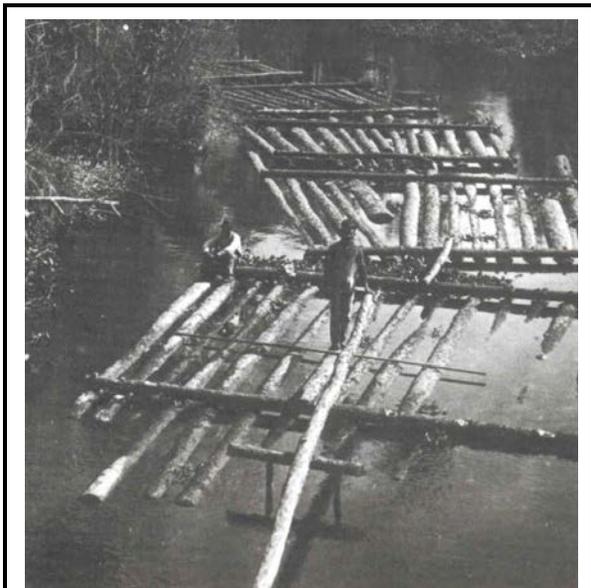
Questions:

1. What does the text mean when it says that forestry brings money into the state's economy? Discuss some of the ways that forests bring money into the state's economy.
2. What is forestry?
3. What are some things that forests do for society?

A well positioned tree can keep a house 20% cooler in the summer! Three trees can cut air-conditioning costs in half!

History of Florida's Forests

Originally, forests covered about 28 million acres of Florida's 35.7 million acres of land. The forests stayed intact during 300 years of struggle by England, Spain, and France for the control of Florida. The longleaf pine grew in most of this forest, with Florida being part of 90 million acres of the longleaf pine ecosystem that spread almost unbroken from Virginia to east Texas. Frequent fires, started by both lightning and Native Americans, allowed the fire-adapted longleaf pine ecosystem to do well. The fires also gave the land an open, park-like appearance with low plants and grasses that were easy to traverse.



Floating pine logs down the Oklawaha River to the sawmills in 1901. Forests along rivers were some of the first to be cleared because of the ease in which the logs can be delivered to the mills. (Photo courtesy of the Florida State Archives)

During the American Revolutionary War in the 1770s, Florida's forests supplied lumber and pine *pitch* to England. In the 1830s, cutting of Florida's timber increased near rivers that served to float logs to sawmills.

Before the 1800s, a traveler could go through continuous longleaf pine forests from South Carolina to Florida

After the Civil War, (the 1870s) timber cutting began in Florida on a more massive scale. Several reasons brought this about. First, the nation's population was growing and moving westward, creating a need for lumber to build new cities. Then, large steam-powered logging equipment came about that made it easy to harvest the virgin timber. Third, railroads came into all parts of Florida that created a fast, easy way to transport the heavy wood. Finally, the naval stores industry increased in the early 1900s to tap Florida's slash and longleaf pines. **Naval stores** was the common name for pine pitch that was used for sealing wooden ship hull-seams, waterproofing cloth and rope, making glues and varnishes, and for sealing the insides of clay pots. Cutting marks known as "cat-faces" into living longleaf and slash pines removed the pitch. The naval stores industry was Florida's biggest industry in the early

1900s, and Florida was the world's leader in naval stores production.



A young slash pine plantation in North Florida. Slash pine becomes pulpwood size quicker than longleaf pine do. As a result, slash pines are widely planted where longleaf once grew. This can lead to problems if the site is not suitable for slash pine.

After 1930, lumber production dwindled rapidly as the big companies ran out of readily

In the 1300s, France's forests were so reduced, and wood was so scarce that wooden coffins were often only rented for the funerals and then reused.

available virgin timber. Most of them practiced "cut out and get out" timbering practices that did not provide for a lasting, or **sustainable** supply of timber in Florida. These lumbermen saw the vast acreage of forests and assumed that there were plenty of trees to last their lifetime. The 19.2 million

acres of pine forests that Florida had in 1870 became only 7.5 million acres by 1937. Lumber mills closed down, towns were deserted, and the land became barren and non-productive.

The state of Florida decided to create the Florida Board of Forestry in 1927 to reestablish the forests across the state. They organized the **Florida Forest Service** "to gather information on forests, their care and management, to prevent and extinguish forest fires, and to enforce all laws pertaining to forests and woodlands." In 1969, legislation moved the agency into the Department of Agriculture and Consumer Services, changing the name to



This photo by the US Forest Service shows the cat-faced trees of a turpentine orchard. Turpentine orchards provided the naval stores industry with pitch that was used for water-proofing sealants, glues, and varnishes.

the Division of Forestry. Then in 2011, the name was changed back to the Florida Forest Service in recognition of the agency's role in the economy and protecting the natural resources of the state of Florida.

Austin Cary was known as the "Father of Southern Forestry" for his preaching of sustainable forestry practices. He died on the University of Florida campus in 1936.

The Florida Forest Service created programs that helped landowners replant trees on their land. It soon became popular to make paper from the pulp of southern pines. This changed the look of Florida's forests. The turpentiners that had developed a distinct heritage in Florida disappeared as cellulose from pulpwood replaced pitch demands. This change caused quick-growing slash and loblolly pine to replace much of the remaining longleaf forests.

The longleaf pine acreage continued to decline to less than one million acres by 1989. Despite the loss of longleaf forests, Florida replants 135 million new seedlings each year. Since the beginning of the Florida Forest Service, industry and private landowners have planted more than six billion trees. Florida is on its way to more sustainable management of its forest resources. The era of "*cut out and get out*" is gone.

There is 30% more timber volume per acre in the U.S. today than in 1952.

Questions:

1. What were Florida's early forests like before the 1800s? What was the dominant pine species?
2. What was Florida's biggest industry in the late 1800s and early 1900s? What happened to that industry and why did it happen?
3. What new technologies from post civil war times to the mid 1900s changed forestry in Florida on a major scale? Think about and write down what Florida gained and what Florida lost with the development of these new technologies.
4. Who was Austin Cary? Research this important figure in Florida's forestry history and write down his beliefs and accomplishments. Teachers, have your students research other founders of modern forestry in the United States as well.
5. Do you think the number of forested acres is growing or shrinking in Florida? Support your answer with research from sources other than this book.

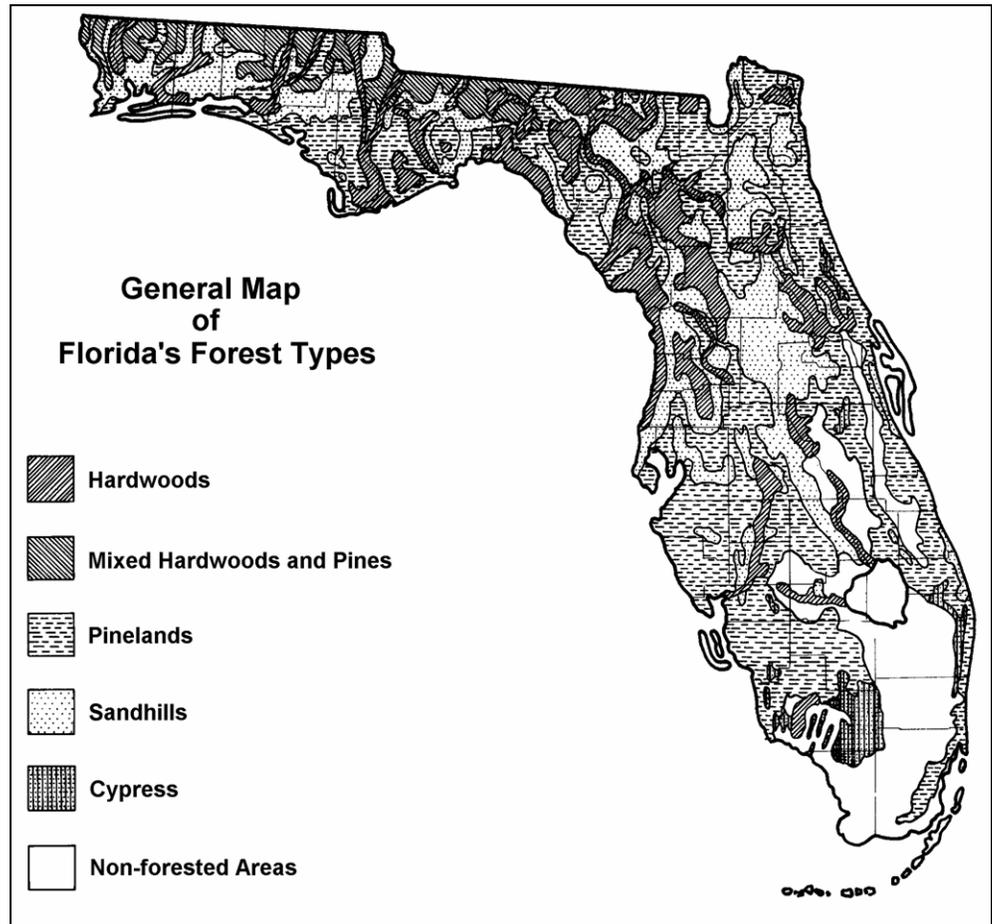
Forest Communities

For a state with such little topography, Florida has many different types of forest communities. In fact, a change of elevation of only a few feet in Florida could mean the difference between one type of forest community and another. This map shows some of the main types of forest communities in Florida.

The communities shown on the map on this page only

lists general forest communities. These communities contain thousands more micro-communities. The soil type in each of these communities is a main factor that determines which species can grow there. It is very important to know the soil type of the area before developing a forest management plan.

The hardwood forests consist of oaks, hickories, sweetgums, dogwoods, and more. These might be hardwood swamp communities with titi, tupelo, bays, maples, ash, hollies and other moisture-loving trees. Often times, these communities mix with pine forests. A loblolly pine forest could mix with swamp hardwood species, just as longleaf pines could mix with turkey or live oaks. The pineland community generally includes the flatwood slash and longleaf pine forests, while the sandhills include the pine and oak scrub communities. Cypress communities are usually wet swampy areas or areas along rivers or creeks. Bald cypress communities grow along moving waterways, while pond cypress communities grow in pockets of low topography, and usually form a group of trees in a shape known as a dome.

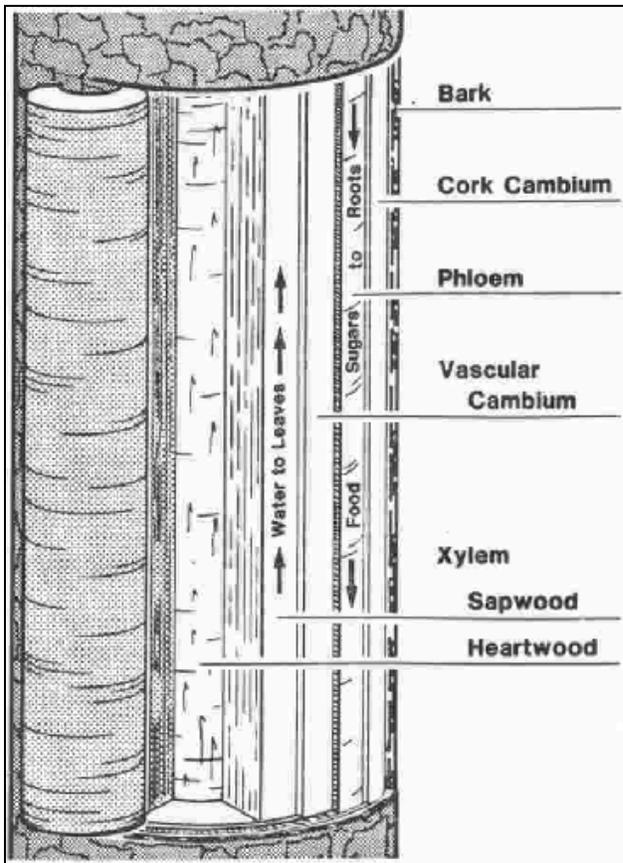
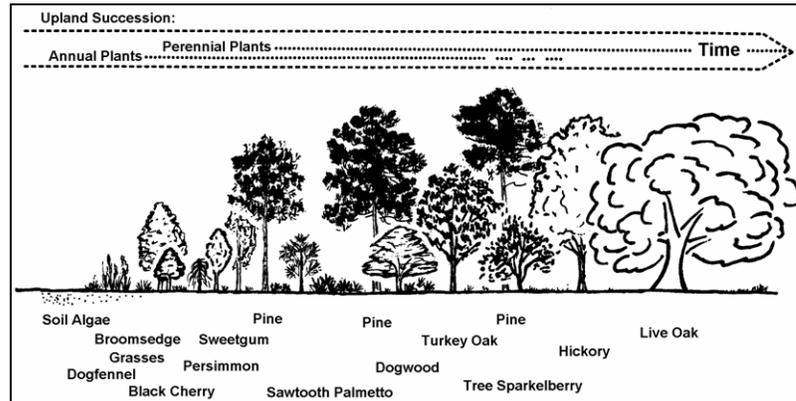


Succession

All plants and animals live in an environment to which they are specifically adapted. As environmental conditions change, so do the species of plants and animals.

Succession is the process by which plant communities change over time. During succession, plant communities change according to factors that affect the plants living

there. For instance, what will happen if a pine forest that is used to fires throughout the community every several years eventually stops having these fires? The oak community (that does not tolerate fires) will probably take over. Succession begins with the first species to occupy a bare site (the pioneer species.) Over time, these species replace species that grow better at that site at that particular time. Shade, fires, soil moisture, predators, and even human influences determine which plant community will occupy a site at a particular time. If a certain community maintains their control on a site because of their reliance on an outside factor (such as fire, or humans) then it is a sub-climax community. A community that is stable without outside factors (such as an oak forest) is a climax community.



The Tree

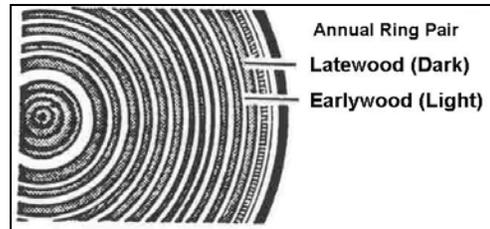
Any discussion of forestry would be incomplete without a look at the major component of the forest, the tree itself. A tree has **roots** that take in water and nutrients. It has a **xylem** that carries these necessities up the tree to the **leaves**. The leaves make food for the rest of the tree, which travels down to the roots by the **phloem**. Here is a closer look at each one of these main parts of a tree, plus a few more:

The roots have tiny **root hairs** that absorb water, nutrients, and oxygen that the tree must have to carry on its life processes. Many plants, including pine trees, rely heavily on tiny fungi in the soil called **mycorrhizae** that assist in water and soil absorption. Roots also help to anchor the tree against wind and water. The **taproot** is the main support root for trees and can

penetrate deep into the soil. The *feeder roots* are also known as the surface or *lateral roots* because they grow laterally just below the soil surface and generally absorb most of the nutrients and moisture.

The *xylem* is the woody portion of the tree and consists of two types of wood, the *sapwood* and the *heartwood*. The sapwood is the living outer portion that takes water and nutrients up from the roots to the leaves. The heartwood is the old, dead sapwood that serves as support for the tree and as a waste repository.

The xylem has a series of *annual rings*. Each growing season, the tree adds one annual ring. Each ring consists of a light and dark band of wood. The earlywood is the lighter colored, less dense wood. The latewood is the darker, denser wood. The *vascular cambium* cells divide in the xylem to create diameter growth.



On a hot summer day, a large tree can transpire 900 gallons of water. This can provide the cooling effect of six room-sized air conditioners!

The *leaves* are the tree's food-making factories. Leaves use a process known as *photosynthesis* to convert water, minerals, carbon dioxide, and the energy from the sun into sugars and oxygen. The tree uses sugar for food, while the oxygen is a waste product. The green substance in the leaves, *chlorophyll*, makes photosynthesis possible. Openings in the leaf known as *stomata* release most of the water that the leaf takes up. This cools the surface of the leaf and the air around it. This process is *evapotranspiration*.

The *phloem* is a narrow band of spongy tissue just inside the bark that takes food from the leaves to the rest of the tree. The vascular cambium cells are also responsible for the addition of new phloem tissue. The cambium layer creates xylem cells on the inside of the cambium and phloem on the outside. If a tree's phloem is severed around the tree, the tree will die because the roots would not get enough food. This is known as *girdling*. Foresters sometimes girdle undesirable trees to open up the canopy for emerging pine seedlings or grasses that are beneficial to wildlife.

One mature tree absorbs about 13 pounds of carbon dioxide per year. One acre of trees supplies enough oxygen each day for 18 people to breathe!

The *cork cambium* is responsible for producing the dead cells that make up the *bark* of the tree. 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 the longleaf pine is one of the reasons for the tree's tolerance to fire.

Questions:

1. A relationship between two living things where both are benefitted is called mutualism. What is the name of the fungus that is involved in mutualism with trees by helping their roots absorb water and nutrients? What other organisms have mutualistic behaviors?
2. When do you think a tree might have a long tap root, and when might it have little or no tap root? Explain your answer.
3. Give some reasons how the absence or presence of trees might affect the earth's climate.
4. What part of the tree do you think we make lumber out of?

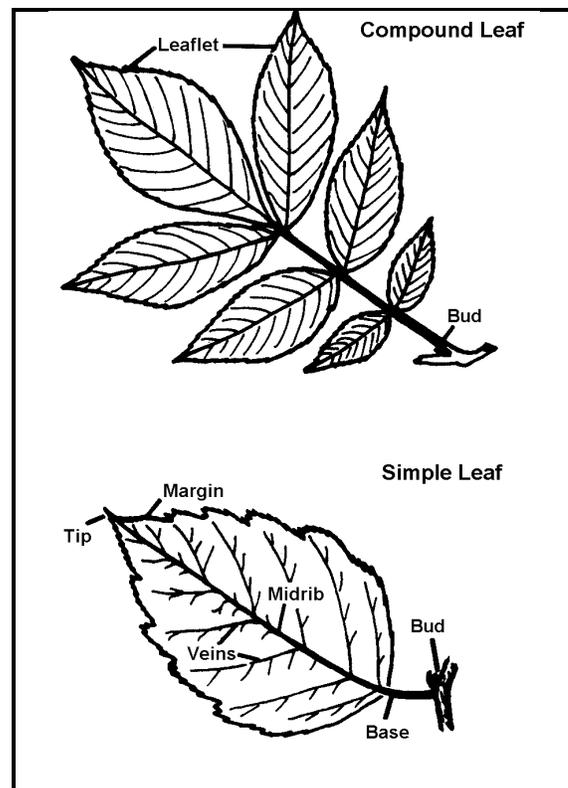
The oldest living tree is the bristlecone pine in the southwestern US. It is about 4,600 years old, and started its life when the Egyptians were building the pyramids!

Dendrology

Dendrology is the science of tree identification. This section will look at tree characteristics that are useful in identifying tree species. Scientists use an established system of Latin names to describe every species. These names avoid confusion between common names. For instance, *Quercus laevis* is known to people as both the turkey oak and the blackjack oak. The word *Quercus* refers to its genus, the word *laevis* refers to its species.

Broadleaf trees generally have wide leaves that shed each fall (*deciduous*), and have dense, hard wood. The easiest characteristics to observe when identifying these trees are the shape, arrangement, and margin patterns of their leaves. A leaf has a **simple** shape if it has one leaflet per bud. A leaf has a **compound** shape if it has more than one leaflet per bud.

There are always exceptions to the rules. Many broadleaf trees do not lose their leaves in the fall such as the southern magnolia and the live oak. Some broadleaf trees such as the cottonwood and willow have very soft wood.

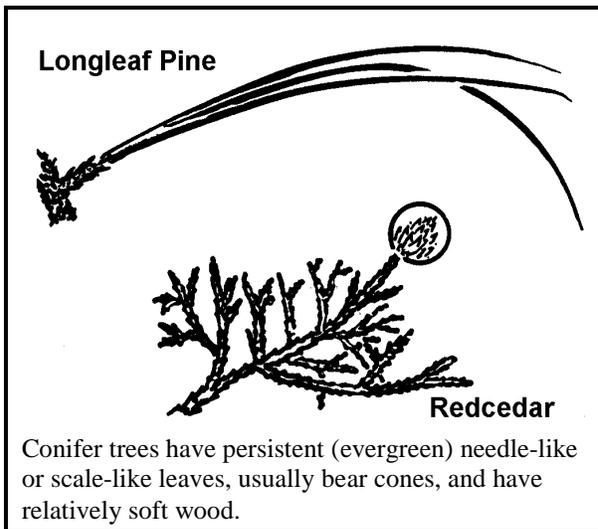
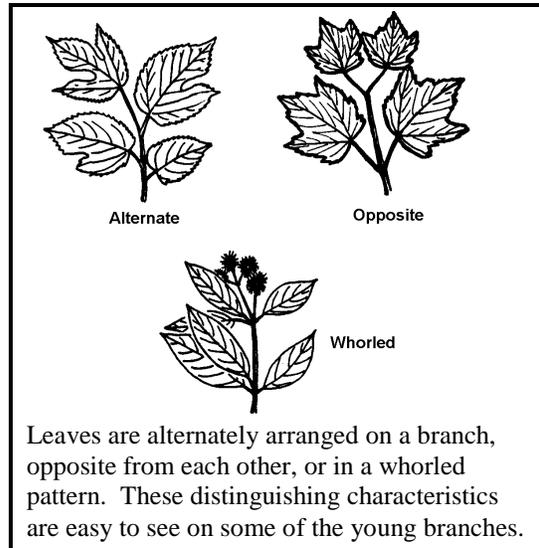


Conifer trees have persistent (*evergreen*) needle-like or scale-like leaves, usually bear cones, and have relatively soft wood. The

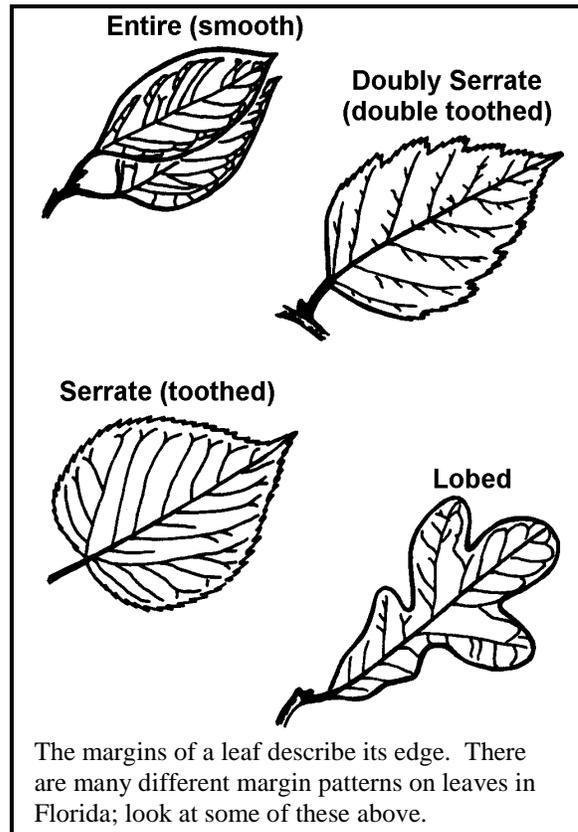
The tallest redwood measured was 367 feet tall. That is 62 feet taller than the Statue of Liberty!

conifers do not conform to the general rules either. The baldcypress loses its leaves in the winter, the red cedar bears a fleshy fruit

instead of cones, and longleaf pines have wood that is denser and harder than the wood of some broadleaf trees.



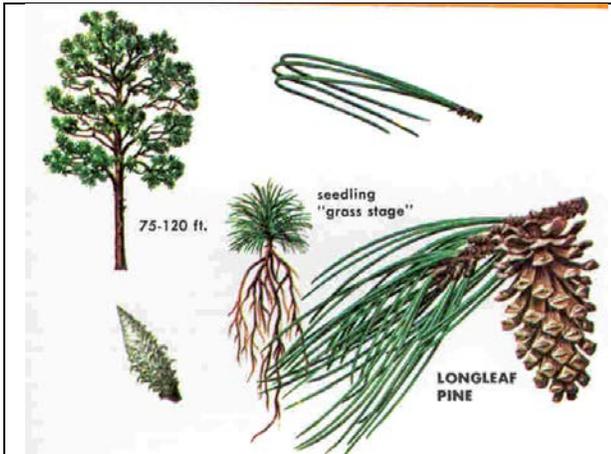
The *margins* of a leaf describe its edge. There are many different margin patterns on leaves in Florida. Leaf arrangement refers to the way leaves on the same branch are associated to one another.



Questions:

1. What is dendrology, and why do you think it is important to know dendrology when you are studying forestry?
2. How can recognizing the shape, arrangement, and margin of the leaves help you in identifying the plant?
3. Go outdoors and find an example of a simple leaf, a compound leaf, and a needle. Also find examples of alternate leaves and opposite leaves. Look at the differences between these and especially the placement of the bud.

Some common pine species in Florida's forests:



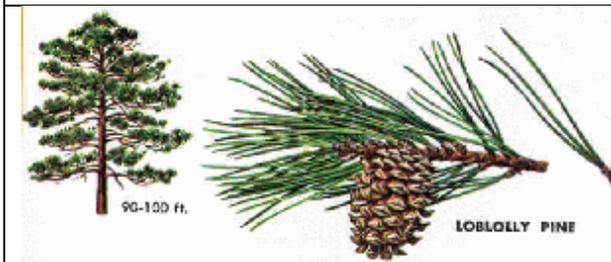
Pinus palustris

Longleaf pines are found throughout the state, except for the southern tip of the peninsula, along pond margins, in pine flatwoods, and on sandhill sites. The needles are 6-17 inches long, in clusters of three, and gathered towards the ends of the thick, scaly twigs. The cones are six to ten inches long, sometimes slightly curved, with small curved prickles. The wood is heavy, hard, strong, tough, and durable. It is used in a variety of building materials along with pulpwood.



Pinus elliotti var. elliottii

Slash pine originated along pond margins, but second growth north Florida slash pine now forms a large part of the pine forests of Florida. A variety of slash pine (*Pinus elliotti var. densa*), known by the common name of south Florida slash, is found along the lower east and west coasts and on adjacent islands. The needles, which occur in clusters of two or three, are from 4 to 11 inches long. The cones are mostly three to six inches long, may be glossy or varnished, and are armed with fine prickles. The wood is heavy, hard, strong, tough, durable, and very resinous. It is used in building materials and for pulpwood.



Pinus taeda

Loblolly pine grows on moist, clay soils in northern Florida. The needles are 3 to 9 inches long in groups of three. The cone is 3 to 5 inches long, are very prickly, and sometimes grow in persistent groups of 2-3 on a branch. The wood is less durable than longleaf and slash pine, and is mostly used for pulpwood and interior building material.



Pinus clausa var. clausa and
Pinus clausa var. immuginata

The Ocala sand pine and the Choctowhatchee sand pine are naturally found on very sandy soils around Ocala national Forest and the western peninsula respectively. The needles come in groups of two, and are 2-3 inches long. The cones are 2-3 inches long, and persist on the tree for a long time. The wood is light, brittle, and not very strong. It is principally used for firewood, pulpwood, and knotty pine paneling.

Here are examples of some other common Florida trees:

 <p>BALDCYPRESS</p> <p>100-125 ft.</p> <p><i>Taxodium distichum</i> var. <i>distichum</i></p>	 <p>60-80 ft.</p> <p>SOUTHERN RED OAK</p> <p><i>Quercus falcata</i></p>
 <p>40-50 ft.</p> <p>LIVE OAK</p> <p><i>Quercus virginiana</i> var. <i>virginiana</i></p>	 <p>40-50 ft.</p> <p>POST OAK</p> <p><i>Quercus stellata</i></p>
 <p>60-80 ft.</p> <p>BLACK TUPELO</p> <p><i>Nyssa sylvatica</i> var. <i>biflora</i></p>	 <p>50-75 ft.</p> <p>PIGNOT HICKORY</p> <p><i>Carya glabra</i></p>
 <p>75-80 ft.</p> <p>RED MAPLE</p> <p><i>Acer Rubrum</i></p>	 <p>SWEETGUM</p> <p><i>Liquidambar styraciflua</i></p>

Part Two: Forest Management

Introduction

How important are forests to you? Name a couple things that you get from the forest. It is easy to think of items such as wood, furniture, or paper, but did you consider any of the 5,000 other products that have ingredients in them made from trees? These include some kinds of ice cream, paints, cosmetics, toothpaste, rayon fabric, photographic film, hot dog casings, and many other things.

Each year, every person in Florida uses enough wood and paper to make up a tree 100 feet tall and 16 inches in diameter!

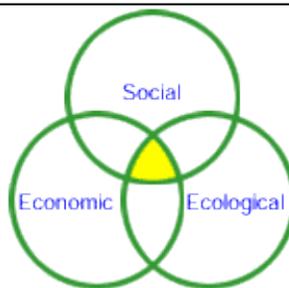
Trees also provide oxygen, clean water, food and cover for animals. Animals exhale carbon dioxide. When we burn fossil fuels such as coal and oil, it produces carbon dioxide. Plants turn carbon dioxide into oxygen. Trees and plants also move our water through the water cycle by transpiration and prevent soil erosion by holding soil particles together with their roots.

To make sure that we have trees in Florida for all of these uses, foresters use silviculture. **Silviculture** is the art, science, and practice of establishing, tending, and reproducing forest stands of desired characteristics. It is based on knowledge of species characteristics and environmental requirements. Besides planting trees, foresters also use practices such as fertilization, thinning, burning, controlling pests, harvesting, regeneration, and other activities that maintain a forest in a productive and healthy condition.

An acre of trees can remove 13 tons of dust and gasses from the surrounding environment every year!

Sustainability is a very important concept to think about when studying forestry. Sustainability is the ability for something to last forever. How is forestry sustainable? Long before logging crews cut the trees, the foresters already have plans to replant the area with new seedlings. Thus, the wood products taken when we remove the trees will be available when the new seedlings mature. Sustainable silvicultural operations make sure that wood and wood fiber is around as long as we keep replanting trees and managing them properly. If a forester's goal is to keep the supply of large timber sustainable, the forester must manage the forest so that the amount of large timber that is

harvested does not exceed the amount that can be grown to replace it. If the forester is trying to keep the supply of smaller timber or pulpwood for paper sustainable, then the forester should manage the forest for small trees in much the same way.



It is important to manage resources in a way that does not harm the living and non-living things that make up the ecosystem, while providing for the aesthetic beauty, recreational opportunities, and profit that people desire.

Sustainability is about much more than the wood products, though. The parts of the ecosystem that surround forestry practices (such as air and water quality, soil quality, wildlife

value, and recreation and aesthetic value) should be sustainable as well. Scientists and foresters understand that the forest is a part of a great cycle. The nutrients, the water, the air, and the living things all make up the forest and allow it to prosper. With any one of these components damaged, the forest has little hope of being completely sustainable. Just looking into the near future is no longer enough; forest managers must consider how the practices done today will affect the earth many generations later. If we want to ensure that forestry is a completely sustainable practice, we must consider all of the components of the ecosystem.

Concrete floors need 21 times more energy to produce than do wood floors.

The challenge for foresters of the past generation was to replace the “cut out and get out” habits with more sustainable reforestation practices. The challenge for foresters today is to create and popularize a forest management method that is completely sustainable ecologically, socially, and economically.

Your challenge for the remainder of this book is to think about how the forestry practices you read about are or are not sustainable. How does it compare with the sustainability of other natural resources, such as oil, or metal? How can certain forestry practices be more sustainable than they are now? As you read this book, think about how you would go about managing a forest that sustainably supplies economic, ecological, and social benefits.

Questions:

1. List ten wood and ten non-wood products that come from trees.
2. Define silviculture in your own words.
3. What does sustainable mean? How has forestry become more sustainable in the past 100 years in Florida? How can forestry continue to become more sustainable in the next 100 years?

Each person in Florida uses 675 pounds of paper per year.

Planting a Forest

Forest management is a great stewardship of your land. There is a definite pride and pleasure in seeing your forestland providing for aesthetics, wildlife, conservation of ecosystems and natural resources, and recreation while at the same time supplying society with the forest products they demand. Many landowners consider the financial profit from timber management an important objective, and many landowners care deeply about taking good care of their land.

Ten new trees are planted by forest landowners for each Floridian every year.

Planting pines and direct seeding are forms of *artificial regeneration*. Florida's primary species for wood products are pines. Northern states tend to use more hardwoods than Florida does. The main species planted in Florida include the slash pine, loblolly pine, longleaf pine, and sand pine. Each of these species prefer full sun, and require a certain amount of site preparation to assure as little competition from faster

growing grasses, shrubs, and trees as possible.

Knowing which species to plant is very important. Slash pine grows naturally on fertile pond margins; longleaf pines grow naturally on sandy sites; loblolly grows well on upland soils with clay; and sand pines grow on scrublands. Planting the species that is appropriate for the site will reduce the possibility of problems with insects, disease, or poor growth. See the section on forest soils below for more information.

If the site supports turkey oak ("blackjack" oak) and not laurel oak, then this is a very dry site. Longleaf pine was historically the native species on most pine sites except for the wet areas next to and in cypress ponds (where slash pine originated), and with the hardwoods in the creek bottoms (where loblolly originated). Longleaf has better insect and disease resistance, better fire resistance, and is a much better tree for wildlife. It also makes great pine straw and valuable big timber.

Longleaf as a seedling has no stem and stays close to the ground like a clump of grass (called a *grass stage*) in order to be resistant to fire. During this time the seedling is building an extensive root system. Once height growth is initiated, after two to five years, growth is very rapid.

Scalping is a common site preparation practice for planting cropland and pastureland. Scalping peels back the sod to a depth of about 4 inches and for a width of about 2.5 feet.



The Longleaf pine starts its life in a grass stage...



...which makes it more resistant to fire.

This creates a mineral soil strip, reducing competition from weeds. Scalping improves initial growth and survival of the seedlings, and it reduces the likelihood of infection by certain soil insects and diseases. One insect of particular concern is the White Fringe Beetle which will eat the roots of young pines.



Bedding is used to raise seedlings out of standing water.

Heavy mechanical site preparation might be necessary to prepare a site for planting if there is a lot of vegetation or logging debris. This method usually uses **chopping** to knock down gallberry, palmetto, and small trees (about 6" and less), root raking to clear logging debris and large trees, and **prescribed burning** to clean up chopped vegetation or piles created by root raking. If the land periodically gets wet, then **bedding** is probably necessary to raise the seedlings out of potentially standing water.

Natural regeneration, establishing a new forest from an existing forest, might be possible with the combination of a selective harvest and prescribed burning. A seed tree cut with a density as low as three to five trees per acre, followed by a prescribed burn in the summer months can open up the bare mineral soil for seed drop in the fall. Pine seeds require contact with bare mineral soil in order to germinate. This method of reforestation is a great alternative to completely clearcutting a forest and then replanting if you want to keep the cost of site preparation low.

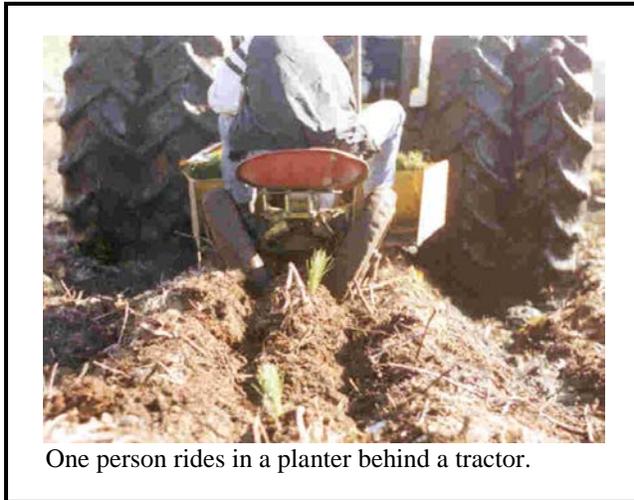
When replanting a cutover forest, it usually requires tougher site preparation. These treatments often include **herbicide**, burning and **V-Blade planting**. A pine stand usually has hardwood trees growing under the pines that can re-sprout, or **coppice** from the stumps. Herbicides can be applied with either a broadcast or banded application, and can be applied before or after planting. Woody herbicide, often broadcast over the entire area before planting, can be applied directly to hardwoods to control their growth. Meanwhile, an herbaceous herbicide can be applied in narrow strips called bands. These bands are placed along the rows where the seedlings are planted to reduce grass and weed competition that



A chopper might be necessary to clear vegetation before planting.

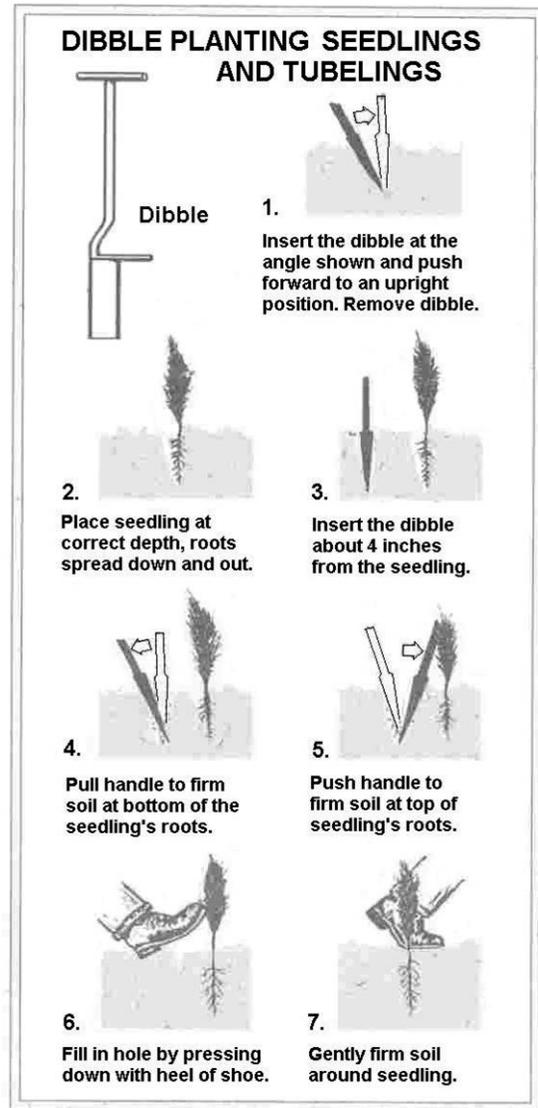
appears after the soil has been disturbed. Herbicides should be properly used according to the labeling directions to assure minimal disturbance to water quality and site ecology.

Prescribed burning is another tool useful for reducing logging debris and preparing a site for planting. The burn not only removes logging debris, but can also reduce the amount of competing vegetation that would rob the seedlings of water and nutrients. Using prescribed burning throughout a rotation of the pines helps control hardwoods before planting the next crop of seedlings, further reducing reforestation costs.



One person rides in a planter behind a tractor.

Winter, from December through February, is the best time to plant trees, when tree growth is slowed. **Containerized** seedlings, which are grown in a mixture of soil and fertilizer, have an increased chance of survival. Most reforestation is accomplished by a farm tractor and a tree-planting machine planting bareroot seedlings. **V-Blade planting** uses a medium size bulldozer with a “V” shaped steel blade up front to clear logging debris with a tree planter pulled behind. This eliminates the need for expensive root raking. In addition, the nutrients in the debris stay where all the young trees can make use of it. Sometimes hand planting tools such as a **dibble bar** or hoedad are used to hand plant seedlings. The diagram on the right provides instructions for planting with a dibble bar.



Spacing guidelines:

Slash or Loblolly on pasture or cropland.	605-726 trees per acre	6'x12', 5'x12', or 6'x10'
Slash or loblolly on cutover land or other rough sites.	726 trees per acre	5'x12' or 6'x10'
Longleaf on bahia pasture and financial returns are important.	726 trees per acre	5'x12'
Longleaf on pasture and financial returns are secondary.	605 trees per acre	6'x12'

Forest Soils

Soils are examined to determine which tree species are best suited for particular sites. Select a site to evaluate its soils for forestry purposes.

First, examine the amount and quality of the organic material on the soil's surface. If there is none, this may indicate the area has either been burned, or 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. Thick layers of damp, partially decomposed organic matter indicate a wet site.

Surface Soil Texture – Tree Species		
Surface Texture	Water Holding Capacity	Tree Species to Manage
Sand*	Poor	Longleaf Pine Sand Pine
Silt	Good to Excellent	Slash Pine Loblolly Pine Longleaf Pine
Clay	Excellent	Loblolly Pine Longleaf Pine

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

Second, examine the uppermost layer of mineral soil. Squeeze the soil, notice the texture. Soil is made up of little particles of various sizes that are grouped into three classes; sand, silt, and clay, each smaller than the previous group. A quick and dirty way to tell the primary make-up of a soil sample is to squeeze some moist, but not damp, soil in your hand. Sand will not really maintain any shape unless damp, silt will stay clumped together, and clay can actually be spread into thin ribbons and hold that shape. Refer to the soil texture table to determine the effects of soil texture on soil conditions.

Top Soil Observations – Tree Species						
Top Soil Condition	Amount of Organic Matter	Erosion Factor	Aeration	Available Nitrogen	Fertility	Tree Species to Manage
Dark-colored Soil (black, brown, grey)	Excellent	Low	Excellent	Excellent	Excellent	Slash Pine Loblolly Pine
Moderately Dark-colored Soil	Good	Medium	Good	Good	Good	Slash Pine Loblolly Pine
Light to Pale-colored Soils (brown to yellow)	Low	High	Low	Low	Low	Longleaf Pine Sand Pine

Third, examine the soil color. A rule of thumb is the darker the soil, the more fertile it will be. Look at the table listing top soil conditions and the relationship to color.

Fourth, use the soil auger or sampling tube to examine subsurface conditions, and measure the depth at which any of the following occur: 1. Obvious changes in soil texture, 2. Mottling, streaking, or flecking by other colors, 3. Moisture or saturation of the soil.

Managing a Forest

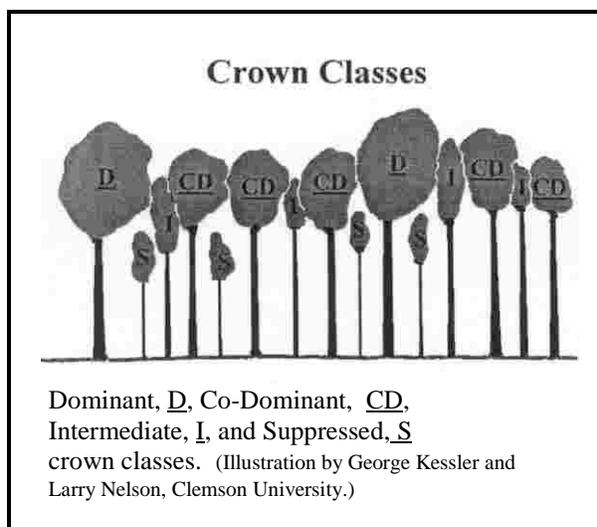
A productive forest requires good management throughout the rotation. The forests took care of themselves in the days before roads, farms, and subdivisions. Periodic fires from lightning kept vegetation low. This frequent disturbance allowed pines and grasses to regenerate, basically keeping the forest at one stage of succession. Insects and diseases also kept each other in-check. All of these combined occurrences helped to keep overcrowded forests thinned out. The natural order of things kept the forests healthy.

Florida has become fragmented with roads, homes, and shopping centers. Allowing nature to simply take its course is no longer practical for Florida's forests. The forests are simply too fragmented by human habitation to allow nature to completely manage the forests. Additionally, demands for forest products require sound forest management practices. Activities such as thinning and burning should be done according to management plans in order to produce and maintain a healthy forest. With the concern for proper stewardship of the land growing quickly; wildlife habitat, soil and water conservation, and even recreational opportunities are being incorporated more and more often into management plans.

In commercial forests, annual growth exceeds harvests and losses due to insects and disease by 33% each year.

If a forest stand contains at least 90% of the same tree species, as in a Slash Pine plantation, it is considered pure. A stand that has more than one dominant species, such as a Longleaf Pine/Turkey Oak stand, is called a *mixed* stand. If the trees in the stand are all the same age, it is called an *even-aged* stand. *Uneven-aged* stands consist of trees that regenerated at many different stages of the stand's history. A mixed stand can be either even-aged or uneven-aged, and the same is true for pure stands.

Not all of the trees in the forest are the same size, even if they are the same age. Factors like genetics, health, sunlight, water, or nutrient availability affect how quickly a tree grows, and how big it can get. The tallest trees that rise above the others and get full sunlight on their crowns are the *dominant* trees. Most of the trees are usually *co-dominant*, which are still tall and get a good amount of sunlight, but are not quite as tall as the dominant trees. *Intermediate* trees get some sunlight from above, but none from the sides because the taller trees block the light. The slowest growing and weakest trees are the *suppressed* trees. They get no direct overhead sunlight.

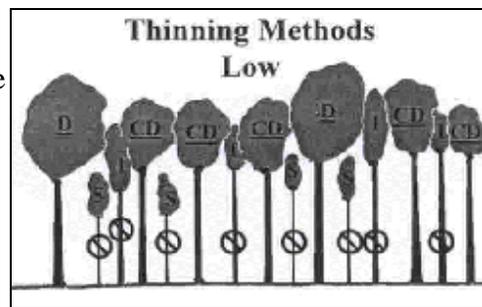


Thinning

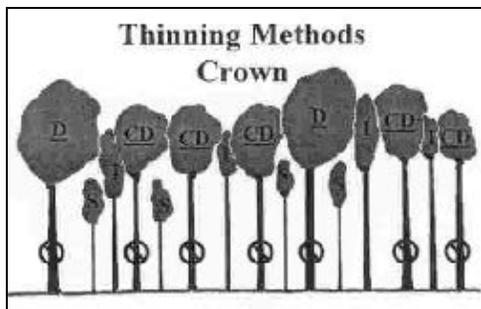
In order to keep your forest healthy, the trees must have room to grow. If they do not get enough sunlight, water, and nutrients, they could become unhealthy. Because an area of land can only grow so much wood, a forest with too many trees will have mostly small, suppressed trees. It is very important to keep your forest thinned. Otherwise, serious problems such as stunted growth, insects and disease, or death can occur.

In Florida, thinning should occur on stands that have a basal area of 120 sq.ft. or more, before the trees get too crowded. This often occurs when the stand reached 10 to 15 years old. If the forest gets too crowded, pines tend to stunt in growth and face difficulty recovering once favorable growing conditions return.

To determine if your stand needs thinning, you should look at a couple of factors. One such factor is latest growth rings. Take a core sample using an increment borer and observe the changes in the width of the growth rings as the tree ages. Rings that get closer together toward the outside of the tree, near the bark, indicate tree growth has slowed.



Another way to determine if a forest needs thinning is by looking at the branches and needles of the *canopy* trees. A live crown ratio less than 33% is an indication that thinning is necessary. Live crown ratio is the ratio of the height of the live branches (from the bottom green branch to the top green branch), to the total height of the tree; generally expressed as a percent.

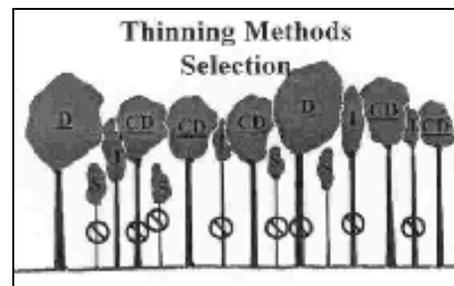


Once you have determined that a stand needs thinning, there are a several ways to get the job done. One method is by removing all of your suppressed and intermediate trees. This is called Low Thinning, or thinning from below, and removes the trees that may not grow well.

Another method is Crown Thinning, sometimes known as high-grading. This removes the dominant and co-dominant trees and leaves the

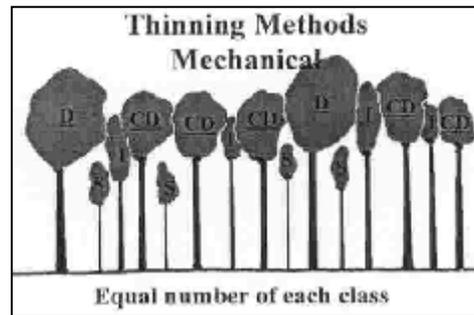
suppressed and intermediate trees to grow. This works with some tree species, but not with Florida pines.

Selection Thinning is just what it sounds like. Foresters decide which trees to remove by looking at each one and determining which ones are healthy but need more space to reach their full potential.



Mechanical Thinning is probably the easiest thinning to conduct in a forest. This usually involves taking out certain rows within a plantation, and allowing the other trees to grow. The result is an equal number of each class of tree. A common mechanical thinning would be to remove every third, fifth, or every other row.

Sometimes, foresters mix mechanical thinning with another type of thinning, such as selection thinning. For example, this allows the forester to remove every fifth row or so for access, and selectively remove the suppressed and diseased trees between the removed rows.



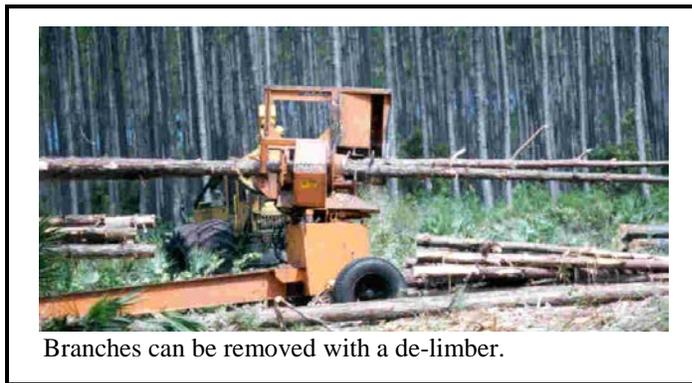
For every ton of paper recycled, we save 7,000 gallons of water, 4,100 kw of electricity, and 3.3 cubic yards of landfill space. Producing paper from recycled fibers reduces air pollutants by 7.4% and water pollutants by 35%.

Harvesting

Many factors affect logging practices, such as the tract size, volume, accessibility, season, terrain, species, the distance to the mill, and ecological considerations. Pulpwood makes up most of the wood that is harvested in Florida. Pulpwood creates items such as paper and the countless other everyday items that are made from the *cellulose*. Cellulose is a thickener that can be found in everything from toothpaste to milkshakes. Larger diameter trees become *chip-n-saw, saw timber, poles* or *veneer*. Two by fours are cut from chip-n-saw wood with the remaining chips being used for pulp production. The saw timber is made into larger lumber. Pole class timber is used for utility poles because it is tall and straight. Veneer is sliced into thin boards that are glued together for plywood.



The cutting and grappling head of a feller-buncher.



Branches can be removed with a de-limber.

There are seven main phases to a logging operation: tree felling, limbing, skidding, sorting, bucking, loading, and transporting. The phase of harvesting that is most well known is the *tree felling*. This can be done with either chain saws or mechanical shears or saws attached to vehicles called *feller-bunchers*.

After a tree is felled, a *skidder* would then take the wood to the landing area to be sorted into the different products according to size. Here it is usually *de-limbed* and *bucked*, or cut into the desired length. Sometimes, trees that will be loaded without being bucked will be delimbed on the way to the loading deck. Pine sawlogs are normally bucked into eight or 16 foot logs, and are worth more to buyers if they have less rot, crooks, or bends. Then they are loaded onto trucks for transporting to the mill. In some cases, specialized equipment can do most of these phases at once. In other cases, *whole tree chipping* is done on location to transport the wood to paper mills in chips.

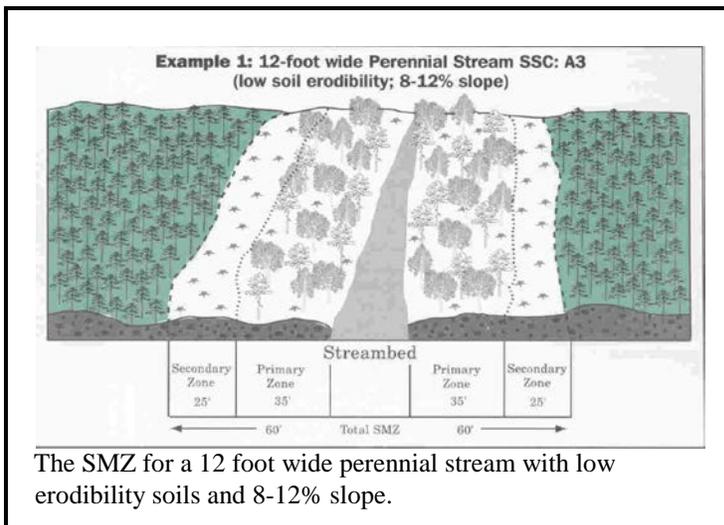


Logs are sorted according to size class before being loaded.

Best Management Practices

When implementing any forestry practice, it is very important to make sure you do it in a way that will minimize negative impacts on the soil and water quality. Disturbing the soil close to a body of water such as a lake, stream, river, creek, or wetland can cause water quality problems. Sedimentation, nutrient pollution, and chemical pollution are harmful to the aquatic life in these waters and to the terrestrial life that depends on these waters for survival. This includes human beings!

This is where *Best Management Practices* (BMP's) come into play. BMP's are set rules that are necessary for protecting the state's soil and water quality as well as other ecological values during forestry activities. Since 1981, foresters from the Florida Forest Service have monitored the use of the Best Management Practices on forestry lands and have noted about 98% compliance. Programs, such as the Florida Forestry Association's *Master Logger Program*, certify loggers after they have completed educational courses that cover environmentally sound harvesting techniques involving BMP's, protection of *endangered species*, and changes in the silvicultural rule.

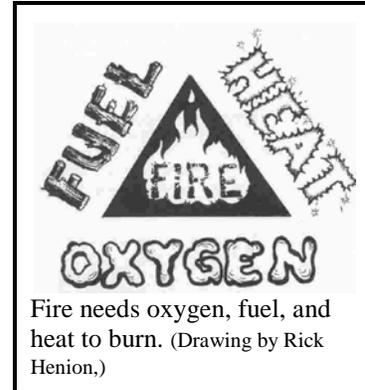


As one of these practices, foresters pay strict attention to *Special Management Zones* (SMZ's). These zones place limits on logging and other silvicultural operations that may disturb the water quality of nearby water bodies. The purpose of having an SMZ is to protect water quality by reducing or eliminating forestry related inputs of sediment,

nutrients, logging debris, chemicals, and water temperature changes that can harm water bodies. SMZ's vary in size and severity of restrictions based on numerous factors including stream width, stream type, soil type, and slope.

Prescribed Fire

One of the cheapest and most effective practices used in the management of pines, is a well-planned and executed prescribed burn. Pine ecosystems, particularly the longleaf pine, are specially adapted to thrive in frequently burned areas. Prescribe fire, as the name implies, is planned and thought out; much like a doctor would prescribe a medication. It is the application of fire, by trained individuals, used under specific conditions, to achieve measurable results.



Prescribed burning accomplishes a number of objectives that are mentioned throughout this book, including the reduction of fuel buildup, the control of undesirable plant species, the improvement of wildlife habitat, site preparation for regeneration, control of diseases such as brownspot needle blight and root rot, and the improvement of forage for livestock.



Use care, and have the proper equipment when doing a prescribed burn. (Drawing by Rick Henion, State of Maine Forest Service)

A common reason for the use of prescribed fire is to reduce *forest fuels* such as leaves, grasses, shrubs, and small trees. This is useful for controlling competing vegetation in the pine stand, and for reducing the threat of a wildfire. Fuel reduction burns are best in the winter when temperatures are cooler, and when the pines are dormant. Once surface fuels have been reduced, growing season (spring and early summer)

prescribed burns will yield the best results for ground cover restoration and undesirable scrub control.

Longleaf pines are well adapted to winter backfire burns at any stage of their lives. The best time being when they are in the grass stage, or when they have a height of 10 feet to their lowest green branch. Slash and loblolly pines are most resistant to fire when they have a diameter of at least four inches, and a height to the lowest green needles being higher than 10 feet from the ground.

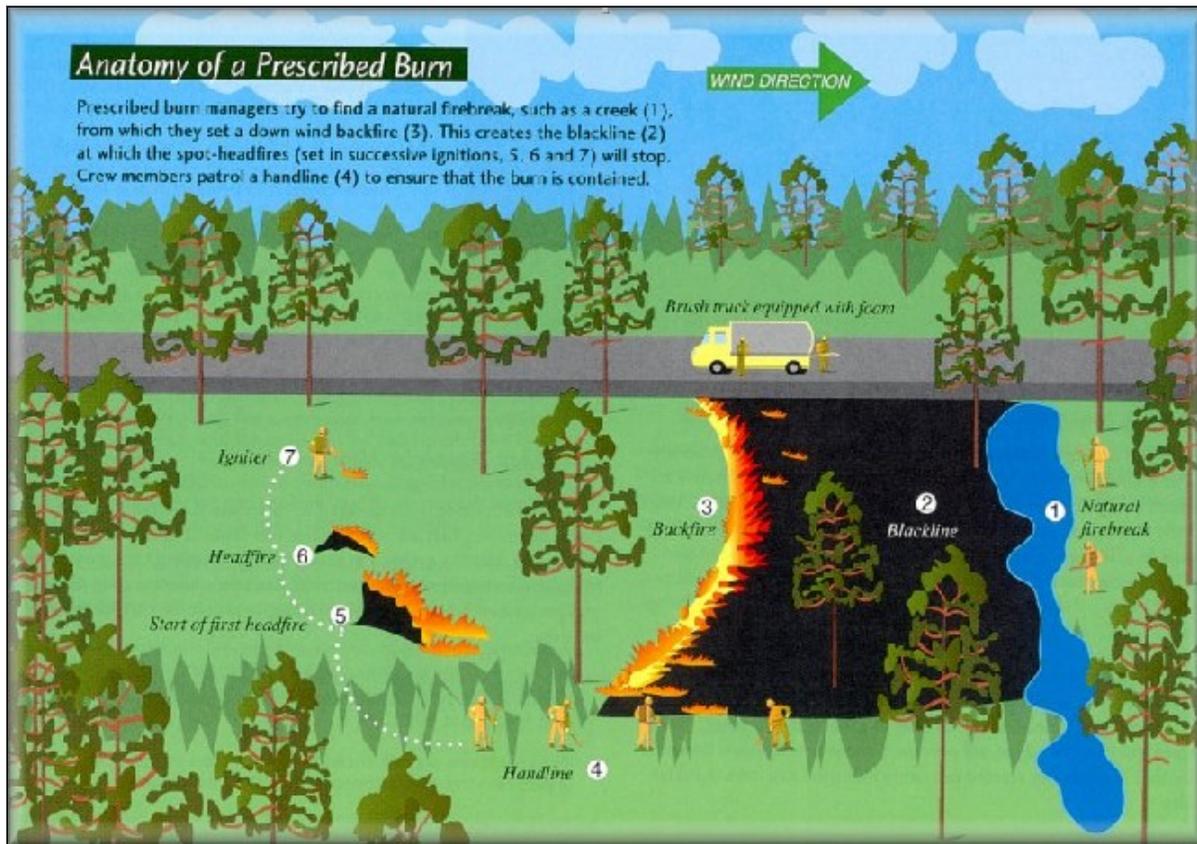
The wind speed, humidity, temperature, soil moisture, and vegetation moisture content for a prescribed burn vary according to your objectives. A burn on a cold day with a relative humidity of 30% - 50%, light winds of 5 - 10 miles per hour, and ½ to 1 inches of rain one to three days prior would produce a less intense burn than on a hot, windy, or dry day.



A fire-fighter uses a fire-rake to clear the fuel. This makes a fire break to stop an advancing fire.

First, a good **fire break** is positioned around the burn area using natural barriers (sandy areas or water), hand tools (fire rakes and shovels), or large equipment (fire plows and engines). Various firing techniques accomplish the prescribed burning objective. One common technique involves using a **backfire**, a fire that burns into the wind. This is generally the safest, coolest, and slowest method of control burning.

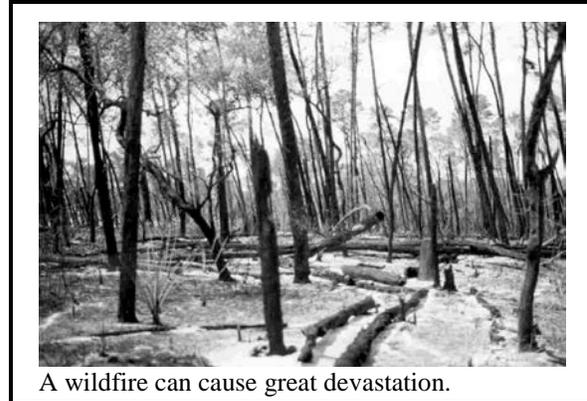
The burn moves into the wind until it burns a wide area behind it known as a black-line. The fuel consumption here creates a barrier for hotter, quicker fires, such as **head** and **flank fires** (see illustration below), to run into without escaping the planned burn area. These hotter fires are good if the objective is to control hardwoods, or to reduce debris or vegetation for planting.



Since the 1980s, billions of acres burned in Florida wildfires. Less than 1/3 of those were caused by lightning strikes, the rest were caused by people.

In the past, prescribed fire use was reduced because of a misconception that all fire was harmful. Although wildfires are dangerous and costly, prescribed fires can prevent damages caused by wildfires. Fire is a natural part of Florida's ecosystem, and we need it to maintain the ecology. Without fire, the unique ecosystems of Florida could be

drastically changed or disappear altogether. The fuel loads can build up to unnatural levels and cause widespread forest fire disasters such as the ones we had in 1981, 1985, 1989, 1998, and 2001. Over 500,000 acres burned in the summer months during each of these years. On May 12, 1985, 500,000 acres burned on a single day. That day would later be dubbed “Black Friday.”



Wildlife Management

Timber management greatly influences the quality of wildlife habitat available on a landowner’s property. Wildlife and timber management can co-exist to produce valuable timber and wildlife habitat. In fact, it takes very little “give” in timber management to “get” a lot of benefit for wildlife management. Species selection, age of the forest, tree spacing, and other management actions will determine how well timber and wildlife objectives mix.

On the correct site, longleaf pine has many advantages over either slash or loblolly pine. The two primary reasons for increased wildlife value in longleaf stands are: 1) reduced canopy development and closure; and 2) increased fire tolerance. Additionally, Longleaf pine produces larger seeds than other pines.



Gopher tortoises dig holes that serve as the homes of many other species, including the endangered Florida mouse and indigo snake.

Longer rotations allow for multiple thinnings, which open the canopy and allow sunlight to reach the ground for herbaceous vegetation growth. Older trees also provide wildlife habitat that is disappearing in Florida. Initial seedling spacing of 5' x 12' will ensure proper growth development of trees and yield viable timber production. Subsequent thinnings will open up the tree canopy and allow sunlight to stimulate the growth of desirable ground cover for wildlife habitat. Prescribed burning (throughout the rotation) is the main management tool that compliments both timber production and wildlife management.

After planting the pines, mowing once a year (September through February) is a good practice to open rows for wildlife travel, create escape and nesting cover, and to reduce herbaceous competition for the pines. This will also stimulate new tender growth, an excellent source of browse. Mowing every row of the plantation the first year will allow seedlings to grow above existing herbaceous vegetation. After that, mow every third row annually, rotating the rows mowed, to leave some “rough” habitat.

Generally, after the pine trees have reached a safe height, prescribed burning every 2-5 years will maintain desired conditions. Prescribed fire will recycle nutrients for the

pinus, as well as promote new herbaceous vegetation growth for wildlife. To maximize the burning benefits for wildlife, the forest should be broken into several different burning compartments, with about one third of the forest burned in any year. This will allow adjacent areas to be left in cover for wildlife.

Another way to increase habitat diversity is to provide *edge* between two or more habitat types. This area where two plant communities join, also known as an *ecotone*, is very attractive to wildlife. Many animals find their food and shelter requirements here. Take, for example, a pine forest merging with a hardwood swamp. Deer, turkey, squirrels, and rabbits may prefer to feed in the pine forest; however they also need dense swamp vegetation for cover, nesting, and bedding.

The edges of firebreaks can provide excellent nesting and foraging habitat and will provide travel corridors for wildlife. Disking during the winter months (November through February), will promote native weeds and legumes such as partridge pea, beggarweed, and common ragweed. Prescribed burning in the summer months encourages grasses such as wiregrass. All of which provide important seeds to Bobwhite quail and many songbirds.

As a result of hunting regulations and careful forest management, the white tailed deer population has grown from 4.5 million in the U.S. to over 16 million in the past 30 years.

Dead, standing trees, known as *snags*, provide excellent habitat and feeding grounds for woodpeckers, squirrels, owls, and other wildlife. One snag per acre may be left standing following a harvest, or other forestry operation. Fallen snags serve as cover and feeding grounds for beneficial snakes, rabbits, insects, and plants. Beneficial insects and pathogens that control harmful insects and diseases use dead wood. This is nature's way of keeping these pests in check.

With all these combined management activities, landowners can greatly improve their property for wildlife while still growing valuable pine trees for future economic return. When considering all of the management practices available to landowners for improving tree growth, rotational mowing and prescribed burning are two of the least expensive activities they can utilize to improve valuable wildlife habitat on their property.

Recreation

It is difficult to talk about the many ways forests are valuable to people. We use paper, wood, cardboard, and many other forest products every day, but what about the number of times we actually go into forests to hike, camp, swim, or have a picnic? Many people do not think of forests as recreation areas like amusement parks or playgrounds. Still, almost every American uses forests for some type of recreation. Many forests in Florida are used for recreation. These areas are also valuable for timber, wildlife, water, clean air, biodiversity, grazing and other uses. People value an area that they can use for

recreation. In other words, using some ecosystems for recreation might have been the very reason they still exist.

People who travel to these forests for recreation are tourists. They spend money on businesses both inside the forests and along the forest boundaries. Rangers, tour guides, horseback outfitters, and many other jobs are created when a forest is used for recreation. People buy backpacks, fishing gear, tents, food and other supplies that help them recreate in forests. People spend billions of dollars each year on lodging, transportation, and supplies just to observe wildlife in Florida's forests and natural areas.



Forests provide society with many wonderful things – including places to have fun, escape, explore, be with family, and learn about new things. They also provide jobs for many people who help visitors to the forest take part in recreation. Forest managers are beginning to understand that they have an important role managing for recreation in order to allow people to experience the forest and protect the forests at the same time.

Forest Health

Forests in Florida are aesthetic, environmental, and economic resources of inestimable value. Trees and forests statewide (and everywhere) are habitats for countless insects, microorganisms and plant species, some of which are beneficial and some of which are problems or pests. Problem or pest organisms can disfigure, kill or slow the growth of valuable wood crop or landscape trees. Dense growth of non-native pest plants may disrupt forest ecosystems, displacing native plants, affecting wildlife habitat and altering fire regimes. The extent, type, and severity of the damage caused by such organisms (especially native pests) depends on a variety of factors such as the species of tree(s) and organism(s) involved, forest type, environmental conditions (floods, droughts, etc.), and the influences of humans (site disturbance, tree injuries, cultural and management practices). Human influence is a major factor in the spread and impact of non-native pests.

For purposes of simplicity, this section will focus on a few select examples of important insect pests, disease-causing fungi (fungal “pathogens”), and non-native, invasive pest plants that damage or threaten Florida's forest resources. These organisms are problematic when they infest (insects), infect (pathogens), and invade (pest plants) trees or forest systems to an extent that the damages they cause or threaten to cause are economically, aesthetically, or environmentally unacceptable. At what point these

impacts or concerns generate response action depends, among other things, on management and ownership objectives. For example, some people may not be bothered by a few damaged or dead trees as these often provide excellent wildlife habitat. Others, in landscape or wood production situations, may be very unhappy about a few, or even one, damaged or dead tree(s). Unfortunately, in the case of non-native pests, the need for response is often unrecognized or inadequately prioritized until it is too late, and the problem becomes overwhelming or even unmanageable.

Let's look at some important terms before taking a look at our example pest organisms. Grasping these terms will facilitate understanding the interactions of pest organisms, trees and forests. For our purposes:

- Forest Pest:** An organism capable of, under certain conditions, causing unacceptable damage to trees or forest systems (or, in some cases, simply being a nuisance).
- Disease:** The sustained and progressive impairment of tree structure or function.
- Pathogen:** An organism capable of causing a disease; most tree pathogens are fungi (plural of fungus).
- Native:** A species (insect, microorganism, or plant) that is a normal and naturally occurring component of a region or ecosystem; these organisms are often low impact as forests pests, but can become serious problems in response to environmental influences or the actions of humans.
- Non-native:** A species (insect, microorganism, or plant) that does not occur normally or naturally in a region or ecosystem; these "exotic" organisms are more likely to be serious forest pests.
- Exotic Invasive Pest Plant:** A plant species not native to a particular environment or ecosystem that aggressively "invades" a native forest or ecosystem disrupting the system's natural composition, function, wildlife habitats, or fire regimes; these plants are "foreigners", introduced purposefully (as ornamentals or for other purposes) or inadvertently from overseas, and are able to establish self-sustaining, expanding populations.
- Incidence:** A measure of occurrence; either frequency (how often, how much, how many, etc.) or distribution (localized, widespread, etc.)
- Impact:** A measure of severity of damage; for example, widespread incidence of an insect, pathogen or pest plant does not necessarily mean serious impact; impact is high only if the damage is high.

Some Important Diseases of Pines in Florida's Forests

Brown Spot Needle Blight (fungus pathogen: *Mycosphaerella dearnessii*)

This fungal disease is common and can be serious on young longleaf pines. Infections on the pines' needles result in distinct dark brown spots, typically surrounded by bright yellow "halos". In time, infected needles die, turning a distinct reddish-brown in color. Infections sometimes occur in nursery-produced seedlings, if nurseries are located in areas of high disease pressure. Serious infections can inhibit the growth of and even kill young longleaf pines. Fungicidal sprays are effective controls in forest nurseries. Carefully applied prescribed fire is the best control method in forest settings.



Longleaf pine seedling with severe Brown Spot Needle Blight infection.

Pitch Canker (fungus pathogen: *Fusarium circinatum*)

"Pitch Canker" infections occur on virtually all species of pines. Symptoms are most dramatic on slash and longleaf pines. Infected shoots (terminal and lateral) display a



Slash pines exhibiting terminal "flagging" (shoot dieback) due to Pitch Canker infections.



Resin-soaking in wood tissues of a Slash pine branch resulting from a Pitch Canker infection.

characteristic "flagging" (i.e., reddening and sometimes drooping of needles). These shoots often exude copious amounts of resin ("pitch"), and their interior wood tissues are typically resin-soaked. Pitch canker can occur on pines of all ages, but it is most common in plantations 10-15 years of age. Infection does not usually result in tree death, but deformed, slow-growing trees can be economically or

aesthetically problematic. This disease is highly influenced by tree nutrition; excessively fertilized pines (especially high N) are often more seriously damaged than unfertilized pines. Control of pitch canker is facilitated by good forest management practices including use of genetically resistant pines where available, avoiding overstocked stand situations, wise use of fertilizers, and sanitation-salvage harvests if necessary.

Fusiform Rust (fungus pathogen: *Cronartium quercuum* f.sp. *fusiforme*)

This disease is ranked as the most serious disease of loblolly and slash pines in southern forestry. The fungus infects nursery seedlings and young pines killing them outright or seriously deforming them so as to render them unfit for wood products. Infections are recognized on infected pines by distinct tumor-like swellings (galls) on branches and main stems. In nurseries, fungicidal sprays are effective for preventing seedling infections. In the field, control is facilitated by use of genetically resistant loblolly and slash pines, use of alternative and less susceptible species where feasible (e.g. longleaf), minimizing site preparation and early fertilization to reduce target infection area (long, tender shoots) on young pines, prescribed fire to reduce populations of oaks (necessary alternative host species in the life cycle of the fungus), and sanitation-salvage harvests.



Elongated (fusiform) gall of Fusiform Rust on the stem of an infected pine. The bright yellow aecial pustules of the pathogen only occur during early spring.

Annosum Root Disease (fungus pathogen: *Heterobasidion annosum*)

This disease, when it occurs, typically appears in pine stands several years after thinning or other partial harvest operations. Microscopic airborne spores of the fungus primarily infect freshly cut pine stumps. Following infection, the fungus grows through the stumps into the roots of residual standing trees. Roots of infected trees initially exhibit a general resin-soaking. Over time the pathogen rots the roots of its victims leaving the roots in a very characteristic “white stringy rot” condition.



Windthrown Slash pine indicative of possible Annosum Root Disease.



Crown thinning in a Slash pine infected with *H. annosum*.

Infected stands often have pines displaying crown-thinning, windthrow, outright mortality, and sometimes bark beetle infestations as most bark beetles respond to some sort of pre-disposing tree stress. Salvage harvests are the only “control” option in badly diseased stands. Prevention of infection through treatment of freshly cut stumps with commercially available and registered borax formulations is effective, but the economic utility of this practice in Florida is unknown.



“White stringy rot” in root of a pine; typical of advanced infection by *H. annosum*.

Some Important Forest Insects of Florida's Forests

Southern Pine Beetle	<i>Ips</i> Engraver Beetle	Black Turpentine Beetle
<p>Most common in loblolly pine, but all Florida pines are potential hosts.</p> <p>Look for needle discoloration from green to yellow to red to brown, and small lumps of whitish resin called pitch tubes in between bark plates (approximately ½ inch wide) up to 60 feet up the trunk. Also notice narrow S-shaped <i>galleries</i> under the bark.</p> <p>To help prevent SPB attack, maintain tree health, thin dense stands and avoid mechanical damage. Trees with active beetle infestations should be cut and removed to prevent further spread. Additionally, a buffer strip 50-100 feet wide should be cleared to prevent spread in forest stands.</p>  <p>Pitch tubes appear at the SPB entrance holes in the cracks of the bark plates, and look a little bit like popcorn.</p>	<p>All Florida pine species are potential hosts.</p> <p>Look for needle discoloration from green to yellow to red to brown, and small lumps of reddish orange to whitish pitch anywhere on bark plates (approximately ½ inch wide) up the trunk and branches. Also notice Y, H, or I-shaped galleries in the inner bark.</p> <p>The presence of <i>Ips</i> beetles generally tells you that the tree is stressed. To help maintain tree health and prevent attack, avoid damage to trees, thin out forests before the trees get stressed, plant the right species for the site, and conduct harvests during the winter.</p>  <p><i>Ips</i> pitch tubes may appear anywhere on the bark plates and may vary in color. Some pitch tubes have little to no sap flow depending on the health of the tree.</p>	<p>All Florida pine species are potential hosts.</p> <p>Look for needle discoloration from green to yellow to red to brown. Also look for large clumps of pinkish-white, reddish-brown, or purplish-gray pitch (approx. 1 inch or more wide) from the butt to 10 feet up the tree.</p> <p>The BTB develops more slowly, and is not as lethal as SPB and <i>Ips</i>. A good rule of thumb to determine the effect of these beetles is to count the number of pitch tubes. If the number of tubes is greater than the DBH in inches, the tree will probably die.</p> <p>To prevent attacks, maintain tree health and avoid tree damage. BTBs can attack fresh stumps, so cutting stumps low to the ground or grinding them may help prevent build-up of BTB populations.</p>  <p>BTB pitch tubes are large, generally restricted to the lower parts of the stem, and often have a visible entrance hole.</p>

Pine Tip Moths

All Florida pines are susceptible, although longleaf pine is rarely attacked.

Look for foliage discoloration, dead or dying branch tips, hollowed-out shoots, and resin beads or flakes and fine silk webbing on branch tips.

To prevent tip moth damage, plant the best pine species for the site, using less-susceptible species when possible (e.g., longleaf pine). Allow some weed growth in young plantations to help promote natural enemies of the tip moth. Carefully timed insecticides applications can provide control. Pruning out infested tips is an option if handwork is feasible. Stands are generally not susceptible after they mature and the crown closes.



Branch tip damage caused by the Nantucket pine tip moth.

Pine Web Worm

Pines most at risk at 1-2 years old.

Look for balls or lumps of dark pellets on stem or branches near bud along with some loss of foliage.

To control, handpick and destroy the nests and larvae and promote natural insect parasites. Growth loss may occur while infested, but death is uncommon.

Promote tree health and vigor to aid in the recovery from webworm defoliation.



Frass nest of the pine webworm.

Pine Sawflies

All Florida pines are susceptible.

Sawfly outbreaks can occur over a widespread area on 8-10 year cycles. Heavy defoliation may reduce tree resistance to other pests.

Look for loss of foliage, with branches appearing tufted or having a bottle-brush appearance. Needles may also have a straw-like appearance or small light-yellow patches along their length. Colonies of the sawfly larvae feed all over the branches, with their pellet like waste in the leaf litter.

Natural enemies usually keep sawfly populations at low levels, and outbreaks collapse on their own.



Pine saplings defoliated by the larvae of the slash pine sawfly.

Some Important Non-native Invasive Pest plants of Florida's Forests

Cogon grass

GRASS

(Imperata cylindrica)

This highly invasive perennial grass species is a pest plant in 73 countries and is considered one of the top 10 worst weeds in the world. Cogon grass is easily recognized by its yellowy-green leaves with serrated edges and an offset midvein, showy cream colored seedheads, sharply pointed rhizomes, and dense monocultural growth. Cogongrass is native to Southeast Asia and was first introduced into the southeast United States in the early 1900s for erosion control and livestock forage. Cogon grass now occurs in 7 southeastern states and throughout Florida. Invasive in mesic and xeric sites, cogon grass infestations reduce species diversity, alter ecosystem processes (especially fire ecology) and reduce forest productivity and tree survival. Cogon grass can reproduce by seed, and has been widely spread through movement of small pieces of rhizome (root) in soil or on equipment.



A. Invasion in a pine plantation.

B. Offset midvein.

Japanese climbing fern

VINE

(Lygodium japonicum)

Japanese climbing fern is a perennial fern with climbing vine-like growth reaching lengths of 90 feet. Vine stems are thin and wiry, usually dying back to a rust-color in winter. The leaflets (pinnae) are opposite, compound and finely dissected. Often found in disturbed areas such as roadsides and ditches, but can also invade bottomland and floodplain forests, pine flatwoods, and most moist sites. It forms dense tangled mats, which can cover the ground and shrubs, shading and killing understory vegetation and tree seedlings. Japanese climbing fern is native to eastern Asia and was first introduced into America during the 1930s for ornamental purposes. While Japanese climbing fern occurs primarily in north and central Florida, the related plant, Old World climbing fern (*Lygodium microphyllum*) which occurs in central and south Florida. Both species are spreading very rapidly as their dust-like spores are carried by wind, water animals, and equipment.



A. Leaflets

B. Invaded plantation

Chinese tallow

TREE

(Sapium sebiferum or Triadica sebifera)

Chinese tallow is a fast-growing, deciduous tree with a milky sap, which commonly grows to 30 ft tall. Leaves are simple and alternate, with broadly rounded bases tapering to a slender point, and becoming yellow to red in the fall. The white, 3-seeded fruit resemble popcorn, thus the common name "popcorn tree". Chinese tallow trees have been widely promoted for use in ornamental landscapes in the southeastern United States. In northern and central Florida, the tree has escaped cultivation and invades closed-canopy forests, bottomland hardwood forests, lakeshores, and wetlands. Chinese tallow can rapidly displace native vegetation in Florida wetlands by forming dense monospecific stands.



A. Leaves

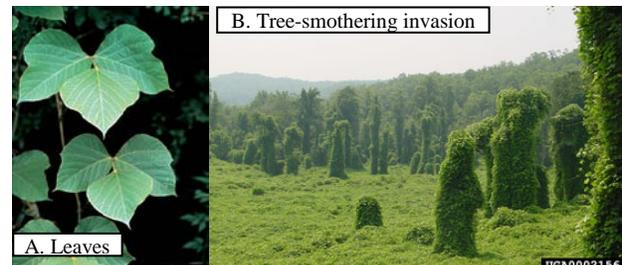
B. Tree - fall color

Kudzu

VINE

(Pueraria montana var. lobata)

Kudzu is one of the most widely recognized non-native pest plants in the southeastern United States, where it is invading approximately 7 million acres. A climbing deciduous vine which can reach lengths over 100 ft., kudzu generally grows in a dense mat. Kudzu's compound leaves have three broad leaflets, sometimes with shallow lobes. Stems and leaves are hairy. Kudzu occurs in open, disturbed areas such as roadsides, right-of-ways, forest edges, and old fields. Kudzu often grows over, smothers, and kills all other vegetation including trees. Kudzu is native to Asia and was first introduced into America in 1876 at the Philadelphia Centennial Exposition. It was widely planted throughout the eastern United States in an attempt to control erosion.



B. Tree-smothering invasion

A. Leaves

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Sustainable Forestry and Multiple Use Management

In recent years, many members of the public became increasingly concerned about the sustainability of forestry practices around the world. People started to question the motives of forest landowners, and the forestry practices that supplied people with their wood products. Why are foresters harvesting the old growth timber in the Pacific Northwest? Will the cutting of the tropical rain forests cause an ecological disaster?



To address these concerns a group of timber users, traders, manufacturers, retailers, and representatives of environmental and human-rights organizations met in California in 1990. They discussed how they could reduce unsustainable deforestation. An idea formed to allow independent organizations to certify sustainable wood products so that the public can identify them. This might create a public demand for sustainable wood products, and then reduce unsustainable deforestation. The Forest Stewardship Council© was later founded in Toronto, Canada, in 1993, and has paved the way for independent certifying bodies to sprout up and begin the work of certifying the particular wood products that come from sustainable forestry operations.



A similar program adopted by the American Forest and Paper Association in 1994 is the Sustainable Forestry Initiative® program. SFI combines environmental standards with sustainable growing and harvesting of timber. Environmental, professional, academic, and public representatives review forest products industries that participate. Other programs such as the Forest Stewardship Program and the American Tree Farm System also emphasize sustainable forestry.

There will always be a need to harvest timber. As long as forest managers use sustainable forestry practices and multiple use concepts, timber harvesting will be environmentally sound and improve our forest ecosystems.

Urban Forestry

The growth of cities has led to a specialized form of forestry which has been named Urban Forestry. Its aim is to protect and improve the quality of life in urban and suburban areas by helping to create in them an attractive and health environment through the proper use of trees and related plant associations.

Green areas improve the living conditions of Florida cities by providing peace of mind to the inhabitants. Trees also reduce noise and air pollution, shade homes and streets from the sun, and hide unsightly views.

Urban forestry practices resemble rural or classical forestry in many ways. The Urban Forester determines community objectives, inventories trees, develops plans, implements urban forestry practices, and protects the trees from insects, diseases and construction

damage. In general, the urban forester works closely with city or county governments to develop and implement policies towards trees and other plants.

The initial phase of preparing an urban forestry plan is inventorying the trees. The urban forester prepares either a canopy analysis or a street tree survey. A canopy analysis measures the percentage of an urban area shaded by trees. This information is obtained through the use of aerial photographs, and enables the forester to identify specific areas in the city that need more shade trees.

The street tree survey is much more detailed. It consists of an on-the-ground survey which records numbers of trees, species, ages, sizes and their condition. The survey is essential to the development of plans for planting, tree removal, pruning, and determining the recommended species.

The inventories form the basis for a community plan which outlines the priorities for urban forest management and identifies the kinds of work required to achieve the community's goals. This work may consist of such practices as street tree planting, public involvement planting projects, pruning and maintenance, and tree removals.

One important aspect of urban forestry is the protection of trees and shrubs during urban development. Ordinances exist in many municipalities in Florida. In addition, specific practices for tree protection during construction have been further developed. These include identification of valuable yard trees, and their protection from heavy equipment, excavation, and fill operations.

The Future?

Forestry is changing every year. New science, new technology, market demands, changing climates, political attitudes, and public perceptions drive changes in forestry. An important thing to remember when encountering change is to try to remember what changes happened in history.

World trade policies, increases or decreases in the supply and demand of wood products, profitability of intensive forest management, increasing environmental concerns, and the demand for wood products could result in changes in the way that we manage forests in the near future. The next generation of foresters has the task of taking forestry through these changes and developing an industry, science, and art that is sustainable and beneficial. Foresters are in a very important profession. No better opportunity exists for a person who wishes to utilize the Earth's natural resources for society's needs while benefiting the Earth at the same time. Forestry has the potential of being the most sustainable and ecologically friendly industry in the world, and the next generation of foresters gets the honor of accepting that challenge.

A challenge that meets future Florida foresters is the challenge of sustainable forestry in the state. We are adding 1,000 new Floridians each day, and losing 130 square miles of forests each year as urbanization expands to meet the needs of this migration. To deal

with this, we need people like you to manage Florida's forests for the necessary things that they provide to the ecosystem, the people, our state, and our planet.

Questions:

1. Is forestry in Florida the same now as it was one hundred years ago?
2. Do you expect it will be different 100 years from now?
3. Do you think the foresters of the past knew that forestry would be as it is today, and do you think they welcomed change?
4. Do you think forestry changed for the better in Florida throughout history? If so, do you think that it will continue to change for the better of society?

These are questions you might ask yourself before resisting change, because, like it or not, forestry is headed for many changes. A smart attitude to take when facing inevitable change might be, "How can I make this work?" instead of, "This is too difficult, and I will not do it."

The significant problems we face today - cannot be solved by the same level of thinking that created them.

-Albert Einstein

Always keep learning, and always explore new ideas without prejudice.

Questions for Part 2

1. What is the difference between artificial regeneration and natural regeneration? Give an example of how a forester can regenerate a forest using both methods.
2. What is site preparation? Describe some methods of site preparation before planting pine trees.
3. Are most planted forests in Florida pure or mixed? Are they even-aged or uneven-aged?
4. What benefits does thinning provide?
5. What are the seven main phases to a logging operation?
6. Why do foresters practice Best Management Practices when engaging in forestry activities?
7. What is a Special Management Zone?
8. What are six reasons why prescribed fire might be used in a forest?
9. What is a backfire? What is a flank fire? A head fire?

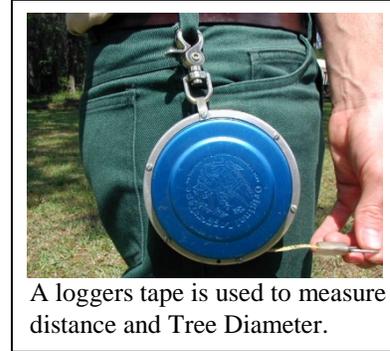
10. What are three ways in which a forester can manage a pine forest with wildlife habitat conservation as an objective?
11. How can a forest's ability to draw people toward it for recreation benefit that forest? How do you think it can harm the forest?
12. When are trees more susceptible to disease and insect infections?
13. What is integrated pest management and what are some examples?
14. What does sustainable and multiple use forest management do to help forestry and our society?
15. If you had to write a forest management plan for land that is void of trees, which order would you address the different topics below? There are several right answers for this question and several wrong answers as well! Explain your answers.

site preparation	harvesting	wildlife habitat
recreation	thinning	planting
Best Management Practices	prescribed burning	sustainability

Part Three: Forest Measurements

Introduction

Now that you have learned what activities are needed to manage a forest, you must learn how to properly measure your forest for growth rates, volume, health, and other important factors that determine how well your forest grows. To measure these things, foresters learn how to draw and read maps, find these locations in the forest, measure the sizes, growth, and volumes of the trees in the forest, and interpret these results. By using special tools, and some knowledge, you can easily learn how to apply forest measurement skills.

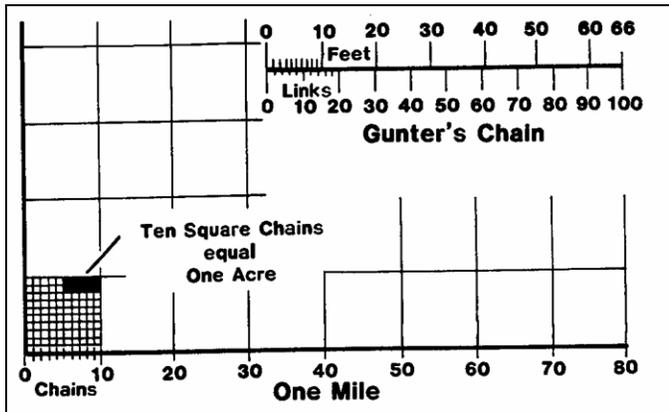


A logger's tape is used to measure distance and Tree Diameter.

To be able to measure the forest, sometimes we need to know how far it is from one point to another. How can we do this easily without carrying a really long measuring tape? We can *pace* it off, which is walking and counting every other step.

Learning to pace off distances is very useful. If you are able to determine long distances without using a measuring instrument, you can accomplish such things as:

set up a field for a pickup game of football, determine the area of your back yard, find out how far you can hit a golf ball, or even map a forest!

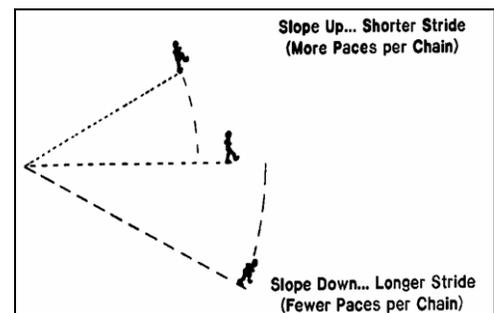


The standard unit of distance measurement in forestry is the *Gunter's Chain*, which is equal to 66 feet in length. It may seem like an awkward number to use, but the number 66 divides evenly with 5,280, which is the number of feet in a mile. Therefore,

there are exactly 80 chains in a mile. In addition, if you have an area of 10 square chains, you have exactly one acre. These numbers are easy to remember.

First you need to learn how to pace a chain. On a flat, level surface, measure out 66 feet with a logger's tape or other measuring device. Now walk those 66 feet while counting the number of paces or steps that you take. If you count the number of paces, you count after both your right and left leg takes a step (So if you start with your right foot, you count a pace for each time your left foot hits the ground.)

If you count the number of steps you take, you count every time each foot hits the ground. Therefore, the number of steps you take is usually two times the number of paces. Use whatever method you prefer, but make sure to take relaxed, normal steps. You do not want to have to take giant leaps to count your chains - this will wear you out! Walk the 66 feet several times with normal steps, and average your results. You can now measure all kinds of distances now that you know how to

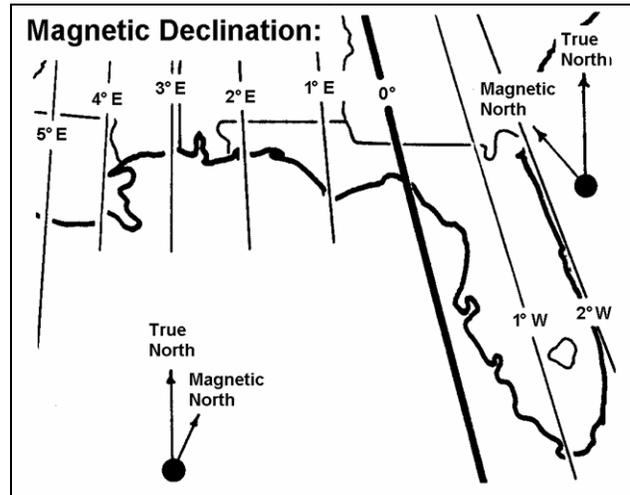


pace a chain! Just remember, if you are walking uphill, you take more steps to get the same distance, and if you are walking downhill, you take fewer steps. Learn how to adjust for this.

Using an Azimuth Compass

Compasses that are graduated into 360 degree marks (0°-360°) are called azimuth compasses. A reading from this compass is called an *azimuth*. North will have an azimuth of 360° (or 0°), while south will have an azimuth of 180°. An azimuth compass with a rotating dial on its face is commonly used by foresters and in forestry competitions.

All compasses point to the earth's magnetic North Pole, which is more than 800 miles from the earth's geographic North Pole, so keep in mind that your



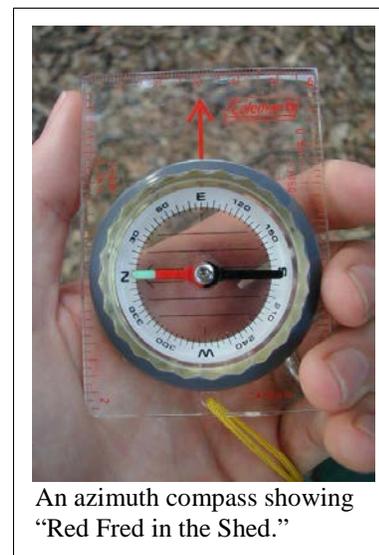
compass reading may be from 0° to 3° to the east or west of true north, depending on where you are in Florida. In fact, in some western States this error can exceed 20°. You will need to account for this error when taking an azimuth from a map and trying to traverse it on the ground. Using a handheld GPS (Global Positioning System) may help with this problem, but it can create other problems. A GPS uses satellites in Earth's orbit to find your exact position on the earth by using trigonometry.



A simple Global Positioning System (GPS) unit. Foresters use GPS units to map forests and to pinpoint special locations accurately.

location, simply hold the compass flat on your open palm with the direction arrow (located on the base) pointed in the direction of the object. Rotate the compass dial until the slot on the dial is aligned with the compass needle that points toward magnetic north. Since many compass needles are colored red, and the arrow on most compass dials fit snugly around the needle, the act of fitting these two together is easily remembered as, “*Put Red Fred in the Shed.*” The azimuth degree reading is the number in line with your direction arrow! Please remember to stay away from any metal or electrical objects while using a magnetic compass or your needle will go a little wild!

When using a compass to measure the azimuth to an object from your present



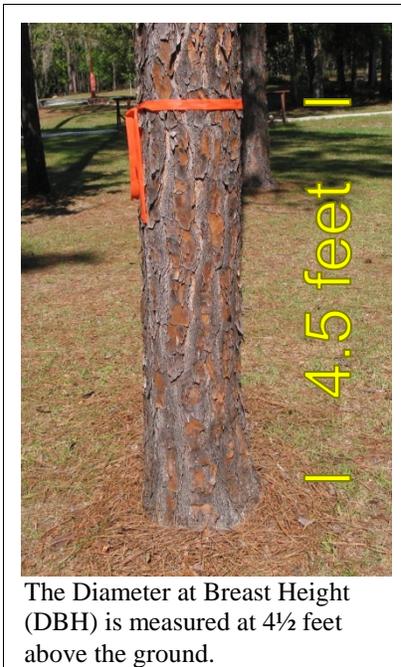
An azimuth compass showing “Red Fred in the Shed.”

If you are given the azimuth degree reading and you want to travel in that direction, simply dial that number to your direction arrow, and turn your body until “Red Fred” is in the shed! Find an object that the direction arrow is pointing toward and walk in that direction. If you pick an object in the distance to walk towards you are more likely to follow the correct azimuth than if you walk looking at your compass.

Remember the magnetic declination mentioned earlier? This comes into play when you take an azimuth from a map and try to walk that direction on the ground. If the map has a west declination, you must add this to the azimuth; however, an east declination would be subtracted. For example, let’s say that you look at a map and determine that in order to get to a bridge from your current location you must follow an azimuth of 45°, and the map has a magnetic declination of 2° east. Subtract (east declination) 2° from the 45° azimuth to get the 43° magnetic azimuth you must follow on the ground. Some compasses, however, have an adjustment for declination so that you can skip all the math.

Measuring Trees

Trees are measured to determine the volume and growth of both the individual tree, and the entire forest stand. The data taken from tree measurements can determine the health of the forest and help in determining the value of its wood.



Diameter: If you were to cut a tree down, and measure the average distance across the cut, you would come up with its diameter. Since we cannot cut down every tree we want to measure, it is far easier to use a diameter tape. Diameter tape is wrapped around the *circumference* of the tree at 4½ feet above the ground, the standard point of measurement for tree volume computations. This is called the *Diameter at Breast Height (DBH)* and is much easier than measuring the diameter at the base of the tree.

Since wrapping a regular measuring tape around the tree will only get us the circumference, you would want to make sure to use a specially calibrated diameter tape. This tape uses the formula of Circumference = π

x diameter, so that you don’t have to calculate it! This makes every inch of diameter appear to be 3.14 inches long on your diameter tape! Most diameter tapes also have a standard tape measure on the reverse side, so be sure to use the correct side.

Diameter measurements are often 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 some products. Diameters are usually tallied to the nearest inch. Round up when the measurement is .6 or more, and round down when less than .6.

Class	Pulpwood	Chip-N-Saw ¹	Saw Timber ¹	Poles ²	Veneer Logs
Use	Paper, wood by-products	Small lumber	Large lumber	Utility poles	Plywood
DBH	> 4.6"	> 8.6"	> 11.6"	Varies	> 14"
Top diameter	2 – 4"	5 – 6"	8"	6"	8"
Time to grow	8-15 years	12-20 years	20-30+ years	18+ years	25+ years

¹ Straight log at least 16 feet long with no forks, large branches or diseases.

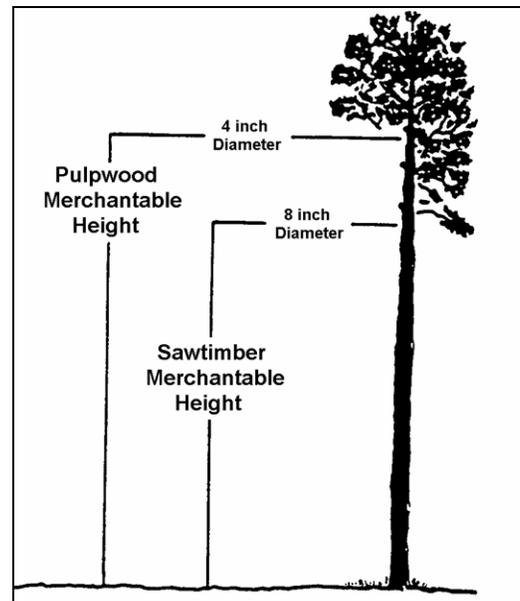
² Long, straight, nearly perfect stem.

Tree Height: Foresters use a couple of different types of instruments to measure tree height. These include the Biltmore stick, the hagameter, the clinometer, or one of several instruments that use lasers to get more accurate readings.

The *clinometer* is a popular tool used by foresters that tells the user how tall the tree is by using *trigonometry*. Trigonometry is a type of mathematics used to determine angles and lengths in geometric figures, especially triangles. Many clinometers do the math for you when you look into them at the tree, but require that you stand one chain away from the tree. You can easily build your own clinometer if you want to save some money, and learn something at the same time!

There is a difference between *total tree height* and *merchantable tree height*. The total tree height is the height to the top of the needles. The merchantable tree height is the upper limit of useable wood for a given product on a tree stem. A tree's diameter gets smaller toward the top of the tree, this is known as taper. Pulpwood height is measured to a 4 inch minimum at the top of the tree. So, in this case, you would measure the tree's height up to where it tapers to around 4 inches in diameter. For other wood classes, you would measure to a larger diameter, usually an 8 inch top.

Heights are often measured in units larger than the standard foot. Pulpwood is often measured in 5 ¼ foot sticks (16' minimum), and sawtimber is measured in 16 foot logs. After the first full log, these products can be measured to the half-log. Always round down when measuring heights.



Tree Growth: Some trees grow well, others don't. Numerous factors affect how a tree grows. The amount of sunlight, nutrients, and water a tree gets, genetics, competition, and the site suitability of a tree all have an affect on the individual tree's growth. Foresters try to determine if a tree is growing as well as its potential, and, if not, why it is not growing as desired. To do this, foresters use a drill-like tool called an increment borer. This tool can be bored into a tree and extract a tube that shows the annual rings of *earlywood* and *latewood* that the tree has put on throughout its life.



A student uses an increment borer at a summer camp at Withlacoochee State Forest.

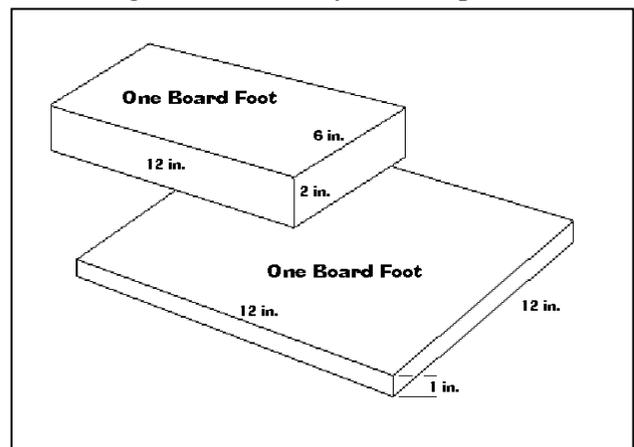
Counting each dark ring should tell you the age of the tree. If the rings are close together, the tree grew slowly that season, if they are far apart, it grew quickly. A change from widely spaced rings to narrow rings indicates slowed growth, which might be from competition, drought, or some other stress.

As an activity, look at some tree stumps or wood products that have the tree rings showing. Do you see where the tree put on good growth in a season, and where it put on little growth? Can you tell anything else about that tree's life by looking at the rings? Believe it or not, there is a science called Dendrochronology that looks at tree rings to determine events in history that affected the tree.

Volume Determination: Once the trees are measured for diameter and merchantable height, the tree volumes can be computed using volume tables. Volume tables vary by product, species, geographic location, date, and user preference. To use a volume table, find where the tree's DBH intersects with its merchantable height, this will give you the merchantable volume of the tree. Below are examples of a pulpwood volume table and a sawtimber volume table.

Pulpwood is generally measured by the *cord* or by weight. A cord of wood is a stack of round wood that measures four feet high, four feet wide and eight feet long, and contains 128 cubic feet. But since that stack also contains air space and bark, a conversion factor of 90 cubic feet of solid wood per cord is used for standing timber. Once you add up all of the cubic foot values of all the pulpwood trees to give you your total volume, divide this number by 90 to get the number of cords of pulpwood. One cord of pine pulpwood is equivalent to 5,400 pounds, or 2.7 tons.

Sawtimber is measured in board feet, generally thousands of board feet (MBF), or by weight. A *board foot* is a unit of measure containing 144 cubic inches of solid wood. Examples of a board foot include a piece of



wood 12 inches by 12 inches by one inch thick; or a board six inches wide, 12 inches long, and two inches thick; or an 18 inch long 2" x 4". One thousand board feet of pine sawtimber is equivalent to 15,000 pounds, or 7.5 tons.

Pulpwood Volume Table							
(cubic-foot volume, second growth Southern Pine)							
Number of 16-Foot Logs							
DBH	0.5	1	1.5	2	2.5	3	3.5
5"	0.8	1.3	1.8	2.2			
6"	1.4	2.4	3.2	4.0	4.7		
7"	2.0	3.4	4.6	5.7	6.7	7.7	
8"	2.6	4.4	5.9	7.3	8.7	9.9	11.1
9"	3.2	5.4	7.3	9.0	10.6	12.2	13.7
10"	3.8	6.4	8.6	10.7	12.6	14.5	16.3
11"	4.4	7.4	10.0	12.5	14.7	16.9	18.9

Gross Tree Volume Table							
Scribner Log Rule, Form Class 78							
Volume (Board Feet) by Number of Usable 16-foot Logs							
DBH	1	1 ½	2	2 ½	3	3 ½	4
10"	28	36	44	48	52		
11"	38	47	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

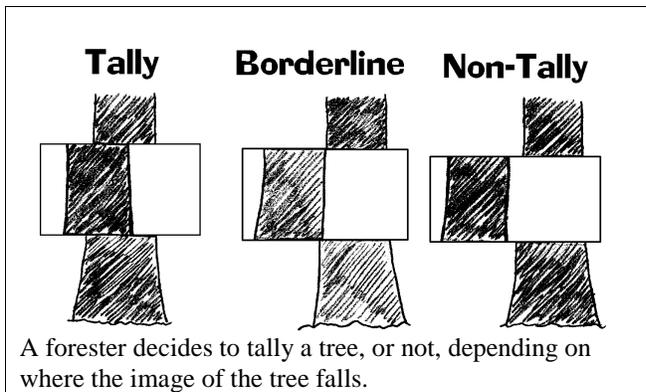
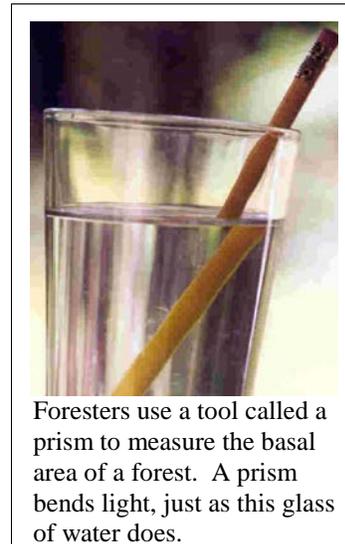
Measuring Stands

Sampling: When measuring entire stands of trees, foresters do not count every tree; instead, they sample sections of the forest to get a good idea of what is there. These small sections are called plots. A *plot* is a smaller section of the forest that is assumed to be representative of the entire forest. The number of plots needed to estimate the volume of the stand is determined by the variation of the trees within the stand. If the trees in the stand are similar in size, fewer plots are needed. As a general rule, there should be one plot for every three acres, and a minimum of at least five plots no matter how small the stand.

Plot locations should be chosen prior to going into the stand to eliminate the tendency to find a plot that looks good. Once the number of plots is determined, a grid pattern should be laid over a map of the stand. The grid should be of the proper size to make the number of intersections match the number of plots while encompassing the entire stand.

Basal Area: *Basal area* is the cross-sectional area of a tree 4½ feet above ground. The basal area of all trees in an area describes how much area is occupied by those trees, and is generally measured in square feet per acre (ft²/acre). This measurement is a good way to tell when an area is getting “over crowded,” regardless of the size of the trees.

The way that foresters determine the basal area of a forest is to use something called a *prism* to tell them which trees to tally (count). A prism is an object that bends light rays as they pass through it. When light bends, objects can appear to be distorted! The distance the object is from the prism and the size of the object determine how distorted it appears. One example of this is when you put a pencil in a glass of water and it appears to be broken. Just like that pencil, trees can look distorted behind a prism.



When using a prism to measure basal area, you are using a variable point sampling. This means that trees are counted at different distances from the

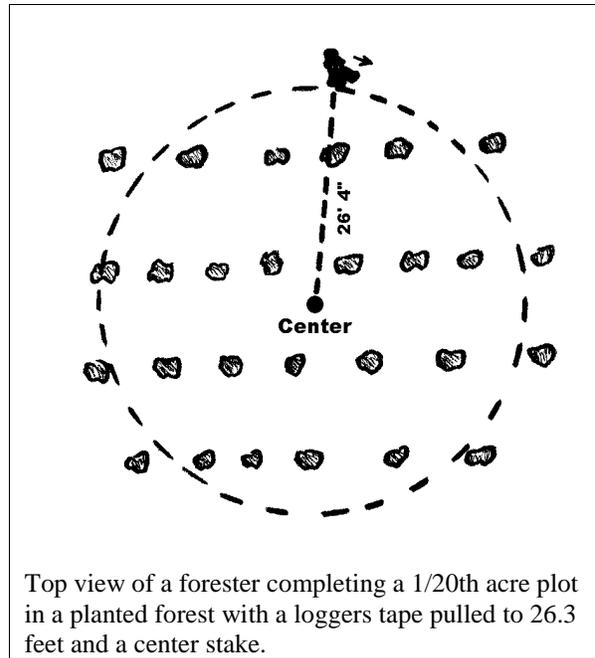


A forester looks through a prism.

center of the plot based on their diameters. The mathematics behind this is very complex, but luckily using a prism makes applying the theory very easy. Foresters find their plot center, and

count the number of trees that are in their plot by looking through the prism. If the tree and the tree's image in the prism are overlapping, the tree is inside the plot; otherwise, it is not counted. A common prism is called a 10 factor prism, which means that each tree that is counted with the prism is multiplied by 10 to get your basal area. For example, a count of 10 trees with this prism will compute to 100 ft² of basal area per acre for that plot.

Tree Density: Basically, this determines how tightly packed the trees are, and is expressed in trees per acre or TPA for short. Density counts are most often used when stands are young, since these measurements don't take tree size into consideration. Many foresters use $\frac{1}{20}$ th acre circular plots to determine TPA. In the Tree Planting section you learned that, depending upon the objectives and species planted, seedlings should be spaced at certain densities. Below are directions to do a $\frac{1}{20}$ th acre circular plot to determine if the planting density was correct.



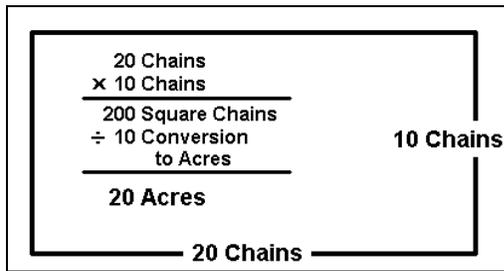
Top view of a forester completing a $\frac{1}{20}$ th acre plot in a planted forest with a loggers tape pulled to 26.3 feet and a center stake.

Begin by randomly choosing your plots, then travel to these locations (by using your compass and pacing skills) with your Jacob staff and loggers tape. Upon arrival at your plot, stick your Jacob staff into the ground and connect the end of your loggers tape to it. A $\frac{1}{20}$ th acre circular plot has a radius of 26.33 feet, so take the tape out to 26 feet, 4 inches and travel around in a circle, counting the trees that the tape can reach. This is easy if the trees are shorter than your waste, but tall trees require a little bit of moving around to get your count! When you arrive at your starting point, multiply your final count by 20 (since there are twenty $\frac{1}{20}$ th acres plots in one acre) to get the number of trees per acre! Average the density from each of your plots, and you have a pretty good estimation of the density of trees in your forest stand.

Measuring Area

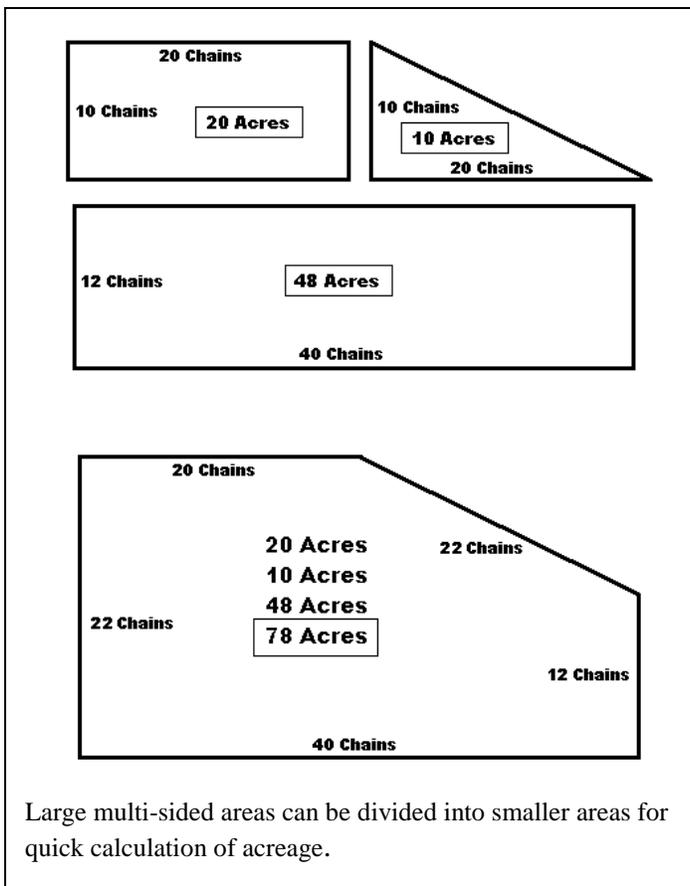
Foresters have some high-tech ways to determine acreage using GPS units and computer programs such as ArcView. Although these are accurate ways to determine the acreage of a stand, they require expensive equipment and the knowledge of how to use it. Another method is to use the compass and pacing skills learned earlier and some basic math skills. The following section describes how to measure a small stand in this manner.

Acreage Estimation: Converting paced dimensions to acres is easy if the area is paced off in chains. We know that there are 10 square chains in an acre, and we learned earlier how to measure chains by pacing. By determining the number of square chains in an



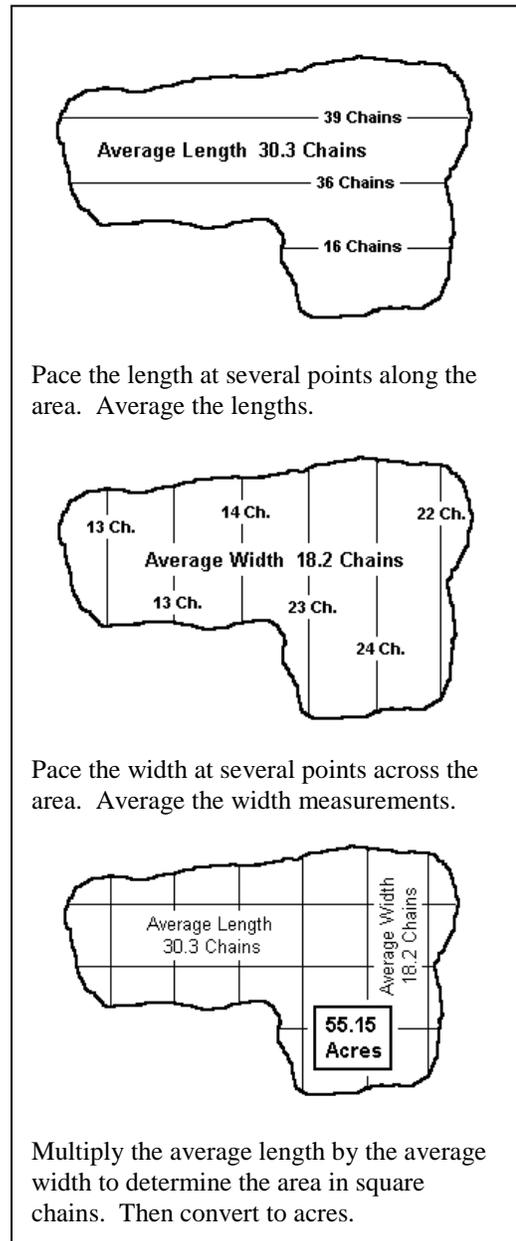
area, then dividing by 10, you can find out how many acres are in a stand. With your compass in hand, to make sure that your lines stay straight, and parallel or perpendicular as needed, you are now ready to start measuring.

When an area is rectangular, measure the length and width in chains, multiply the length times the width, then divide by 10. Make sure that your area is rectangular since this won't work on any other shape. Since triangles are basically one-half of a rectangle, measuring these shape areas are almost as easy. Measure the length and the width, making sure that the transects are perpendicular; multiply the length by the width, divide by two, then divide by 10.



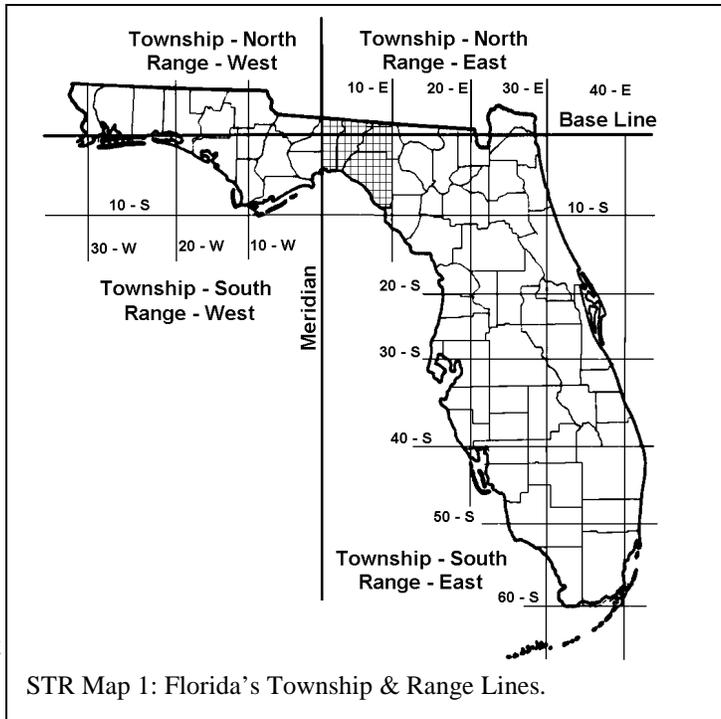
Some areas can be broken down into combinations of triangles and rectangles. Simply add the smaller sections together to get the total area.

What about areas that are irregularly shaped? Another method must be used in this case. By measuring parallel transects and averaging the lengths you can estimate the average length of the



area. Then do the same for the width by averaging parallel transects of the width that are perpendicular to the length transects. Multiply the average length times the average width, then divide by 10 to get the total acreage.

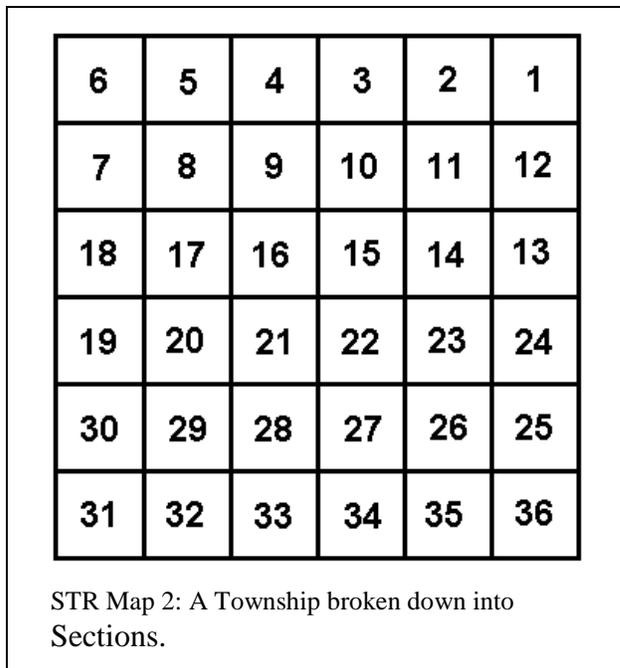
Section, Township, and Range: For purposes of standardizing property lines throughout the state, Florida is divided into blocks, called townships, measuring 6 miles by 6 miles (See STR Map 1). The sides of the townships running east and west are called *township lines*. Those running north and south are called *range lines*. The numbering system for the whole state begins with a concrete monument called the *Prime Meridian marker* near the state capital in Tallahassee.



STR Map 1: Florida's Township & Range Lines.

The numbers grow larger as the distance from the Prime Meridian marker increases. Each township line is also designated either north or south, and each range marker is east or west, depending on the direction from the Prime Meridian marker.

Each township is divided into 36 sections; each section one mile square (640 acres). Numbering of these sections within a Township is quite odd. Starting in the upper right corner of the Township, sections are numbered left and down in a serpentine pattern. See STR Map 2.

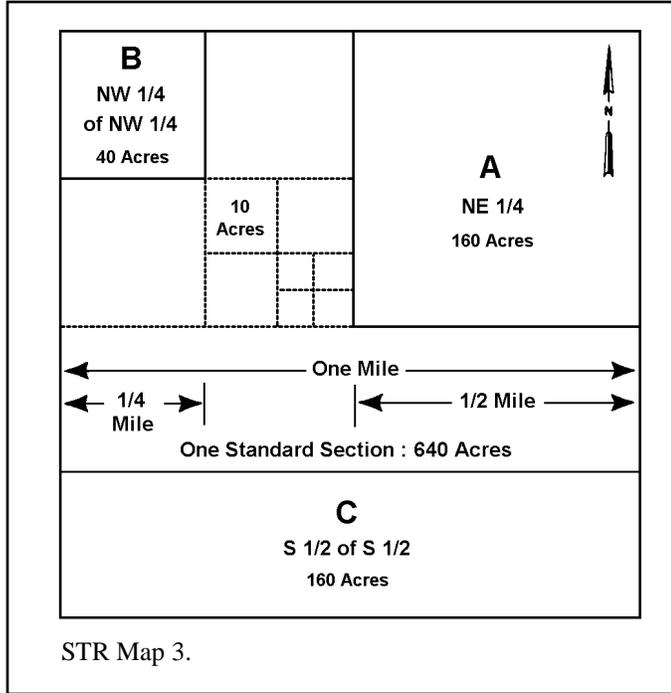


The legal description of a particular piece of property indicates section first, then township number, and range number. Sections can be further divided into quarters and quarters of quarters (STR Map 3). In this manner, a piece of property as small as 2.5 acres can be described so that it cannot be confused for another 2.5 acres anywhere in the State of Florida.

To find the legal description of a piece of property, find its location on a map that shows the section, township and range numbers, and write them down in that order. For example, if the section to the right was located in Section 36, Township 8 South, Range

16 East, then this would be part of the legal description. If the property you are describing is parcel “B,” in the upper left hand corner, the description can be made more accurate. The full legal description of that piece is: the NW $\frac{1}{4}$ of the NW $\frac{1}{4}$ of section 36, Township 8 South, Range 16 East.

As you can see from the map, not all descriptions use $\frac{1}{4}$'s, sometimes $\frac{1}{2}$'s are used instead. But, all legal descriptions use rectangles. Sometimes an odd shaped piece cannot be described by just a rectangle, but maybe two rectangles can describe the area. In this case, describe each rectangular part separately.



As an activity to practice using these mapping skills, find the section-township-range of your school, and then of your house. Break it down to the smallest quarter.

Glossary

alternately arranged leaves	Leaves that are arranged one after the other on opposite sides of a stem.
annual rings	One year's wood growth, as viewed in the cross section of a tree trunk. One year contains one light and one dark ring.
artificial regeneration	The practice of planting seedlings or direct seeding for reestablishing a forest.
azimuth	The horizontal angular distance measured clockwise from due north.
azimuth compass	A compass that is graduated into 360 degree marks as a means of directional measurement.
backfire	A slow moving fire that burns into the wind.
bare root seedlings	Nursery grown seedlings that are baled and delivered without soil around the roots.
bark	The dead, outer layer of the tree that provide protection from drying, insects and disease, freezing, and fire.
basal area	The cross-sectional area of the tree 4.5 feet above the ground.
bedding	The process of molding the dirt into a hill that seedlings can be planted on to protect them from standing water.
Best Management Practices	Practices that are designed as the minimum standards necessary To protect water quality during forestry activities.
board foot	A unit of volume measurement for saw timber equal to 144 cubic inches of wood.
broadleaf trees	A term used for trees with wide leaves.
buck	When a tree is cut into a desired length.
canopy	The upper leaves of a forest.
cellulose	The main constituent of the cell wall of most plants, prized for it's use in making paper and many other products.
certified wood products	Wood products that come from forests that have been certified as a sustainable operation by an independent organization.
chain	See Gunter's chain.

chip-n-saw	A size class of timber larger than pulpwood and smaller than sawtimber which yields small dimension lumber and wood chips as products.
chlorophyll	The green substance in plants, which acts as a catalyst in the photosynthesis process.
chopping	A mechanical operation that removes small, undesirable vegetation by rolling a drum with multiple blades over it.
circumference	The distance around the perimeter of a circle.
clinometer	An instrument used to measure the heights of objects by using trigonometry.
co-dominant trees	Trees in the upper portion of the forest canopy that are taller and bigger than all but the largest “dominant” trees.
compass	An instrument used to determine magnetic north and an azimuth.
compound leaves	Leaves that are made up of several leaflets together in a single leaf.
conifer	Trees that have needle-like or scale-like leaves, and usually bear cones.
conservation	The controlled use and systematic protection of natural resources.
containerized	A seedling that grows in a small container with soil around the roots.
coppice	A process by which apical buds form new stems from the stump or roots of a tree.
cord	A stack of wood 4'x 4'x 8' (128 cubic feet) which contains both solid wood and air. Generally results in about 90 cubic feet of solid wood.
cork cambium	The layer of soft growing tissue in a plant that develops into new bark and new wood.
deciduous	A tree that sheds all its leaves at the end of the growing season.
de-limb	The process of removing the limbs from trees during the harvest operation.
dendrology	The science of tree identification.
diameter	The straight-line distance through the center of an object.
diameter at breast height	(DBH) The diameter of a tree measured from a point 4.5 feet above the ground.

dibble bar	A spade like device used to open holes for planting trees.
dominant trees	The tallest, broadest trees of a forest that get the most sunlight.
earlywood	The lighter colored, less dense wood that grows in the spring and summer.
ecotone	An area where two plant communities come together.
edge	See ecotone.
endangered species	A species with a population small enough that the US government has determined that it needs special protection to survive.
environmental conditions	Conditions that are a result of weather, climate, or the other parts of the ecological system.
evapotranspiration	The process by which water is released as a vapor into the atmosphere through evaporation and respiration.
even-aged forest	A forest that consists of trees of similar age.
evergreen	A tree that holds onto its leaves though more than one year.
feeder roots	Roots at or near the soil surface that absorb most of the water and nutrients needed by the tree.
feller-buncher	A wheeled or tracked vehicle with a timber cutting shear or saw that cuts and stacks harvested trees in one operation.
fire break	A natural or man-made area where there are no forest fuels to carry a fire.
flank fire	A fire burns perpendicular to the wind.
Florida Forest Service	The agency organized by the Florida Board of Forestry in the 1920s to help Florida replenish its wood resources.
forest fuels	Any naturally occurring materials that can carry a fire, such as leaves, wood, grass and other vegetation, dead or alive.
Forest Management Practices	Activities such as planting, burning, and harvesting that are incorporated into the management plan of a forest.
Forestry	The art and science of cultivating, maintaining, and developing a forest and related natural resources.
galleries	The tunnels that insects make in wood.
galls	A swelling on a leaf or stem caused by an insect or pathogen.

genetically resistant variations	A plant or animal that is resistant to a disease, virus, or other infection/infestation because of genetic characteristics.
girdling	The practice of severing phloem tissue around a tree's circumference.
grass stage	The early life stage of a longleaf pine or south Florida slash pine that resembles a clump of grass.
Gunter's chain	A unit of length equal to 66 feet.
harvest	The activity of taking wood products from the forest.
head fire	A fire that moves in the direction of the wind.
heartwood	Dead, inactive phloem located in the center of the tree.
herbicide	A chemical that is able to kill certain types of plants.
Integrated Pest Management	Pest management that involves a variety of control measures for insects and diseases.
intermediate trees	Trees that receive some sunlight from above, but none from the sides due to competition from the dominant and co-dominant trees.
lateral roots	Roots that grow along the surface rather than deep into the soil.
latewood	The darker, more dense wood that grows in the fall and winter.
leaves	The tree's food making factories that also respire for the tree and serve as insulation and protection from inclement weather.
log	A cut tree 16 feet long.
margins	The edge of a leaf. Descriptions often help in the identification of the species to which the leaf belongs.
Master Logger Program	A program developed by the Florida Forestry Association that certifies loggers who have completed courses dealing with environmentally sound logging techniques.
merchantable tree height	The height of the portion of a tree that can be used for wood products.
mixed forest	A forest that has more than one dominant species.
multiple use forestry	Managing forestland for more than one purpose; such as for timber, wildlife, aesthetics, recreation, and soil and water conservation.

mychorriza	Beneficial fungi that aid a root to absorb water and nutrients.
natural regeneration	The practice of relying on seed produced and spread from standing trees or coppicing for regeneration of a forest stand.
Naval Stores	Products such as turpentine and rosin derived from gum or resin of pines used in the naval industry
oppositely arranged leaves	Leaves that grow directly across from each other on a branch.
pace	Two normal, relaxed steps.
pathogen	An organism capable of causing a disease.
pesticide	A chemical that kills or repels animal or insect pests.
phloem	Tissue which conducts food manufactured in the crown to the rest of the tree.
photosynthesis	The food making process of all plants. Carbon dioxide and water are combined to form sugars and oxygen using light energy.
pitch	The rosin inside a tree. It is commonly seen when it comes out of a tree after it is injured.
plots	Points in the forest where sample measurements are taken.
poles	Round timbers that are placed upright in holes in the ground.
prescribed burning	The application of fire as a management tool to obtain specific objectives desired to maintain and cultivate a forest.
Prime Meridian marker	A concrete marker in Tallahassee where the Township numbering system for the state begins.
prism	An instrument that is calibrated to determine the basal area of a forest by refracting light through a wedge shaped piece of glass.
pulpwood	Standing timber or cut roundwood that is suitable for converting to pulp for making paper or cellulose based products.
range lines	Parallel lines 6 miles apart running north-south that are numbered to denote east-west locations of townships.
recreation	Engaging in activities for fun and enjoyment.
reforestation	The act of putting trees back where they once were.
root hairs	Tiny projections of tree roots that absorb the bulk of nutrients and water required by the tree.

roots	The part of the tree that absorbs water and nutrients, and anchor the tree against wind and water.
rotations	The length of time from stand establishment (planting) to final harvest.
sapwood	Active xylem tissue, the layer of wood that transports water and nutrients from the roots to the crown.
saw timber	Trees suitable for the production of lumber.
scalping	The practice of peeling back the top layer of soil in a strip about 2.5 feet wide and 4 inches deep that reduces competition from other vegetation.
silviculture	The science of producing and tending a forest.
simple leaves	A leaf that does not have leaflets, only one true leaf.
skidder	A rubber-tired or tracked vehicle designed to pull logs through the woods to loading areas.
snags	Standing dead trees.
Special Management Zones	An area immediately adjacent to a body of water where certain restrictions apply to forestry activities to protect the water quality.
stomata	Openings in the leaf that releases water vapor to cool the leaf and the air around it.
suppressed trees	The slowest growing, weakest trees of a forest that receive no direct sunlight.
sustainable	The ability of something to last forever.
Sustainable Forestry Initiative	A program adopted by forest industries that encourages sustainable forestry operations.
taproot	The main supportive root of the tree's root system. It serves as support for the rest of the tree and also aids in water and nutrient absorption.
total tree height	The total height of a tree from its base to the top of its highest leaves.
township lines	Parallel lines 6 miles apart and running east-west that are numbered to denote north-south locations of townships.

tree-felling	The process of cutting down (felling) a tree.
trigonometry	A branch of mathematics that uses the measurements of angles to determine relative information.
uneven-aged forest	A forest that is made up of trees that are of different ages.
vascular cambium	The zone of xylem and phloem development where cells divide and differentiate into either xylem cells or phloem cells.
V-blade planting	Planting that uses a bulldozer with a blade shaped like a "V" to clear logging debris and vegetation so that seedlings could be planted by a planter pulled behind it.
veneer	Thin sheets of wood that are glued to other materials or each other, often to make plywood.
whole-tree chipping	The process of chipping an entire tree into small pieces to be used as mulch, pulp, or fuel.
whorled leaf arrangement	Leaves that are arranged in a pattern that circles the stem.
wildlife	Animals found in natural settings.
xylem	Woody tissue which transports water and nutrients from the roots to the crown consisting of millions of tube-like cells.

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