TEXAS STATE WOODLAND CLINIC

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Texas State Woodland Clinic Manual

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Introduction

Each year woodland clinics are held in East Texas to provide young people with a working knowledge of forestry. The clinic culminates each year in a contest each spring sponsored by the Texas Association of Soil and Water Conservation Districts, the Natural Resources Conservation Service (formerly the Soil Conservation Service) of the U.S.D.A., the Texas Forest Service, and the Arthur Temple College of Forestry at Stephen F. Austin State University. The clinics are held locally by each soil and water conservation district, and the winners from the local clinics go on to the state clinic which is held in late April. Generally, competition has involved two youth organizations, the 4-H Club and the FFA, which compete in separate divisions.

The clinics provide excellent opportunities for students to gain considerable insight into forest land management. They also give students the chance to train and talk with professional foresters involved with the management of company, public and private forest lands. For any student considering forestry as a career choice, this experience can be extremely valuable.

Objectives of the Clinic

1. To familiarize students with the efforts of soil and water conservation districts in stressing proper use of woodlands, the predominant land use in East Texas.

2. To create an awareness and understanding of the value of properly managed woodlands and to promote a greater appreciation of woodlands as a renewable natural resource, dependent on the soil for development.

3. To teach methods of developing and managing commercial woodlands.

4. To recognize that woodlands can be managed to enhance wildlife habitat at the same time that wood products are growing.

Purpose of This Book

The purpose of this instructional guide is to provide teachers and leaders with additional explanations and teaching aids for each of the thirteen events in the woodland clinic. In-depth information is furnished so that teachers and leaders can gain more understanding of the principles in each event. Effort has been made to fully explain each event and to increase the background material so that instructions to the students will be clear and meaningful. If this purpose is accomplished, the objectives of the woodland clinic will become a reality to those exposed to the use and treatment of the East Texas forestlands.

Woodland Clinic History

The Woodland Clinic began in March 1957. Four Soil Conservation Service employees, George Marks, District Conservationist (DC), Marion County; Ted H. Elders, DC, Cass County; Woodrow Harrell, DC, Upshur County; and Leo Fisher, Area Forester, Mt. Pleasant, met with the Area Conservationist, Rayborn Nash, Mt. Pleasant, to discuss the need for forestry training in the schools similar to that being provided through the land judging contest. They were given the go-ahead and developed a set of questions and rules.

The first area contest was held in Marion County in March 1957. It was sponsored by the Northeast Texas Association of Soil and Water Conservation Districts. Each district held a local contest, and their winners were sent to the area contest. Both 4-H and FFA teams participated.

A committee of Soil and Water Conservation District Directors, Stephen F. Austin State University faculty, State Association Field Representatives, and Soil Conservation

Service employees was organized to oversee rules used in local contests, provide leadership, and arrange a State Woodland Clinic that would give the winners in each district's local contest an opportunity to compete with other winners throughout East Texas. Strong leadership has been provided by the chairman of the committee, who is elected among the committee members and has always been a soil and water district director. Two past chairmen were David Tong and Val Blanchette. The high point individual awards in the FFA and 4-H divisions have been named after these men as a tribute to their efforts in building the State Woodland Clinic. In 1979 the high point individual award in the FFA division was named for David Tong, and the 4-H high point individual award was named for Val Blanchette in 1996. Although the contest has remained generally unchanged through the years, there have been changes to some questions. In order to bring consistency to the contest and to help instructors teach the material, a Woodland Clinic Handbook was developed in 1979. It was written by Allen "Lannie" Dreesen, Extension Service, Ed Holcombe and Joe Daniel, both of the SCS. The State Woodland Clinics have been held in many locations, including Pyrtle Scout Camp, near Carthage (1981 - 1986) and the Stephen F. Austin Experimental Forest, near Nacogdoches.

In 1984, Texas combined with Louisiana and Arkansas to form a regional woodland contest. The first contest was held on May 4 at the Southwest Electric Power Company's Wilkes Lodge near Avinger, Texas. Eleven teams participated. Each state hosts the contest on a rotating schedule. In 1995, teams from Oklahoma joined the regional clinic to make it a four state contest.

Summary of Events

In order to accomplish the objectives set by the State Association of Conservation Districts, woodland clinics are organized into separate events. Each event addresses a particular forestry skill or art.

Question 1: Hardwood Identification

Hardwoods are found throughout East Texas, and an ability to identify them is important in forest management. On this question, ten species of trees (listed on the Question Sheet) will be tagged with a letter from "A" through "J." Students will identify them and enter on the Answer Sheet, the corresponding number from the Question Sheet. The scoring will be one point for each correct identification.

Question 2: Pine Identification

There are four species of pines found in East Texas. Loblolly, shortleaf and longleaf are native, but slash is introduced. In this event, students will identify five tagged trees and/or branches and cones. The samples will be labeled with letters from "A" through "E." and students will place the appropriate number for each species from the Question Sheet on the Answer Sheet. Scoring will be two points for each correct identification.

Question 3: Wood Identification

Several species of trees are valuable for use in products such as furniture, veneer, lumber, etc. It is important to be able to recognize these species from logs or the finished product as well as in the forest. In this event, students will examine 5 blocks of wood tagged with letters "A" through "E" to determine the species of tree from which they were cut. The blocks will be selected from the species listed on the Question Sheet, and students will place on the Answer Sheet the appropriate code for each sample from the Question Sheet. Scoring will be one point for each correct identification.

Question 4: Wood Products

Many products come from properly managed woodlands. The main products in order of decreasing value are: (1) poles and piling, (2) veneer logs and sawlogs, and (3) pulpwood and fence posts. The ability to determine the best market for the trees being sold is important in successful forest management. In this event, students will examine five trees that are tagged with letters "A" through "E" to determine the market for which each is best suited. The coded product from the Question Sheet will be placed onto the Answer Sheet for each tree. Scoring will be two points for each correct determination.

Question 5: Timber-Forage-Wildlife Relationships

Deer, turkey, quail and numerous songbirds, as well as small mammals, depend heavily upon the browse and food produced within the first four feet of the forest floor. Sound management practices can influence the quantity and quality of these understory plants. Browse plants are classified into three categories: first choice, second choice and low value. It is important to recognize the most commonly occurring browse species and their relative importance to deer. In this event, students will identify five browse plants tagged with letters "A" through "E." The plants are listed on the Question Sheet, and the number corresponding to the tagged plant will be placed on the Answer Sheet. Students will also assign the proper utilization or preference rating for each plant ("1" for first choice, "2" for second choice, and "3" for low value). The scoring will be one point for a correct identification and one point for a proper determination of the plant's preference. However, if the plant is not correctly identified, no credit will be given for the utilization rating.

Question 6: Tree Measurement and Volume

Volume has been the traditional measure for wood quantity and continues to be very important today. Volume is a product of height and diameter, and although there are many complicated tools available to make these measurements, the cruiser or Biltmore stick is most commonly used. In this event, students will determine the DBH (diameter at breast height) of five tagged pines to the nearest even inch (12", 14", etc.) and the merchantable height in full logs or half-logs to a 6 inch top. A timber volume table/tally sheet will be provided. Students will determine the volume for each tree and place the total volume for all five trees on the Answer Sheet. Scoring will be 10 points for determinations within 5% of the correct total; 5 points for determinations within 10%. No points will be awarded for those over 10% from the correct Volume total.

Question 7: Site Index and Productivity

Site index is an indicator of the productivity of a site and is expresses as the height, in feet, that the average dominant trees in the stand are expected to grow in 50 years. Site index is influenced by the soil and the climate. In this event, students will be given a site index table and either an increment core or cross section for determining age. Students will round the age to the nearest five years and measure the total height of a marked tree. Using the table, students will then determine the site index and record it on the Answer Sheet. Scoring will be as follows:

Site Index:

Correct site index =	7 points
FIve indices either way =	5 points
Ten indices either way =	2 points
More than ten indices -	0 points

Question 8: Rate of Growth

For best economical gains and good quality lumber, timber should grow at about the rate of five to eight rings (or years) per inch of radius. More than eight years per inch is uneconomical; fewer than five years indicates wasted growing room and usually results in poorer quality lumber. In this event, students will examine either three blocks of lumber, increment cores, or cross sections that are tagged with letters "A" through "C." The samples will have an inch line marked on them, and the students will determine if each piece was growing too fast, too slow, or about right. A code for each growth rate is given on the Question Sheet. Scoring will be one point for each correct determination.

Question 9: Selective Thinning

D+6 is a simple method used in thinning southern pines. It provides for proper stocking and optimum growth of the stand and helps develop a thinning schedule based on tree growth. It uses a series of triangles made up of three trees each having an average of D + 6 feet between them. The number of trees inside the perimeter of the triangle is the number of trees that need to be removed. The quality of each tree is then judged to determine which tree(s) should be removed. In this event, ten pines will be tagged with letters "A" through "J." Since D+6 is difficult to find in some stands, it may not be used in the contest. Students will determine which trees should be cut by considering crown friction, tree quality, dominance and spacing. The letters on the Answer Sheet that correspond to the trees that will be CUT will be circled. Scoring will be one point per tree.

Question 10: Cull Tree Removal / TSI

On millions of acres in East Texas, undesirable trees overtop or compete with desirable trees. These undesirable trees should be controlled so that the land can produce those products most desirable to the landowner. The ability to determine if a tree should be controlled and if

so, how best to control it, is very important in forest management. In this event, students will determine which method, if any, should be used to control hardwood trees similar to the ones tagged with letters "A" through "E." Students will decide from one of four possibilities listed on the Question Sheet: (1) leave, (2) cut, (3) deaden with chemicals, and (4) deaden with chemicals and/or fire (prescribed burning), and place the appropriate number for each tree to the Answer Sheet. Only hardwood trees are to be considered for TSI (no pines). Scoring will be one point for each correct determination.

Question 11. Pine Regeneration

Each year thousands of acres of private non-industrial lands are harvested with no consideration of re-establishing the pine forest. Due to this, the harvest of pine forest recently has exceeded the growth rate. In this event, students will examine a site and determine the best methods for site preparation and pine establishment based upon the stated landowner objectives. Scoring will be based upon three points for correctly choosing the site preparation method and two points for correctly choosing the pine establishment method. The student will check the appropriate site preparation and pine establishment method(s) on the answer sheet. If the site is a hardwood/pine mix and there are no landowner concerns, only the most aggressive regeneration method should be considered (i.e. harvest all trees and control hardwood trees for site preparation; and plant pines for the establishment method)

Question 12: Site Management Concerns

The success of a forest management plan depends on several variables, including site factors. Therefore, it is important to recognize site factors such as soil texture, topography, drainage, etc., and understand how they can affect the application of forestry practices. In this event, students will investigate four site factors: (1) soil texture, (2) restricted rooting depth, (3) wetness, and (4) excessively steep slopes and determine which management concerns (erosion hazard, seedling mortality and equipment limitations) will be affected by the site factor(s). A hole will be dug at the site and information on drainage, site location, etc. will be provided. Students will circle the management concern(s) affected by the site factors. Scoring will be 5 points for a correct answer and no points for an incorrect answer.

Question 13: Compass and Pacing

The ability to use a compass and to pace accurately in a forest is an important forestry skill. In this event, students will travel a compass course that will be set up of three stakes of unknown distance (between 50 and 200 feet) and two different azimuths. Students will determine the azimuth and distance between the first and second stakes, make the turn at the second stake and determine the azimuth and distance between the second and third stakes. The student must give the correct azimuth and correct distance. Scoring will be as follow:

i. Azimuth
   a) full credit for the correct azimuth within 3 degrees either way - 4 points (2 points per leg)
   b) half credit for the azimuth 4-5 degrees either way - 2 points (1 point per leg)

ii. Distance
   a) full credit for the correct distance within 5% either way - 6 points (3 points per leg)
   b) partial credit for distance between 5 - 10% either way - 4 points (2 points per leg)

Answer Sheet

Team No._____ Score

1. Hardwood Identification

A ☐ B ☐ C ☐ D ☐ E ☐

F ☐ G ☐ H ☐ I ☐ J ☐

2. Pine Identification

A ☐ B ☐ C ☐ D ☐ E ☐

3. Wood Identification

A ☐ B ☐ C ☐ D ☐ E ☐

4. Wood Products

A ☐ B ☐ C ☐ D ☐ E ☐

5. Timber-Forage-Wildlife Relationships

A ☐ B ☐ C ☐ D ☐ E ☐

6. Tree Measurements and Volume ☐

7. Site Index

Site Index: ☐

8. Rate of Growth

A ☐ B ☐ C ☐

9. Selective Thinning by D + 6

A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H ☐ I ☐ J ☐

10. Cull Tree Removal/TSI

A ☐ B ☐ C ☐ D ☐ E ☐

11. Pine Regeneration

Site preparation:

_____ CONTROL HERBACEOUS WEEDS
_____ HARVEST ALL TREES
_____ CONTROL HARDWOOD BRUSH & TREES
_____ SELECTIVELY HARVEST PINES FOR RESEEDING

Pine establishment

_____ NATURAL RESEEDING
_____ PLANT PINES

12. Site Management Concerns

EROSION HAZARD | SEEDLING MORTALITY | EQUIPMENT LIMITATION | NONE

13. Compass and Pacing Score: _____

Question Sheet

1.(10 p.) Hardwood Identification - Use the numbers below to identify the tagged trees.

1-ash	10-hawthorn	19-southern red oak	28-sugarberry/hackberry
2-beech	11-hickory	20-water oak	29-sumac
3-black cherry	12-holly	21-white oak	30-sweetbay
4-blackgum	13-hophornbeam	22-persimmon	31-sweetgum
5-black walnut	14-hornbeam	23-redbud	32-sycamore
6-black willow	15-magnolia	24-red mulberry	33-yaupon
7-cottonwood	16-maple	25-river birch	
8-dogwood	17-blackjack oak	26-rusty blackhaw	
9-elm	18-post oak	27-sassafras	

2.(10 p.) Pine Identification - Use the numbers below to identify the tagged pines, branches and/or cones.

1-longleaf 2-shortleaf 3-loblolly 4-slash

3.(5 p.) Wood Identification - Use the numbers below to identify the tagged blocks of wood.

21-white oak	19-red oak	31-sweetgum	11-hickory
5-black walnut	9-elm	34-southern pine	35-eastern redcedar

4.(10 p.) Wood Products - The tagged trees will normally bring the most income if sold as:

1-poles or piling 2-sawlogs or veneer logs 3-pulpwood or fence posts

5.(10 p.) Timber-Forage-Wildlife Relationship - Use the numbers below to identify the tagged browse plants and classify their relative importance to deer.

1-ash	16-maple	28-sugarberry/hackberry	41-honeylocust
2-beech	17-blackjack oak	31-sweetgum	42-Japanese honeysuckle
3-black cherry	18-post oak	33-yaupon	43-muscadine grape
4-blackgum	19-southern red oak	35-eastern redcedar	44-willow oak
8-dogwood	20-water oak	36-Alabama supplejack/rattan	45-sparkleberry/huckleberry
9-elm	22-persimmon	37-beautyberry	46-Virginia creeper
11-hickory	24 red mulberry	38-blackberry/dewberry	47-wax myrtle
12-holly	26-rusty blackhaw	39 Carolina jessamine	48-white fringetree
14-hornbeam	27-sassafras	40-greenbriar	

6.(10 p.) Tree Measurements and Volume - Figure the total volume in board feet of the five tagged trees.

7.(7 p.) Site Index - Write the proper site index in the box.

8.(3 p.) Rate of Growth - For quality lumber and a good economic growth rate, the marked pieces of lumber were growing:

1-too fast 2-too slow 3- about right

9.(10 p.) Selective Thinning - Circle the number corresponding to the tagged trees that should be cut.

10.(5 p.) Cull Tree Removal/TSI - Each tagged tree is typical of trees that could best be controlled by which of the following methods:

1-leave (control not needed) 2-cut
3-deaden with chemicals 4-deaden with chemicals and/or fire (prescribed burning)

11.(5 p) Pine Regeneration - Check the appropriate method(s) of site preparation and pine establishment for this site.

Site Preparation
- Control herbaceous weeds, grass and vines
- Control hardwood brush and/or trees
- Harvest all trees
- Selectively harvest pines for re-seeding

Pine Establishment
- Plant seedlings
- Natural re-seeding

12.(5 p.) Site Management Concerns - Circle the management concern(s) that affect the designated site.

13.(10 p.) Compass and Pacing - Complete the assigned compass and pacing course.

History of the East Texas Forest

For a large part of geologic history, East Texas lay flooded beneath a shallow sea. However, by the time of the Great Ice Age, East Texas had emerged from the retreating sea. Many of the large river valleys and wide flood plains were formed during the centuries of the Great Ice Age. The forests and land began to take shape. About 10,000 years ago, the same time geologists tell us the Ice Age was ending, the first Indians moved into East Texas. They encountered a virgin forest of pine and hardwoods that was vastly different from the modern forest of East Texas. In its virgin state, there was little or no undergrowth in the forest except along streams. The forest was dominated by pine on the upland sites and by numerous species of hardwoods in the stream bottoms.

The forest the Indians found formed the western end of the great southern pine and hardwood forest that stretched from New Jersey down the eastern coast, across all of the Gulf Coast states and into East Texas. In Texas, the pine forest thinned toward the west as the rainfall diminished and disappeared completely where the annual precipitation fell below 40 inches.

The Indian tribes in the area used the forests for hunting and gathering food, fuel for fires and raw materials for lodges. The Indians also managed the forest relatively intensively using primitive tools. Their most important management tool was fire. They repeatedly burned forests to keep them open for hunting and to make travel through them easier. The repeated fires were the primary reason that pine dominated the upland sites. Because of its thick insulating bark, pine was able to survive fires that killed most hardwood species.

In 1828, when Stephen F. Austin was trying to attract settlers to Texas, he described the area as abounding in pine timber and other species such as cypress and cedar. The early settlers had little more impact upon the forest than the Indians. The farms they cleared were small and, like the Indians, settlers depended heavily on the forest for the necessities of life. They also continued the Indian practice of regularly burning the forest to improve hunting and grazing.

As late as 1865, most of East Texas was still covered with virgin forest. Travelers reported magnificent stands of pine as tall as 100 to 150 feet tall and 3 or more feet in diameter at the base. Repeated fire kept the forest floor free of lower vegetation, and stands were often described as "parklike." Even the largest farms and plantations were mostly forested with relatively small areas dedicated to crop production.

The timber harvesting industry grew slowly in East Texas. Even though early leaders saw the potential for sawmill industry it was not until 1877 that the first large-capacity sawmill was constructed, beginning the era of exploitation of East Texas forests. As late as 1880, the entire output from the sawmill industry in Texas was less than 300 million board feet per year. The great eastern white pine forest of the northern United States had largely been cutover, and the market was ripe for what was called southern yellow pine.

The boom in the lumber industry was almost unimaginable. By 1907, just one company, Kirby Lumber Company, was cutting more than 300 million board feet per year. By 1930, only about one million acres of the original 15 million acres of virgin pine remained. The early 1900s have been referred to as the "Cut Out and Get Out" era. Many large timber companies cut themselves out of timber and were forced to close and move by 1930.

The Great Depression of the 1930s marked a new beginning for forestry in East Texas. The lumber industry collapsed during the Depression. Vast areas had been cleared of forest and were being used for marginal agriculture. Fires swept across large areas with little or no effort at control. Not even pines could re-establish themselves on the cutover lands.

In 1933, the Civilian Conservation Corps (CCC) was established to provide jobs for the unemployed. Soon 18 CCC camps were active in Texas under the direction of the

Texas Forest Service. One of the most important roles of the CCC was fighting wildfires on forest land in East Texas. With the control of wildfire, the pine forest once again was established. In 1933, the Texas Legislature authorized the federal government to begin purchasing private land in Texas for national forests. There were vast areas of cutover land available from large timber companies that were desperate for cash. The 604,000 acres of national forests in Texas today are largely made up of cutover lands acquired from large timber companies.

By the 1940s, it was obvious that a continuous supply of forest products for the future depended on carefully managed forest lands. Timber companies, once only interested in harvesting trees, started tree nurseries to produce millions of pine seedlings to replace those harvested. Sustained yield became the rule for forest management. Sawmills scaled down their operations to use smaller trees, and the pulp and paper industry was established to take advantage of the smaller sized trees that replaced the virgin forests of the past.

The forestry program was established at Stephen F. Austin State University in 1946 to train foresters to manage the forest land in Texas.

Forest Ecology

What is a forest? A forest is more than just a group of trees. A forest of any type is actually a community of thousands of plant and animal species. The entire community is strongly influenced by the species, size, age, and density of the trees overhead. What happens to one individual in a community influences others. Competition for light, nutrients, water, food, and shelter is often intense.

For example, if lightning kills a large tree in a dense forest, conditions are changed for many species. Woodpeckers find food and make nesting holes in the dead tree. Young trees and shrubs thrive in the direct sunlight of the newly created opening, and ground-dwelling animals consume some of the new growth.

A stand of old trees may appear to be timeless, but as you have learned, all forests are constantly changing. Change is most obvious in young stands where the trees are growing rapidly. Such stands are ideal habitat for certain species of wildlife. As the trees grow larger, environmental conditions (habitats) become so altered that some species of wildlife no longer thrive there. However, the new conditions may be excellent for other wildlife species. As the stand continues to age, still other wildlife species are favored in the continuously changing environment. These changes are natural in all forests. They cannot be prevented. They can only be accelerated or slowed by human activities. The type of plants and animals that live in an ecosystem are determined by several factors of which the most important are rainfall, temperature, soils and drainage.

In Texas, the western limit of the mixed southern pine-hardwood forest is largely determined by the amount of rainfall. Where the average annual rainfall drops below 35 inches per year, the pine and hardwood forest gradually changes to post oak savannah. Where the Sabine River forms the Texas/Louisiana border, rainfall is about 50 inches and diminishes at the rate of one inch for every ten miles west. At Nacogdoches, 50 miles from the Sabine River, the rainfall is about 45 inches per year.

Temperature works in association with rainfall to limit the moisture available to plants. Areas with higher temperatures require greater rainfall to support forests. For instance, in parts of Colorado coniferous forests grow in areas with less rainfall than Texas. They are able to thrive because the average temperature is several degrees lower than in the forested areas of Texas. If temperatures were lower in Texas, the forest would be able to spread farther west into areas of less rainfall.

Within any forested region, the type of soil and drainage patterns affect the forest that naturally grows there. Both of these factors are related to the amount of moisture and nutrients available to the trees. Upland sites are usually well-drained and are dominated by pines. The bottomlands are generally dominated by hardwood species that survive better in wetter areas. There are a few species of hardwoods that are ecologically adapted to growing on upland sites, and they can usually be found competing with pines on those areas. Areas of mid-slope (between the top of the ridge and the stream bottom) usually consist of mixed pine and hardwood species.

Although biotic communities may appear to be static, they are actually dynamic systems in a constant state of change. The natural, predictable change that takes place in ecosystems over time is called **succession**. Succession is an orderly process in which early plant and animal communities prepare the way for those communities that replace them.

Primary succession is that which takes place on sites never before occupied by living organisms, for example, an island newly created by a volcano. However, most succession takes place on sites where organisms have previously existed. An abandoned farm field, vacant city lot or harvested forest are examples of places where **secondary succession** could begin.

Since succession is orderly and predictable, we can describe with some accuracy the chain of events that occur following the removal of vegetation from a site. The sequence in East Texas and much of the South can be divided into seral stages:

a. The first species to invade bare ground are called pioneer species in what is called the first sere. They are mostly annual weeds and grasses and generally have seeds that are light enough to be spread by the wind or carried by birds or other animals. The first animals to occupy these sites are insects, their predators and small seed eating mammals such as field mice.

b. The second sere begins two to five years later. It is made up of woody perennials such as blackberry, young pines, and other young woody plants including hardwood sprouts from stumps and root stocks. Animals in this stage include most of those in the first sere as well as species such as bobwhite and cottontail rabbits. As the young trees begin to grow over the top of the perennial weeds and vines, the third sere begins.

c. The third sere is called the brush stage and lasts for five to ten years. The site is fully covered with plant species, and trees become the dominant plants on the site. Species such as pine, sweetgum, sumac, and persimmon begin to compete for dominance. The heavy seed species that depend primarily upon mammals to spread them have not arrived on the area yet. It should be noted that on harvested timberlands, sprouts from stumps and root stocks of hardwood species may increase their appearance on the site. In normal circumstances, the site will soon be dominated by pine. Animals that occur in this sere are white-tailed deer, cottontails and cardinals. Bobwhite continue to use the area, but their numbers will soon be decreasing as the habitat changes. This stage has more songbirds, especially during periods of migration.

d. The fourth seral stage represents the maturing forest. Pine trees reach full dominance of the site. Their crowns are taller than those of other tree species on the site. The pines are intolerant of shade and will not reproduce in their own shade. They also need bare or nearly bare ground for their seeds to germinate. It is obvious that the pines cannot continue to exist on the site unless there is some sort of disturbance that starts the process of succession again. The pine needles that fall decay slowly and prepare an excellent site for the large seeded species such as oaks and hickories to begin life.

As we stated earlier, each seral community prepares the site for the next community that replaces it. The pine forest will last for at least 50 years, and there will be individual trees that last for as long as 200 years. Wildlife species found in this type of forest include the white-tailed deer, fox squirrel, woodpecker, wild turkey and black bear. The pine forest that gave East Texas the name of Piney Woods existed largely because the repeated fires that burned across East Texas until the late 1930s prevented the continuation of the successional process. Fire was probably the first tool that humans learned to use to manipulate ecosystems.

e. The final seral stage is called the climax stage. In much of East Texas, the climax forest type is a mixture of oaks, hickories and other shade tolerant species. These tree species reproduce well in their own shade. When a large specimen dies, it is replaced by a younger tree that was growing in its shade. Hence the community stabilizes. However, only rarely in nature does a true climax situation occur. Disturbances such as fires, storms, floods or harvesting almost always occur before the 200-500 years required for a forest to reach the climax sere. Animal species such as the black bear, wild turkey and gray squirrel are found in climax stage forests.

The knowledge that certain species grow best during certain stages of succession allows forest managers to select what seral stage best meets the needs of society and work

at maintaining that stage. Generally, in a well-managed forest, there will be a variety of seral stages represented so desirable habitat for all wildlife species exists in the area.

Forest Management

Good forest management begins with a statement of objectives. These objectives can be in terms of better return on capital investment, more beneficial and diverse habitat for wildlife, healthier and more vigorous and attractive trees, expanded recreation possibilities or various combinations of all of these. With objectives in mind, woodland owners must have a plan to help them reach their goals at a cost they can afford. Woodland owners includes not only private landholders but also governmental agencies which manage forest lands for the public good.

Planting, growing, tending, and harvesting stands of trees is called silviculture. Silva is the Latin word for forest. Silviculture is essential when landowners wish to encourage the production of wildlife, timber, forage, recreation and watershed values. In serving landowner purposes, foresters must work within the natural conditions imposed by tree species and their environmental requirements.

East Texas has over a hundred tree species. In order to manage them in a logical manner, foresters categorize them in groupings called forest types. Each forest type is a group of tree species that normally grow together. These groups are the result of species' growth requirements and the past history of the area. For example, if an area has been cutover, burned or attacked by insects, some species may have been eliminated. In bottomlands, oaks and hickories often grow together. This group of plants growing together is called the oak-hickory forest type.

Silvicultural Systems

Foresters use various practices and treatments to care for, harvest and replace forests. The distinctive form of forest produced from the practices and treatments identifies the silvicultural system as either even-aged or uneven-aged. The principal treatments of silvicultural systems are the cutting methods which are commonly classed as **intermediate cuttings**, such as thinnings, which maintain the vigor, desired composition and structure of the stands in terms of tree species, ages and size classes or as **regeneration cuts** or harvest cuttings which help to reproduce forest stands.

The major regeneration cutting methods used in the United States are clearcutting, seed-tree, shelterwood, single-tree selection and group selection. The clearcutting, seed-tree and shelterwood cutting methods produce stands of trees that are about the same age, but may not be equal in size. These stands are called **even-aged**. The single-tree selection and group selection cutting methods produce and maintain stands containing trees of many ages, called **uneven-aged stands**.

Even-aged System

When the even-aged management system is used, all the trees in the new stand will be approximately the same age. The even-aged management system is best suited to trees that require open sunlight in order to grow, mature and reproduce. There are three harvest or regeneration cutting methods that result in even-aged forest. They are clearcutting, seed-tree and shelterwood methods.

Clearcutting

Clearcutting is the harvesting, in one operation, of all the trees in a stand or an area, with the intention that a new even-aged stand will become established (Figure 1). The new stand may develop by natural processes such as seeds from adjacent stands or sprouts of cut trees. Another natural source of young trees is young seedlings already established when the old trees are harvested. In many cases a clearcut area is regenerated by planting seedlings. With clearcutting, some type of site preparation is often necessary to remove logging debris and competing plants before the new stand can be established.

Seed Tree

The seed-tree cutting method requires leaving several (five-ten per acre) seed producing trees when the mature stand is harvested (Figure 2). These trees provide the seed that is needed to regenerate a new even-aged stand. The seed trees usually are harvested after the crop of new young trees has become established.

Shelterwood

The shelterwood cutting method involves a series of two or three cuttings over a period of years in a mature stand (Figure 3). The first cutting improves the vigor and seed production of the remaining trees and prepares the site for new seedlings. The remaining trees produce seed and shelter the resulting young seedlings. The shelterwood trees are harvested in a second or third cutting, and the young seedlings develop as an even-aged stand.

Uneven-aged Systems

When the uneven-aged management system is used, the resulting stand will be made up of trees of several different ages. Periodically, the forest manager selects mature trees to be harvested. At no time is the entire area cleared of trees. This system is best suited to species that can grow and mature in the shade of larger trees. Oak, hickory, beech and many other hardwoods fall into this group. The only two harvest cutting methods that result in uneven-aged stands are single-tree selection and group selection.

Single Tree Selection

The single-tree selection cutting method differs from the three even-aged cutting methods in that it creates and maintains a stand with trees of many different ages. Foresters examine a stand and judge each tree, and individual trees are harvested as they mature. Seedlings or sprouts grow up in the spaces created by removing mature trees. Periodic thinning, harvesting, and regeneration results in a stand that contains trees of many ages and sizes. Because relatively few trees are harvested at any one time, and the forest floor is generally shaded, this system favors species that thrive in low light.

Group Selection

The group selection cutting method requires harvest of small groups rather than individual trees. The new trees that come up in these small openings are regarded as parts of a larger stand that contains trees of many ages. In either selection system, frequent harvests are needed to maintain a proper balance of tree age classes and sizes.

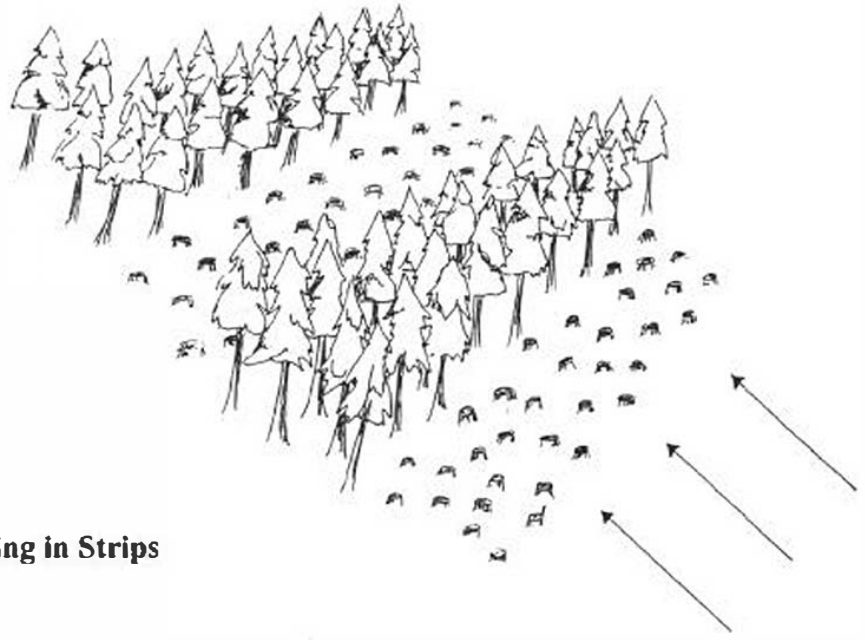


Figure 1. – Clearcutting in Strips

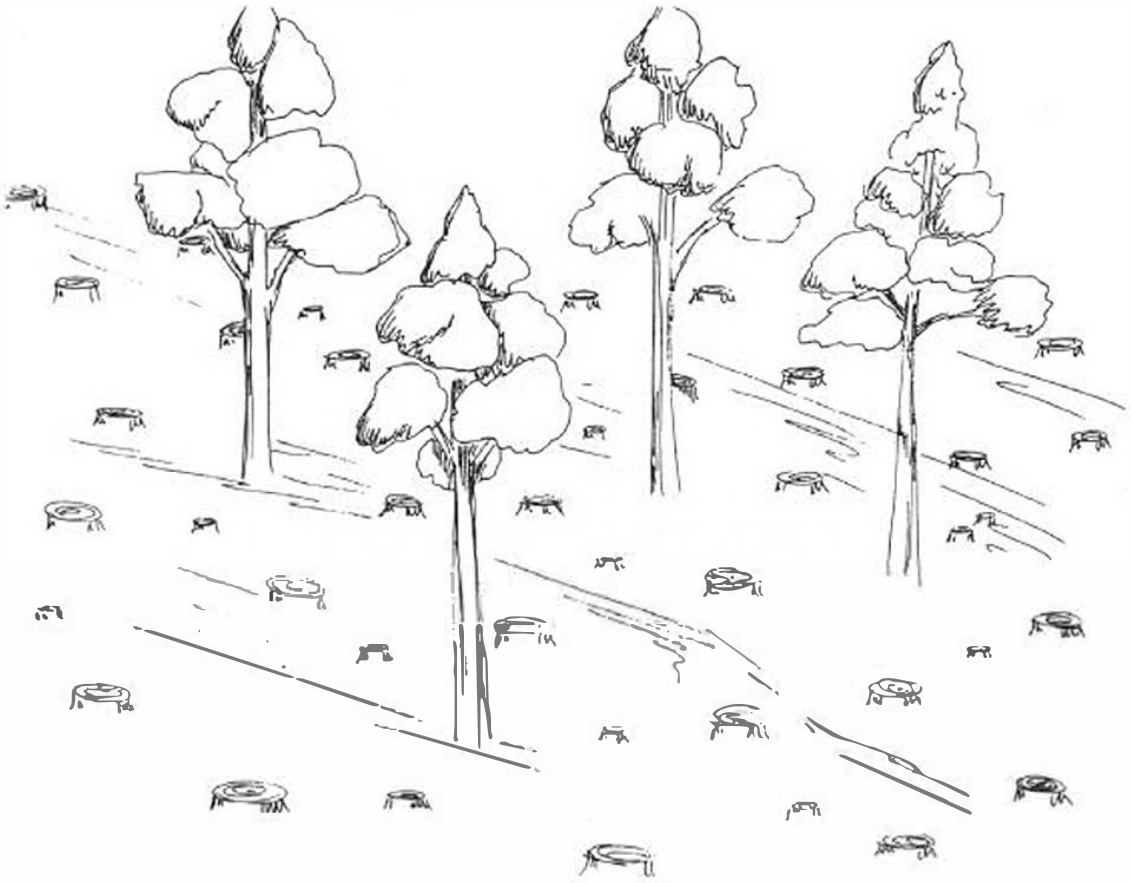


Figure 2. – Seed Tree

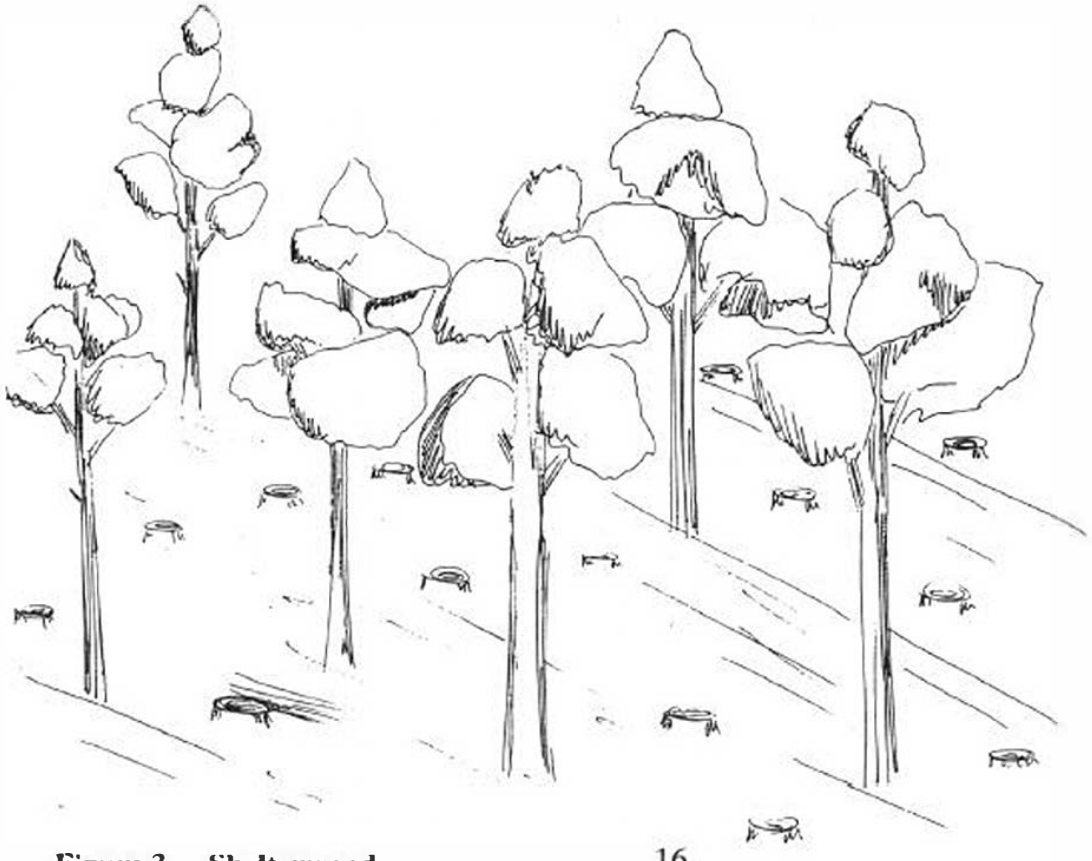


Figure 3. – Shelterwood

Fire as a Management Tool

Fire in the environment can have both good and bad effects. Properly used, it can be a useful management tool. Persons unfamiliar with plant succession tend to view all wildland fires as destructive. The land manager who must maintain food-producing areas for livestock and wildlife, or grow timber for wood products views prescribed fire as an effective and sometimes essential practice. Burning of unwanted waste materials, such as the limbs of harvested trees or the weevil-harboring debris of cotton fields, is an obvious use for fire. More subtle are the uses stemming from the fact that the effects of fire vary with plant species.

Long before humans appeared on Earth, fires were a potent force in the development of plant species. Over vast drought-prone regions, fires started by natural causes burned unchecked. Only species that were resistant to fire's effects, or could develop other survival mechanisms, remained as part of the vegetative complex. Many annual species completed their growth during moist seasons and survived the fires as seeds. Small perennials persisted as bulbs, tubers, or permanent root systems immune to fire by virtue of their position below the ground surface. Some trees grew thick, heat-resistant bark to protect their vital cambium zones. Some conifers stored seed in serotinous cones opened only by fire or severe drought. Thus, in most dry regions and on drier sites in mesic zones, the vegetation that developed owed its existence to recurrent fires. Such vegetation, called fire climaxes, includes some of the world's major range and forest resources. To the extent that fire has different effects on different types of plants, land managers have the opportunity to use fire to favor preferred species over the unwanted.

Just as burning can alter or help maintain certain vegetation types, strict protection from fire can cause vegetative changes, some of them undesirable. Fuel buildup from fire exclusion can also create conditions for catastrophic wildfires. In the Yosemite-Sequoia-King's Canyon area, fire exclusion from the fire-climax sequoia (Sequoia gigantea Decne.) and ponderosa pine (Pinus ponderosa Laws.) forest encouraged a dense undergrowth of white fir (Abies sp.) and incense cedar (Libocedrus decurrens Torr.). Undergrowth essentially excluded sequoia regeneration and built up high fuel levels. Competition from understory species for soil moisture and nutrients also weakens fire-climax trees and makes them more susceptible to insects and disease.

Prescribed Burning Objectives

Prescribed burning is the scientific use of fire under well-defined and controlled conditions in order to accomplish specific land management objectives. More often than not, fires prescribed primarily to meet one objective accomplish others as well. A burn that removes litter to improve grazing also removes fuel that could produce a wildfire hazard and reduces unwanted brush encroachment.

On the other hand, some adverse effects are almost inevitable. The best conducted range burn may consume some usable forage, and it may temporarily expose the area to increased erosion and loss of soil nutrients. Thus, burning should be prescribed only when benefits unquestionably exceed costs and damages. Prescriptions are designed to accomplish objectives with minimal adverse affects.

Hazard Reduction

Any fire in a forest or range environment reduces fuels. Hazard reduction by prescribed fire aims to keep surface fuels (leaves, needles, dead limbs, etc.) at a manageable level so that if and when a wildfire occurs, it will burn with less intensity and cause less damage. Accumulated litter can become dangerous in the South, although rapid decay limits total fuel buildup. Conditions are much worse in the mountainous Northwest, where accumulations of dead fuel may reach more than 54 tons per acre and where woody materials require more than 20 years to decompose naturally.

Strict fire prevention over several decades has caused heavy fuel accumulations and extreme wildfire hazards. Prescribed fire is the most effective and economical technique for reducing hazardous fuels. Costs generally average about $10-$20 per acre in East Texas. Areas treated by prescribed burning experience far less damage from severe wildfires than untreated sites.

Control of Undesirable Species

Fire effectively kills or controls young woody vegetation. A sapling's or tree's resistance to fire increases as diameter increases. Hardwoods under a pine overstory or mesquite on a range become more of a problem with increased growth.

As even-aged forests develop, seedlings or sprouts of shade tolerant species tend to invade them. Although of little harm to the crop tree, such understories proliferate when the stand is thinned and hamper re-establishment of the species after harvest. Since small stems are more readily killed by fire than larger ones, prescribed fire initiated when crop trees become reasonably fire resistant can effectively control such undesirable understories. The crop trees, being larger, are uninjured by fire of sufficient intensity to kill the above-ground parts of the unwanted understory trees. Since most understory species sprout readily, burning should be repeated before sprouts grow to fire-resistant diameters. Such burns may also reduce fuels and thus reduce the potential for destructive wildfires.

Site Preparation

Fire is an important tool in the removal of debris and undesirable understory on areas being prepared for regeneration. Prompt site preparation is desirable. A prescribed burn is often the most efficient way to prepare an area for natural regeneration, direct seeding, or planting. Timing of fire is most important where natural regeneration is desired. A hot burn in the fall just before the major seed fall helps assure a good surface condition for seed germination.

Artificial regeneration by direct seeding or planting is a widely used method of establishing new forest stands. Often, a fire as hot as safety permits is used to consume surface litter and all but the largest pieces of logging slash remaining from the harvest. If the area is to be planted, materials may be windrowed and burned. Site preparation for planting is more expensive, but the results are generally more favorable.

Wildlife Habitat Improvement

Prescribed burning benefits habitat for most game species. It kills back hardwoods that have grown out of reach of browsing animals. As sprouts develop, browse becomes available, abundant, palatable, and nutritious. Game birds generally benefit from the reduction of some undergrowth. Turkeys, particularly, can be manipulated from one area to another because of their preference for burned areas. Many species of wildlife will benefit from the herbaceous vegetation (legumes especially) that spring up after a fire.

Prescribed fire is a widely recognized necessity for habitat management in the South. It is also recognized as a beneficial tool on elk range. General broadcast burns under pine forests and patch burning in hardwood areas are the most common forms of burning used.

Range Improvement

Burning woods, range, or pasture to produce lush green growth is a practice as old as a man's use of grazing animals. This practice is followed worldwide, although research has not always found burning to be beneficial in some areas.

Even though research has shown a marked decline in total plant cover with fire protection over a period of years, too much burning also can have adverse effects. Bluestem grasses (Andropogon sp.) decline with annual burning. Experimental burning

every three or four years has shown no significant change in either botanical composition or average yield of forage. With thinning and prescribed burning, longleaf pine (P. palustris Mill.) stands remain open enough to provide forage for both cattle and wildlife.

Disease Control

Brown spot [Schirrhia acicola (Dem.) Siggers] has been recognized as a serious disease of longleaf pine since the turn of the century. Earlier, while Indian and white settlers burned the longleaf pine forest regularly, destroying spore-infected needles, there was no real problem with the disease. With strict fire control, brown spot became a limiting factor in longleaf pine management.

Longleaf pine is most susceptible to brown spot in the grass stage, after which the plants become more resistant. Prescribed burning is used during the last two or three years of this stage to destroy the infected pine needles. Fire is the only economical control for brown spot presently available.

Another use of fire might be to help control a root rot (Fomes annosus) especially common to loblolly pine (P. taeda L.) and slash pine (P. elliottii Engelm.). The disease is widespread in thinned stands. Removing the litter with late spring or early summer burns encourages biological activity that inhibits the spread of the fungus.

Sanitation burning for reduction of insect pests associated with agricultural crops, particularly cotton production, is indispensable in some areas of the world. While concern over air quality has reduced such burning in the United States, the practice is ubiquitous in many regions of Africa, Asia, and Latin America.

Administrative

Timber marking, measurements (cruising), and harvesting (logging) all benefit from prescribed burning prior to the actual operation. Savings in time and reduced wear (and tear) on the body are special realizations from burning.

Environmental Problems with Burning

Burning of woody and herbaceous materials produces water vapor, carbon dioxide and particulate matter, some of which is emitted into the air. In this period of environmental concern, the public and governmental bodies are very conscious of air and water quality. At present, all 50 states have statutes pertaining to burning and air pollution. Unfortunately, information is inadequate to fully evaluate the contribution of prescribed burning of forest, range or agricultural wastes to air pollution.

Except on certain highly erosive soils, the judicious use of fire in land management on Coastal Plains sites does not decrease long-term soil productivity. Burning surface litter on steep slopes in regions where rainfall may be intense does result in unacceptable soil loss.

There is a dearth of research pertaining to prescribed fire and water quality. While intense wildfires damage a watershed and adversely affect aquatic life in streams, low-intensity prescribed fires over limited areas probably have little effect on water quality.

Prescribed Fire in Perspective

The many demands upon land for wood products, for more wildlife habitat, for optimum aesthetic values, for more and better livestock range, and for increased food and fiber production necessitate use of the best management tools available. At the same time, it is important to weigh the benefits of these tools against their adverse effects on people and the environment.

Prescribed burning is an efficient, economical land management tool. It can rapidly decompose excessive organic matter without harm to the environment. The costs of otherwise disposing of agricultural wastes or accomplishing other tasks for which fire is now employed would be intolerable.

Present knowledge indicates that prescribed forest and agricultural burning can be continued with minimal adverse affects. The most serious objection to burning is the limited visibility that may persist temporarily in the vicinity of the fire. Smoke can be a severe problem near some airports, highways, and urban areas, but this problem is gradually being corrected through better use of fire management plans and greater dependence upon accurate weather forecasts and fuel analyses. In those areas classified as smoke-sensitive, more expensive management alternatives no doubt will replace fire, and the costs ultimately will be passed on to customers.

HARDWOOD IDENTIFICATION

Outline:

A. Purpose of hardwood identification
B. Learning to identify hardwood trees
C. Using a tree identification key
D. Glossary of terms
E. References
F. Woodland Clinic example

Student Skills:

A. Learn to recognize identifying characteristics unique to several common East Texas trees
B. Understand the differences in growing patterns such as opposite versus alternate leaf arrangement, etc.
C. Understand the use of an identification key
D. Recognize many common hardwoods in the area

Materials Needed:

A. Key for tree identification
B. Branches from trees with different growth patterns (such as opposite versus alternative leaves, etc.)
C. Reference materials

Purpose of Hardwood Identification

Throughout East Texas, hardwoods are found on sites ranging from creek bottoms to sandy uplands. As part of a total understanding of forestry, students must be aware of the kinds of trees that exist in an area. These hardwoods play an important part in the ecology of the forest and in its management needs.

Many East Texas sites are best suited for quality hardwood management. These sites are usually the creek and river bottoms, poorly drained soils, and upland depressions. Generally, upland and well-drained sites are best suited for pine management. However, maintaining pine, even on favorable sites, is difficult. Aggressive hardwoods are capable of dominating a pine stand because they represent the climax vegetation in the successional process. In East Texas, the natural replacement of pine with more shade tolerant and less commercially valuable hardwoods is due, in part, to fire prevention and poor harvesting methods which is leading to reduced timber yields in many places. Forest management tools such as prescribed burning, site preparation and timber stand improvement (TSI) are meant to prevent this natural replacement process. Therefore, the ability to identify the hardwoods growing on a site is important in understanding the successional process and in identifying appropriate management measures.

Many site characteristics can be determined by observing the types of trees growing on the site. For example, river birch grows best on sandy, well-drained creek bottoms, while sassafras is commonly found on sandy uplands. Therefore, hardwoods can often be a good indicator of the soils of the site.

Another reason for hardwood identification is that the better hardwood markets are often species specific. For example, white oak is a valuable wood for furniture lumber while red oak is the most desired species for flooring. Making a good hardwood sale means finding the best market for the type of trees being sold.

Learning to Identify Hardwood Trees

Each tree species has certain identifying characteristics that mark it as being different from others. By careful observation and examination, these identifying points may he learned, and the students can feel confident that they know the tree. The area in which the students live and go to school probably has some trees that they already know. Have the students study these trees and ask themselves why they know them. They may also find some trees they are not sure about. One tree should be studied at a time, although it may be an advantage to select somewhat similar trees and study them by comparisons.

Studying trees as they grow in the woods is the best way to learn them. First have the students observe the tree as a whole, taking into consideration all points that attract attention. Very often there will be something that, either alone or in relation to other points, attracts attention. That feature, when studied, may be the key to a student learning to identify the tree. If possible, collect samples of leaves, twigs and fruit for reference and further study (see Activity I).

Using a Tree Identification Key

An identification key is designed to help identify trees based on certain characteristics. The key provided for this question is based primarily on leaf characteristics but also includes bark, branching and odor characteristics, when applicable.

Using this key successfully simply requires answering questions with either yes or no and following the route indicated by the answer. There are a total of 37 questions in this key, but the most the students will have to answer is nine. If a question gives a student trouble, try both routes - it won't take long to see which route is wrong and which is right. This key is only for those trees listed in the hardwood identification question. Books such as those listed under "References" may be needed to confirm a correct identification.

Before using the key, have the students take a good look at the tree to check its growing patterns. The different patterns are listed in the glossary. Once they have studied the tree, they will be ready to use the key. For practice, have the students try it on a tree they already know.

Glossary of Terms

Leaf growth patterns

Opposite -Two leaves coming from a node opposite each other on the twig (Figure 1A).

Alternate - Leaves from nodes placed singly at different levels on the twig (Figure 1B).

Simple and Compound leaves

Simple - One leaf part originating from the bud (Figure 1C).

Compound- Multiple leaf parts or leaflets originating from the bud (Figure 1D).

Leaf Margins

Smooth / entire-The edge of the leaf is not cut, indented or toothed (Figure 1E).

Toothed - The edge of the leaf is sharply pointed like small teeth (Figure 1F).

Lobed - The leaf edge is cut or divided (Figure 1G).

Persistent and Deciduous leaves

Persistent - Leaves that are evergreen or remain attached long into the winter.

Deciduous - Leaves that fall at the end of the growing season.

Venation

Palmately veined - Major veins converge at a common point normally at base of the leaf.

Pinnately veined - Veins extend laterally from a major vein that runs the length of the leaf.

General Terms

Bud - That part of a twig or stem that contains the beginning form of a flower, leaf or shoot. (Figure 1H)
Climax Vegetation- That stage in succession which is stable and self perpetuating.
Leaflet - A single blade of a compound leaf.
Node - A joint on a stem that usually bears a leaf or leaves. (Figure 1H)
Succession -An orderly process of development that involves changes in species with time.

References

1. Forest Trees of Texas - How to Know Them, 1963. Bulletin 20, Texas Forest Service, College Station, TX.

2. Vines, Robert A., Trees of East Texas, 1977. University of Texas Press, Austin, TX.

3. Harrar, E.S., and Harrar, J. G., Guide to Southern Trees, 1961. Dover Publications, New York.

4. Nixon, E. S., and Cunningham, B. L., Trees, Shrubs and Woody Vines of East Texas, 1985. Bruce Lyndon Cunningham Productions, Nacogdoches, TX.

Woodland Clinic Example

Thirty-three different hardwood trees and shrubs have been selected for identification in the Woodland Clinic. In any given clinic, only ten will be selected for identification, but the students should be able to recognize all thirty-three.

In this event, the students will be asked to identify ten hardwoods tagged with letters. They will enter the number from the Question Sheet that corresponds to that species in the appropriate block on the answer sheet. For example, if the card with the letter A on it is a water oak, the students will write the number 20 in block "A" under question 1. See figure below:

1. Hardwood Identification

A 20	B	C	D	E
F	G	H	I	J

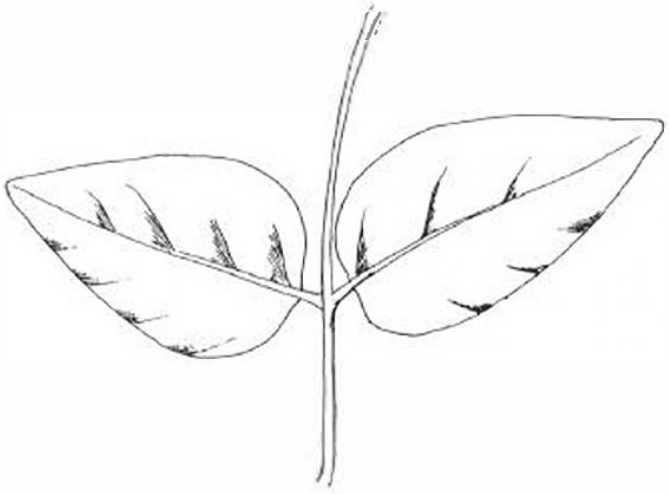


Fig. 1A – Opposite

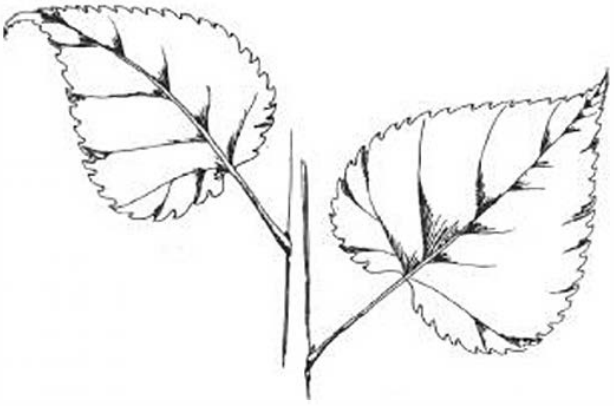


Fig. 1B – Alternate

Fig. 1C – Simple

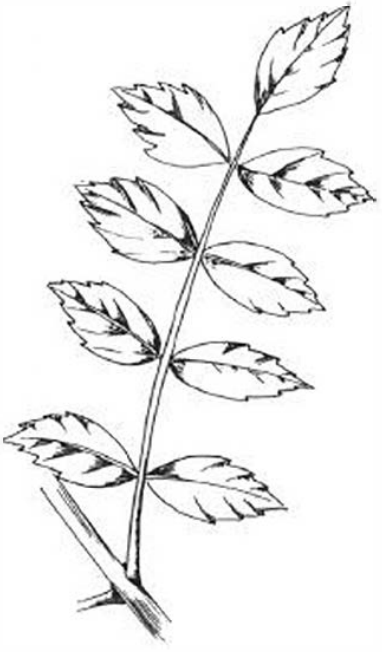


Fig. 1D – Compound

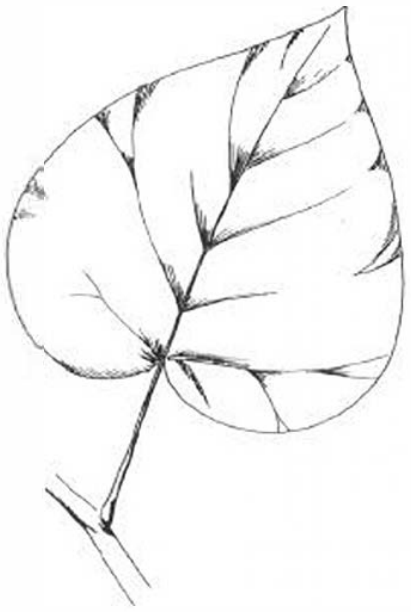


Fig. 1E – Smooth or Entire

Fig. 1F – Toothed

Fig. 1G – Lobed

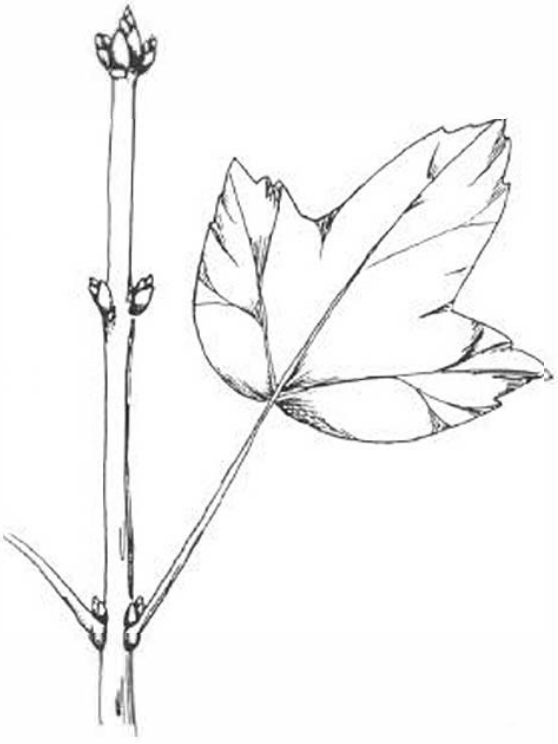


Fig. 1H – Bud & Node

Identification Key

1. Are the leaves opposite each other on the twig?
   yes . . . Go to 2
   no. . . . Go to 5 (because the leaves are alternate)

2. Are the leaves compound?
   yes . . . **ash**
   no . . . Go to 3 (because the leaves are simple)

3. Are the leaves lobed or divided?
   yes. . . **maple**
   no . . . Go to 4 (leaf margins are smooth or toothed)

4. Are the leaf margins smooth or entire?
   yes . . . **dogwood**

   Are the leaves toothed, thick and leathery?
   yes . . . **rusty blackhaw**

5. Are the leaves alternate and compound?
   yes . . . Go to 6
   no. . . . Go to 7 (leaves are alternate and simple)

6. Are there five to fifteen roughly oval shaped, finely toothed leaflets per leaf
   yes . . . **hickory**
   Are there fifteen to twenty-three sharply oval, toothed, long pointed leaflets per leaf?
   yes . . .**black walnut**
   Are there as many as thirty-one leaflets per leaf on a small tree or shrub?
   yes . . . **sumac**

7. Are the leaves alternate, simple and persistent?
   yes . . . Go to 8
   no. . . . Go to 11 (because the leaves are deciduous)

8. Are the leaves armed with spiny teeth?
   yes . . . **holly**
   no. . . . Go to 9 (leaf margins are smooth or toothed

9. Are the leaves 5 to 8 inches long and are the margins smooth?
   yes . . . **magnolia**
   no. . . . Go to 10 (because the margins are toothed)

10. Are the leaves 1 to 2 inches long and toothed?
    yes . . . **yaupon**

11. Are the leaves alternate, simple, deciduous and lobed?
    yes . . . Go to 12
    no. . . . Go to 20 (leaf margins are smooth or toothed)

12. Are the twigs armed with thorns?
    yes . . .**hawthorn**
    no. . . . Go to 13

13. Are the leaf shapes significantly varied on the same tree?
    yes . . . Go to 14
    no. . . . Go to 15 (the leaves are generally the same)

14. Are the leaf margins smooth and do the leaves and twigs have a strong odor when crushed?
    yes . . . **sassafras**
    Are the leaf margins toothed?
    yes . . . **red mulberry**
    Are the leaves pointed and end in a bristle (hair)?
    yes . . . **water oak**

15. Are the leaves palmately veined?
    yes . . . Go to 16
    no. . . . Go to 17 (the leaves are pinnately veined)

16. Are the leaves star-shaped (five lobes) with toothed margins?
    yes . . . **sweetgum**
    Do the leaves have three to four lobes with toothed margins and do the twigs grow in a zig-zag pattern?
    yes . . .**sycamore**

17. Do the leaves end in a sharp point with a bristle tip (hair)?
    yes . . .
    Are the leaves variable in shape on the same tree?
    yes . . . **water oak**
    no. . . . **southern red oak**
    no. . . . Go to 18

18. Are the lobes rounded and are the leaves generally cross shaped?
    yes . . . **post oak**
    no. . . . Go to 19

19. Do the leaves have seven to nine lobes and are they regularly lobed?
    yes . . . **white oak**

20. Are the leaves alternate, simple, deciduous and are the leaf margins smooth or undivided?
    yes . . . Go to 21
    no. . . . Go to 27 (because the margins are toothed)

21. Does the bark have corky projections of bumps?
    yes . . . **sugarberry/hackberry**
    no. . . . Go to 22

22. Are the leaves usually pointed and bristle tipped?
    yes . . . Go to 23
    no. . . . Go to 24

23. Are the leaves variable in shape on the same tree
    yes . . . **water oak**
    Are the leaves wedge or bell shaped?
    yes . . . **blackjack oak**

24. Are the leaves distinctly heart shaped ?
    yes . . . **redbud**
    no . . . Go to 25

25. Are the leaves 2 to 5 inches long, dark green, shiny with blunt points; and are the branches generally growing perpendicular to the trunk?
    yes . . . **blackgum**
    no. . . . Go to 26

26. Are the leaves 4 to 6 inches long, green above and white underneath?
    yes . . . **sweetbay**
    Are the leaves 4 to 6 inches long, green both above and underneath?
    yes . . .**persimmon**

27. Are the leaves alternate, simple, deciduous and finely toothed?
    yes . . . Go to 28
    no. . . . Go to 31 (because leaves are coarsely toothed)

28. Are the twigs armed with thorns?
    yes . . . **hawthorn**
    no. . . . Go to 29

29. Are the leaves narrow and 3 to 6 inches long?
    yes . . . **black willow**
    no. . . . Go to 30

30. Are the teeth incurved and are there rusty colored hairs along the midrib on the underside of the leaf?
    yes . . . **black cherry**

31. Are the leaves alternate, simple, deciduous, coarsely but singly toothed?
    yes . . . Go to 32
    no. . . . Go to 34 (because leaves are doubly toothed)

32. Are the leaves triangular shape and are the teeth rounded?
    yes. . . **cottonwood**
    no. . . . Go to 33

33. Is the bark smooth and dark gray; and do the twigs grow in a zig-zag pattern?
    yes. . . **beech**
    Does the bark have corky projections or bumps?
    yes . . . **sugarberry/hackberry**

34. Are the leaves doubly toothed and is the bark shreddy?
    yes . . . Go to 35
    no. . . . Go to 36 (because the bark is tight or corky)

35. Is the bark reddish-brown and peeling?
    yes . . . **river birch**
    Is the bark grayish brown and shreddy?
    yes . . . **hophornbeam**

36. Is the bark bluish-gray and tight?
    yes . . . **hornbeam**
    no . . . Go to 37

37. Are the leaves doubly toothed; may be variable in shape on the tree or may be somewhat heart shaped, dark green above and hairy underneath; and very veiny?
    yes. . . **red mulberry**
    Are the leaves doubly toothed; oval or egg shaped; and hairy underneath?
    yes . . . **elm**

Student Activity

Trees and shrubs have many characteristics that make each one unique. However, knowing what makes them similar allows us to group them for easier study. The trees and shrubs listed in Question 1 can be grouped as follows:

Opposite Leaves	Alternate Leaves				
	Deciduous Leaves				Persistent Leaves
maple	Compound Leaves	Simple Leaves			holly
dogwood					magnolia
rusty blackhaw	hickory				yaupon
	walnut	Lobed Leaves	Entire Leaves	Toothed Leaves	
	sumac	hawthorn	sugarberry	hawthorn	
		sassafras	water oak	black willow	
		mulberry	blackjack oak	black cherry	
		water oak	redbud	cottonwood	
		sweetgum	blackgum	beech	
		sycamore	sweetbay	sugarberry	
		red oak	persimmon	birch	
		post oak		hophornbeam	
		white oak		hornbeam	
				mulberry	
				elm	

Using the Identification Key, collect the leaves from as many of the trees and shrubs in each group that you can find in the area. When the leaves are collected, they should be pressed in a book and allowed to dry. They can then be mounted on heavy paper and covered with clear contact paper.

In addition to leaves, some trees and shrubs may have unique bark and twig characteristics, such as the ones listed below. Collect twigs and/or small stems from these plants that show these characteristics.

Twigs armed with thorns: hawthorn
Twigs grow in a zig-zag pattern: sycamore, beech

Bark has corky projections or bumps: sugarberry /hackberry
Bark is shreddy or peeling: river birch, hophornbeam
Bark is smooth, tight and gray: beech, hornbeam

PINE IDENTIFICATION

Outline:

A. Purpose of pine identification
B. Learning to identify pines
C. General description of the southern pines
D. Glossary of terms
E. References
F. Woodland Clinic example

Student Skills:

A. Identify the four pine species found in East Texas

Materials Needed:

A. Reference materials

Purpose of Pine Identification

There are four southern yellow pine species found in East Texas: loblolly pine, longleaf pine, shortleaf pine and slash pine. The first three are native to Texas, and the fourth (slash pine) is introduced. These species have numerous traits in common, and yet each has unique characteristics. They may occur on different soils and have differences in management requirements, as explained in the short description of each species below. Therefore, the ability to tell them apart is very important in forest management.

Learning to Identify Pines

Identifying the pines can be done by observing the needles, twigs and cones. The most commonly used characteristic for beginning the separation of the pines is the number of needles in a group or bundle. A bundle of two or three needles is called a fascicle. Shortleaf and slash pines tend to have more fascicles with two needles than with three. Loblolly and longleaf pines, however, tend to have more fascicles with three needles than two. A common memory aid used by many students is that if there are more "2s" than "3s" in a fascicle it must be one of the "Ss" - shortleaf or slash. If, on the other hand, there are more "3s" than "2s," it must be one of the "Ls" - loblolly or longleaf (Figure 2A, B, C, & D).

The following chart will help illustrate the differences among the four pines:

Species	No. of needles per fascicle	Needle Length	Cone Size	Cone color and growth	Twigs
shortleaf	mostly 2	3-5"	1.5-2.5"	reddish brown; grow on a short stalk	At first green & tinged with purple, eventually reddish brown; buds with reddish brown scales.
slash	2 and sometimes 3	7-10"	3-6"	chocolate brown shiny; grow on a short stalk	Orange to brown; brown scales
loblolly	mostly 3	5-10"	3-5"	reddish brown, weathers to a charcoal gray; doesn't grow on a stalk	Reddish brown; buds are scaly
longleaf	3	8-18"	6-10"	reddish brown	Stout, orange brown; buds with silvery white scales

General Descriptions of the Southern Pines

Shortleaf pine has the widest natural range of the four pines. It is found in 22 states from New York to Texas. It has the ability to grow on a variety of sites, but is most commonly found on drier, sandy to gravely clay soils. An unusual feature of the shortleaf pine (up to 8 to 10 years of age) is its ability to re-sprout after cutting or fire. Maturity is reached by 170 years, but they may grow much longer.

Slash pine's natural range is the far southeastern United States. It was introduced into Texas as a commonly used species for planting during the 1960s and '70s. It commonly grows on low, moist areas, but has been planted on deep sands as well. Its fast, early growth had made it popular for planting, but its susceptibility to ice damage and diseases has all but eliminated it from planting in East Texas today. Maturity is reached in about 150 years.

Loblolly pine has the second largest range of the four southern pines and is the most widely planted and utilized of the four. It grows on a wide variety of soils but does best on those with deep surface layers having plenty of moisture and poor drainage. It gets its name from the low depressions in which it grew that were locally called loblollies. Loblolly pine matures in about 150 years.

Longleaf pine is found on the coastal plain from southern Virginia to Texas. In the original forest, it outranked the other three pines in importance. It was used not only for lumber and pulp products but also was extensively used for turpentine production. It is the most distinctive of the southern pines with its tufts of long needles clustered at the end of its branches. Although it grows best on deep well-drained sandy soils, it is found on a variety of sites. This species undergoes a unique "grass stage" where young plants resemble a clump of grass, with only needles exposed above the soil surface. This stage may last for several years. Maturity is reached in 150 years, but it may live over 300 years.

Glossary of Terms

Bud - The undeveloped state of a branch, with or without scales.
Fascicle - A group or bundle of needles; generally 2 or 3 in southern pines
Introduced- Plants not native to a region but brought into it.

References

1. Hicks, Ray R. and Stephenson, George K. 1978. Woody Plants of the Western Gulf Region. Kendall-Hunt Publishing Company, Dubuque, Iowa.

2. Vines, Robert A., 1977, Trees of East Texas. University of Texas Press, Austin, TX.

3. Nixon, E.S. and Cunningham, B. L., 1985, Trees, Shrubs and Woody Vines of East Texas. Bruce Lyndon Cunningham Productions, Nacogdoches, TX

Woodland Clinic Example

In this event, the student will have to identify five tagged samples. These samples may either be trees or branches with cones. At least one species will have to be used more than once and all four species may or may not be in the contest. These five samples will be tagged with letters "A," "B," "C," "D," and "E." The number from the question sheet that corresponds to the sample will be placed in the appropriate block on the answer sheet. For example, if the sample tagged with the letter B is a shortleaf pine tree or branch, the number "2" would be placed in block "B." See figure below.

2. Pine Identification

A	B	C	D	E
	2			

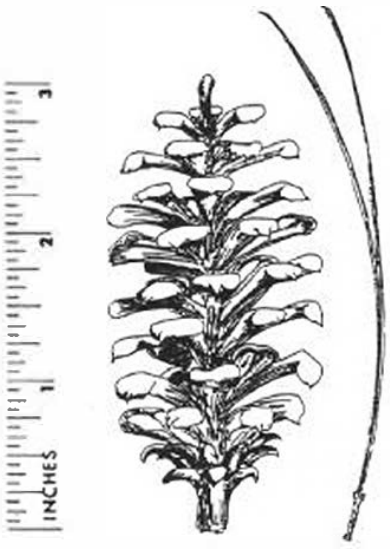


Fig. 2A – Shortleaf Pine

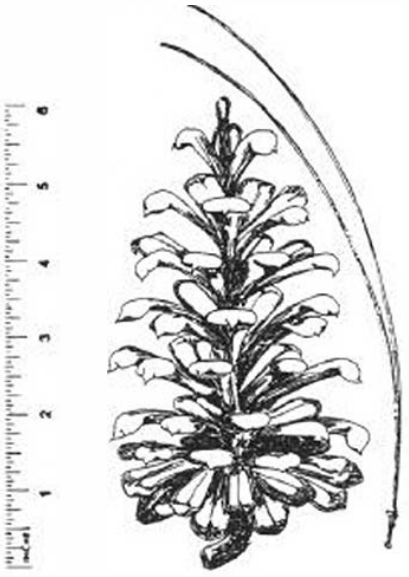


Fig. 2B – Slash Pine

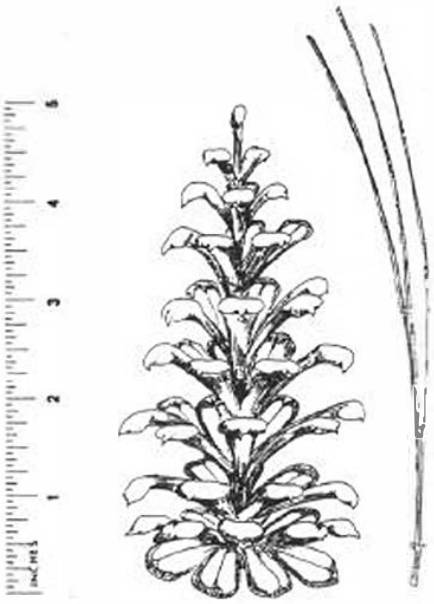


Fig. 2C – Loblolly Pine

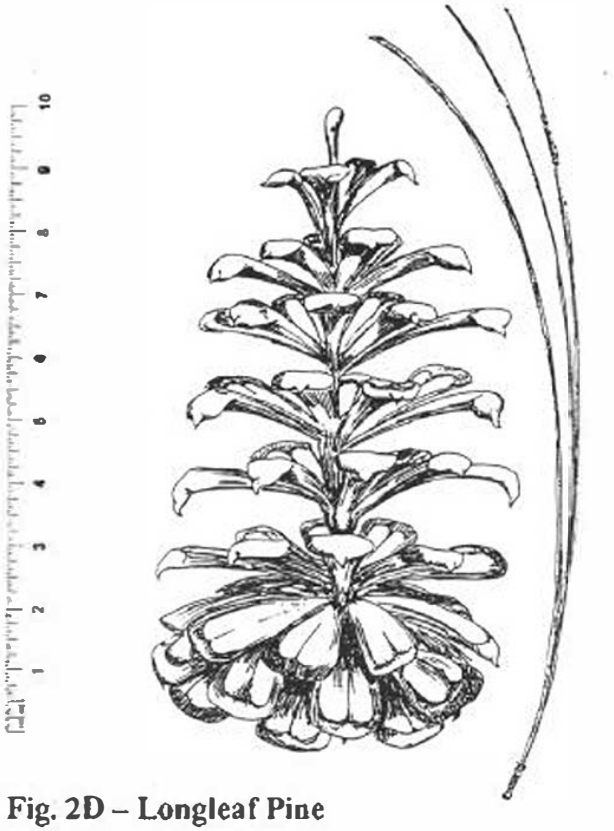


Fig. 2D – Longleaf Pine

WOOD IDENTIFICATION

Outline:

A. Purpose of wood identification
B. Basic anatomical features useful in wood identification
C. Using a wood identification key
D. Hardwood uses
E. Glossary of terms
F. Woodland Clinic example

Student Skills:

A. Recognize common anatomical features and characteristics such as wood rays, heartwood, sapwood, and growth rings,
B. Be able to use an identification key
C. Be able to identify eight common East Texas woods

Materials Needed:

A. Key for identification
B. A set of wood samples from: white oak, red oak, black walnut, hickory, southern pine, elm, sweetgum, and eastern redcedar. Samples can be obtained from local sawmills or from the Texas Forest Service at:

Texas Forest Service
Forest Products Laboratory
P.O. Box 310
Lufkin, TX 75902
(409) 639-8180

Purpose of Hardwood Identification

Hardwoods growing on upland sites in East Texas constitute a forest resource of nearly 2.4 million acres. Additionally, river bottoms and wet soils best suited for hardwood management, bring the total land usage to 7.5 million acres. The southern hardwoods are extremely diverse in species, sites and uses. Over 50 species may be found in the southern forest, and hardwood stands are rarely made up of a single or even of a few species of trees. Often, a forester may have to identify a tree species after the tree is cut instead of before; thus, it is important to be able to recognize several of the common species grown in East Texas.

Basic Anatomical Features Useful in Wood Identification

To understand the basic elements of wood formation, it is important for the students to have a basic understanding of stem growth.

Between the wood and the bark, a sheath of tissue called the cambium repeatedly produces new layers of wood and inner bark (Figure 3A). These layers increase the stem diameter. Only about 10% of the wood cells remain alive for several years; most die during the year they are formed. Some of the living cells occur in wood rays, which are bands of cells oriented horizontally that radiate out from the center like spokes on a wheel. These wood rays form important paths for food transport and storage. In some species such as the oaks, wood rays are very prominent and make a good characteristics for identification.

That outer portion of the wood containing living cells is called sapwood. When all the living processes and functions of the living cells cease, the change from sapwood to heartwood begins. At that time, food stored in the cells is changed and may become darker, which is why heartwood is darker than sapwood in some species. Heartwood may

be more resistant to decay and insects and may be harder to dry or preserve because of this changed food supply.

Diameter growth is most rapid early in the growing season, and as the season advances, growth slows considerably. Wood produced in the early part of the season is called springwood (Figure 3A). The part of the annual growth produced late in the season is called summerwood. It is usually darker in color than springwood and is composed of more and smaller cells per unit of area. One annual increment is made up of springwood and summerwood. In cross sections, the growth increments take the form of annual rings. These may be prominent in many species because of the differences in cell size and color between springwood and summerwood. However, in some species such as sweetgum, annual rings may not be readily visible.

As a stem grows, the cambium layer produces many different kinds of cells. Some cells serve the function of storage; some serve as support for the stem. Vessels or pores are tubelike structures that have water transport as their chief function. Pores may either be about the same diameter across a growth ring or may tend to be larger in the springwood than in the summerwood. Species such as sweetgum tend to have pores of about the same size across a year's growth while species such as the oaks, elms, and hickories tend to have an abrupt change in pore size from springwood (larger) to summerwood (much smaller). In some species such as the white oaks, these pores tend to have saclike structures called tyloses developed in them, making them appear to be clogged. However, the pores in red oaks tend to be unobstructed. The wood of pines and cedar, on the other hand, does not contain pores or vessels at all.

Using a Wood Identification Key

Once students understand the basic structure of wood they can use an identification key. The key is made to identify eight common East Texas woods. These are: white oak, red oak, black walnut, hickory, elm, sweetgum, eastern redcedar, and southern pine. The wood structures that the student must be able to identify to use the key include pores, tyloses, wood rays, sapwood, heartwood, springwood, summerwood and growth rings. Other characteristics that may also be needed are color and smell. The student begins with the number 1. If the student answers that the pores are visible, he or she goes to number 2. If pores are not visible, the student skips over 2 through 5 and goes to number 6. The student should practice on a wood he or she already knows to see how the key works.

Hardwood Uses

Just as hardwoods are variable by species, their uses are varied. Listed below are the common uses for the eight hardwoods in this event:

white oak - White oak weighs about twice as much as pine, and its uniform strength, narrow growth rings and attractive color encourages a wide variety of uses, including fine cabinets, interior trim, flooring, furniture, barrels, plywood, and ships.

red oak - The coarse-grained, light red wood of red oak is used for general construction, slack cooperage, furniture, interior trim, flooring, and fuel.

black walnut - The soft, brown, coarse-grained, easily worked wood of black walnut has made it America's top ranking fine furniture, interior panel and cabinet wood. Its strength and shock-resisting ability, without excessive weight, has made it popular for gunstocks.

hickory - Hickory's close-grained, strong, hard, flexible wood is used for handles of such tools as axes and hammers. It is also used for furniture and fuel.

elm - The wood of elm is light-brown, heavy, hard, tough and so cross-grained that it is hard to split. It is used for slack cooperage, furniture, flooring, crates, and sporting goods.

sweetgum - Sweetgum wood is strong, stiff, easily worked and has a natural grain that when stained can be made to look like many other woods, such as walnut. It is used for furniture, interior trim, baskets, plywood, and pulp.

eastern redcedar - The wood of cedar is fine-grained, brittle, highly aromatic, soft and easily worked. It is used for linings for closets, chests, and a wide variety of wooden and novelty ware.

southern pine - The southern pines have a wide variety of uses, ranging from pulp for paper to construction.

Glossary Of Terms

Annual Ring- See Growth Ring.
Cambium - The growing layer between wood and bark that is responsible for the formation of wood and bark.
Growth Ring - The ring of wood on a cross section surface resulting from periodic growth.
Heartwood - That portion of a tree stem in which the cells are dead is usually discolored and is toward the center part of the stem.
Pore or Vessel - Tubelike structure in the wood of hardwoods that transport water.
Sapwood - That portion of a tree stem in which the cells are alive, is sometimes lighter colored and is found toward the outside of the stem.
Slack Cooperage-Barrels not intended for holding liquids.
Springwood - That portion of the annual ring produced during the early part of the growing season.
Summerwood - That portion of the annual ring produced during the latter part of the growing season and is usually darker than the springwood.
Tyloses - Saclike structures that sometimes form in a vessel or pore.
Wood rays - A ribbon shaped strand of cells extending in a radial direction across the growth rings when viewed on a cross section.

Woodland Clinic Example

In this event, the students will examine five blocks of wood and determine the species of trees from which the blocks were cut. Each of the five blocks will be tagged with a letter from "A" to "E." The student will enter the coded number from the question sheet for the proper species in each block on the answer sheet. For example, the block tagged with the letter "E" is white oak. The student will enter the code number 21 in block E on the answer sheet. See figure below.

3. Wood Identification

A ☐ B ☐ C ☐ D ☐ E 21

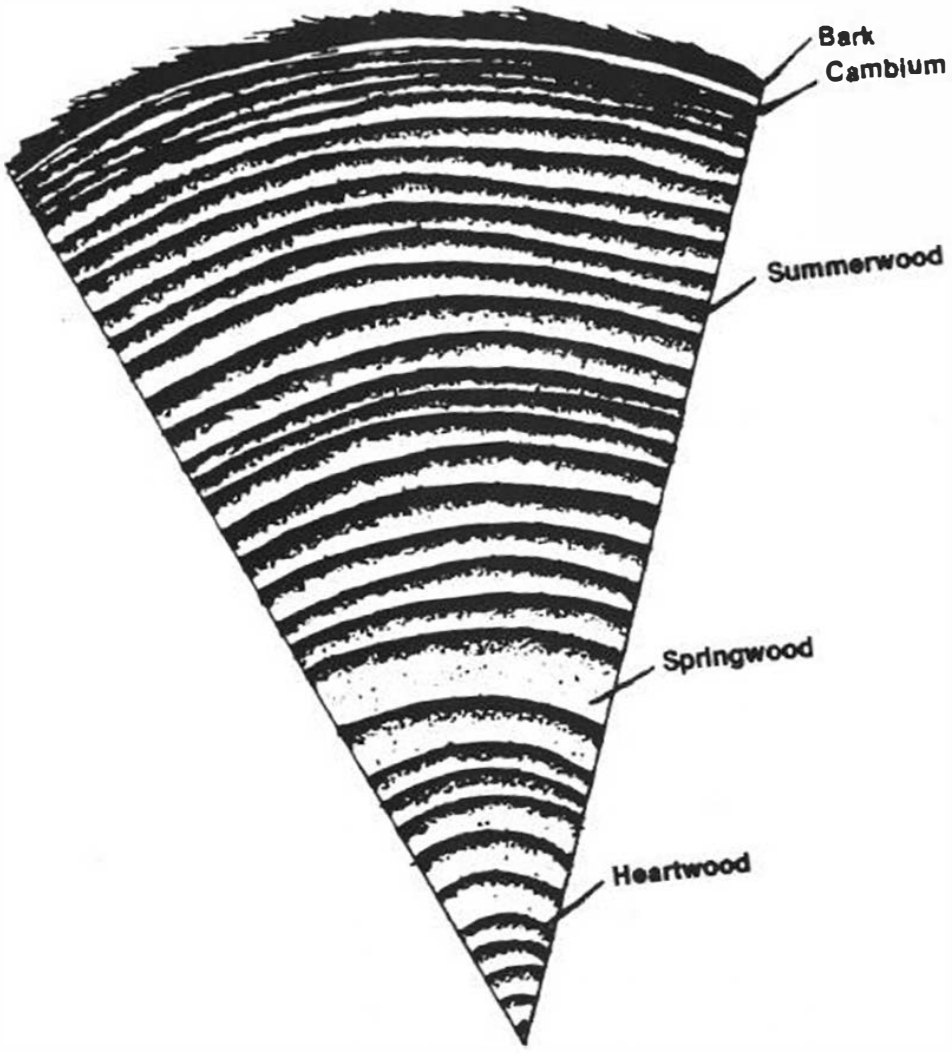


Fig. 3A - Growth Ring Features of a Tree Cross Section

Wood Identification Key

1. Are the pores visible?
   Yes.....Go to 2
   No.....Go to 6 (the pores are not visible)

2. Are the wood rays large and conspicuous?
   Yes.....Go to 3
   No.....Go to 4 (the rays are not distinct)

3. Do the heartwood pores have saclike structures or tyloses in them?
   Yes.....**white oak**
   Do the heartwood pores have few or no tyloses in them?
   Yes.....**red oak**

4. Is the heartwood a rich chocolate brown; does the wood have a characteristic odor when cut freshly with a knife; are the pores scattered and do they gradually decrease in size from springwood to summerwood?
   Yes.....**black walnut**
   No.....Go to 5 (the heartwood is not dark brown and the transition from springwood to summerwood is abrupt)

5. Is the wood heavy and very hard; and are the summerwood pores small and solitary?
   Yes.....**hickory**
   Is the wood moderately heavy and moderately hard; and are the summerwood pores small, numerous and arranged in more or less continuous, wavy bands?
   Yes.....**elm**

6. Are the growth rings distinct
   Yes.....Go to 7
   No.....**sweetgum**

7. Is the sapwood white; the heartwood red or purple; does it have a pencil wood odor?
   Yes.....**eastern redcedar**
   Are there pronounced bands of summerwood?
   Yes.....**southern pine**

WOOD PRODUCTS

Outline:

A. Purpose of identifying wood products
B. Description of uses
C. Requirements for each product
D. Glossary of terms
E. Woodland Clinic example

Student Skills:

A. Identify the main wood products and markets for southern pine timber
B. Understand the quality requirements each product has

Materials Needed:

A. Cruiser or Biltmore stick
B. Plumb line

Purpose of Identifying Wood Products

A listing of all the possible wood products that utilize southern yellow pine would be quite lengthy. Some of the uses of East Texas pines include pulpwood for paper making, sawtimber for lumber, veneer for plywood, utility poles, fence posts, chips for wafer and oriented strand board, shingles, laminated wood products such as arches, and pallet materials. In addition, there are by-products such as bark for landscaping, chemicals for turpentine and some plastics, and even shavings for horse bedding. So, pines have many different uses, but in general, they can be grouped into three common categories: (1) poles and piling, (2) sawlogs and veneer logs, and (3) pulpwood and fence posts. The value of a tree marked for pulpwood would be less than for a tree marked for lumber because pulpwood is used in making a less valuable product, paper. Likewise, a tree cut to be used as a pole would have more value than one marked for cutting into lumber. The value therefore, depends on the intended market and is highest for poles, and lowest for pulpwood. It is important to identify the best market for the product being sold, and a forester must know the specifications for each market.

Description of Uses

Piling - Pilings are round timbers driven into the ground to support other structures such as piers, wharves, bridges, and trestles. Piling is cut only from high quality trees which results in higher prices for the grower. Pilings are air dried and treated to resist insects and decay.

Poles - Wooden utility poles have been found to be, and still are, satisfactory and economical for extensive use. They have high quality requirements and therefore pay good prices to the owner. Only 2% to 5% of all trees in a stand will qualify for poles. Poles are usually treated with creosote solutions and have a service life of 20 to 30 years.

Veneer and Plywood - Plywood is a wood-and-glue sandwich made of veneers or thin layers of wood, usually laid in a crisscross fashion. The veneer is removed from the log by rotating it in a large lathe against a large knife. Because the thin layer is peeled from the tree, veneer logs are sometimes called "peelers." After the veneers are glued and stacked, they are pressed until the glue sets. Veneer logs generally have fairly high quality requirements.

Sawlogs - Sawlogs are usually converted into lumber by first squaring the log (called slabbing) and then cutting the boards with either a circular saw, a band saw, or gang saws. The boards are edged and resawn to desired dimensions. The finished sawn product

is graded, surfaced and dried (usually in a kiln). Over one-quarter of the timber cut in East Texas is used in making lumber.

Pulpwood - Wood used in paper making goes through a long, complicated process. The wood is chipped, cooked in a caustic solution, washed, passed through screens, pressed and dried. Southern pines are commonly used for making newsprint and kraft paper. Kraft is a Swedish word meaning strength which is a necessity for paper used in making sacks and wrapping materials. Pulpwood utilizes about 40% of all timber cut in East Texas. It has few quality requirements, and this shows in the low price to the grower.

Fence posts - There are no generally accepted specifications for posts. The dimensions depend on the intended use, and often a 2.5 inch top diameter is sufficient for line posts. Posts are generally treated in solutions such as pentachlorophenol or creosote for resistance to decay and insects.

Requirements for Each Product

There are two general specifications that determine whether a tree would best be sold as a pole or piling, sawlog or veneer log, or pulpwood or fence posts: (1) size (diameter) and (2) quality.

Poles and piling are the highest valued wood products from pine stands. To qualify for poles or piling, trees have to be very straight for a minimum of 30 feet. The test for straightness is to stand several feet from the tree and drop a plump line, real or imaginary, from the middle of the tree at approximately the 30 foot height to the ground (Figure 4A). If the line stays within the wood from top to bottom, the tree is straight enough to make a pole. This method should be used from two different views. In addition, the tree must not have any ring knots (Figure 4B). A ring knot is a point where several branches encircle the trunk of the tree. Ring knots create weak areas that are subject to breakage. The minimum length for a pole is 30 feet; the minimum DBH (diameter at breast height) is 10 inches. The minimum top diameter is 6 inches outside the bark. Pilings have the same standards except that they need to be much larger in diameter than poles to withstand the pressures of a pile driver.

Sawlogs and veneer logs are the next valuable wood products. The quality requirements are a minimum DBH of 10 inches and a minimum length of one log (16 feet). Sawlogs may have knots and limbs, provided they are not excessive, but veneer logs must be practically branch and limb free. Both sawlogs and veneer logs must be relatively straight, but not as straight as poles and piling.

Pulpwood and fence posts are the least valuable product in the woods, but are an important market for cull and inferior trees that are cut during thinnings. In order to qualify for pulpwood, the DBH must be at least 6 inches. Trees with diameters (DBH) above 10 inches may also need to be sold as pulpwood because of excessive limbs or because at least one log cannot be cut from the tree. In some cases, trees may be sold for fence posts with top diameters as small as 2.5 inches inside the bark.

Glossary of Terms -

Kraft paper - A strong paper, usually brown, used in bags and wrapping paper.
Log - A unit of measure for length of sawtimber; 16 feet.
Ring Knot - A point on a tree where several limbs encircle the trunk. (Figure 4B)

Woodland Clinic Example

In this event, students will be required to identify the best product for five tagged trees. They will enter the coded number from the question sheet in the appropriate box on the answer sheet. For example, a tree tagged with the letter "D" is 14 inches DBH and has a ring knot at about 20 feet above the ground. This tree would best be sold as sawlogs and the number "2" is entered in block "D". See figure below.

4. Wood Products	A	B	C	D	E
				2	

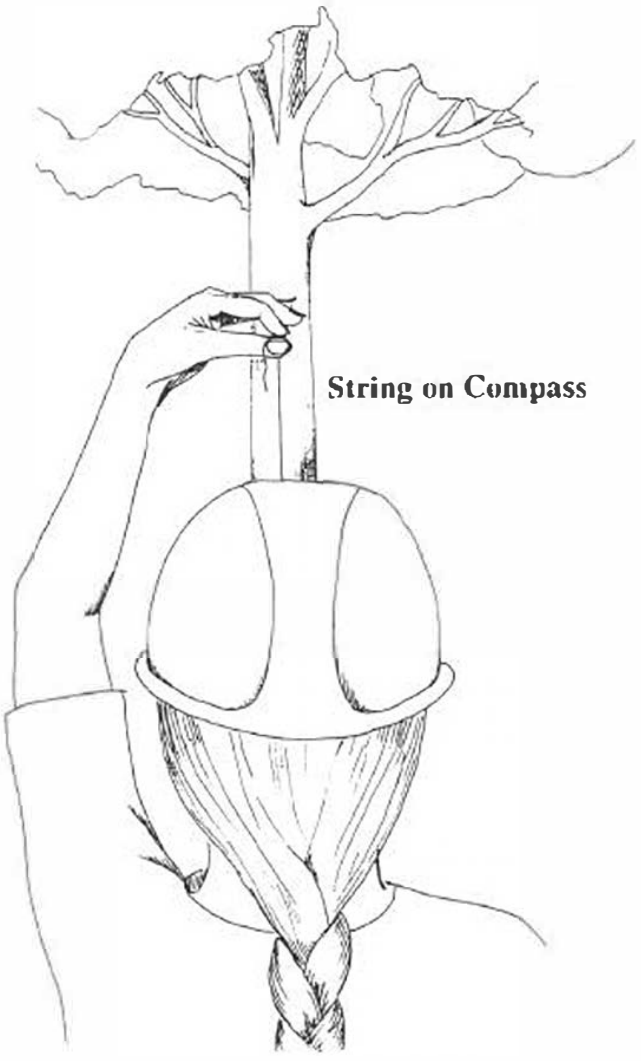


Fig. 4A – Test for Straightness

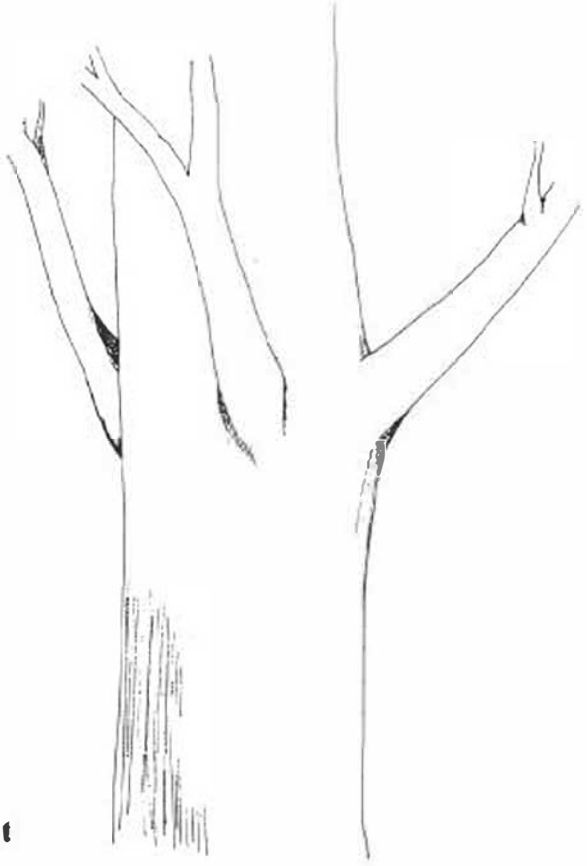


Fig. 4B – Ring Knot

TIMBER-FORAGE-WILDLIFE RELATIONSHIPS

Outline:

A. Purpose of identifying browse plants used by deer
B. Biological facts about deer
C. Nutrient requirements
D. Using an identification key
E. Rating plants by preference of choice
F. Glossary of terms
G. References
H. Woodland Clinic example

Student Skills:

A. Identify commonly used browse plants and rate their relative importance
B. Understand the importance of nutrition in deer health and survival

Materials Needed:

A. Key for identification
B. Reference Materials

Purpose of Identifying Browse Plants Used by Deer

Deer, as well as turkey, quail, song birds and small mammals, depend heavily upon seeds and forage produced by plants within the first four feet of the forest floor. Forest management practices can influence the quantity and quality of these plants by managing the density and composition of the overstory canopy. Therefore, it is important to be able to recognize the more commonly occurring browse species and their relative importance to deer so that the proper forestry practices can be applied.

Biological Facts About Deer

White-tailed deer are the most common big game animal in Texas, and the Pineywoods of East Texas is no exception. Approximately 10.5 million acres of the East Texas woodlands are considered deer range.

The life cycle of whitetail deer, Odecoileus virginianus, begins with the birth of fawns in the spring and early summer. Fawns remain closely associated with the doe during the summer and are weaned by late September. Only about one-third to one-half of the does still have a fawn remaining alive by late summer. The causes of fawn mortality may include malnutrition, disease, parasites and predation. Deer are rather sedentary during the spring and summer because their nutritional needs seldom require a large range during this period of lush, green growth.

Bucks begin growing a new set of antlers in early spring. By September, they begin rubbing the velvet and develop polished antlers. About this time, the breeding season begins, and the deer molt their summer hair and replace it with a darker, heavier coat. Breeding can occur from early fall to late winter, and movements may temporarily increase dramatically during this time.

Deer are ruminants which allows them to feed quickly by partially chewing food, and to complete chewing when in safe cover. They have a very keen sense of smell and good hearing. Snorting and stomping of feet are means of communicating. Their top speed is 30 to 35 miles per hour.

Nutrient Requirements

A deer's health and survival depend on many factors ranging from genetics to cover and water, but the most important (and the one usually needing more attention in forest management) is meeting their nutritional requirements. Plants eaten by deer can be divided into three general groups: (1) browse (leaves and stems of woody plants), (2) forbs and (3) grasses. The percentages of these three will vary during the year, but browse is important year round.

Spring and early summer are periods of abundant, high-quality food supplies. The most common food items include browse, forbs, fruits and grasses. By late summer, shortages of quality food supplies often occur, especially during drought. The succulent browse and young forbs have matured and become less palatable and nutritious. However, deer can stay in good condition if their range is not overstocked. Malnutrition can kill many fawns during this time. The quality of browse is lowest in the fall and winter, and by fall only the leaves of the evergreens are heavily used. Fortunately, fall is usually a period of abundant fruit and nut production. Winter browse supplies are deficient in protein and phosphorus, and deer may be malnourished if they are forced to depend entirely on this supply during this critical period. The winter stress period usually ends by mid-March when spring green-up occurs.

Nutrition impacts many aspects of life for deer. Malnourished deer are more susceptible to disease and parasites. Doe that can come through the critical winter stress period in good condition are more likely to bear healthy fawns in the spring. The antler conformation in bucks is determined by heredity, but size and development are dependent on nutrition.

Everything green in the woods is not necessarily food. Two factors determine whether a plant will be utilized by deer. One is accessibility. If the browse is over 4.5 feet above the ground, deer can not reach it nor use it. Therefore, even though the species may be highly desirable, it has no value. The second factor is deer preference. Browse plants can be classified into three categories: first choice, second choice and low value. Browse surveys are made to determine the extent of utilization of plants. Although deer exhibit definite preferences in browse species, selection of an individual plant may be more related to soil and moisture conditions than species. For example, sweetgum is a low value plant. But under certain conditions, such as in a recently burned area, a survey may show more utilization of this species than on a preferred species because of the fast flush of growth that occurs after a burn. The preference listed below will generally hold true in most cases.

Using an Identification Key

An identification key is designed to help identify trees, shrubs and vines based on certain characteristics. The key provided for this question is based first on whether the plant is a vine or a tree/shrub. Further divisions are based on leaf characteristics, bark, the presence of thorns or spines and the presence of an odor.

Using the key successfully simply requires answering questions with either yes or no and following the route that is given according to the answer. There are a total of 44 questions in this key, but the most the students will have to answer is 9. If there is a doubt about how to answer a question, check both routes. It won't take long to see which way is correct. It should be remembered that the key is only for those plants in Question 5. Reference books may be needed to confirm a correct identification.

Before starting the key, have the students take a good look at the plant to check its growth patterns. The different patterns are listed in the glossary. Once they have studied the plant, they will be ready to use the key. For practice, have the students try it on a plant they already know.

Rating the Plants by Preference of Choice

Although preference can depend on soil and moisture conditions, time of year, etc., the following is a general guide to preference ratings for common browse species of East Texas.

First Choice	Second Choice	Low Value
Alabama supplejack (rattan)	blackgum	beech
beautyberry	dogwood	holly
ash	elm	hornbeam
blackberry/dewberry	hawthorn	black cherry
Carolina jessamine	muscadine grape	eastern redcedar
greenbriar	maple	hickory
honeylocust	red mulberry	blackjack oak
Japanese honeysuckle	rusty blackhaw	post oak
sassafras	sugarberry/hackberry	southern red oak
yaupon	white fringetree	persimmon
	water oak	sparkleberry/ huckleberry
	white oak	
	willow oak	sweetgum
	Virginia creeper	waxmyrtle

-Source: Lay, D.W., Deer Range Appraisal in Eastern Texas, 1967. In Journal of Wildlife Management. 31(3): pp 426 - 432.

Students will need to learn the rating of the plants listed above for the Woodland Clinic.

Glossary of Terms

Leaf growth patterns (see Figures 1A and 1B)

Opposite - Two leaves coming from a node opposite each other on the twig.

Alternate - Leaves from nodes place singly at different levels on the twig.

Simple and Compound Leaves (see Figures 1C and 1D)

Simple - One leaf part originating from a bud.

Compound-Multiple leaf parts or leaflets originating from a bud.

Leaf Margins (see Figures 1E, 1F, and 1G)

Smooth or entire - The edge of the leaf is not cut, indented or toothed.

Toothed - The edge of the leaf is sharply pointed like small teeth.

Lobed - The edge of the leaf is cut or divided.

Persistent and Deciduous Leaves

Persistent - Leaves that are evergreen or remain attached long into the winter.

Deciduous - Leaves that fall at the end of the growing season.

General Terms

Antler Conformation-The general form or shape of antler formation.

Browse - The leaves and stems of woody plants eaten by deer.

Forb - Any plant that is not woody or grasslike.

Node - A joint on a stem that usually bears a leaf or leaves. (see Figure 1H)

Overstory - Those trees that make up the top layer of crowns in a stand of trees.

Range - A region over which a deer will travel.
Ruminant - An animal characterized by a three or four chamber stomach and that chews a cud.
Velvet - A network of blood vessels that nourish antlers.

References

1. Lay, D.W., Deer Range Appraisal in Eastern Texas, 1967. In Journal of Wildlife Management. 31(3): pp. 426 - 432.

2. Nixon, E.S., and Cunningham, B. L., Trees, Shrubs and Woody Vines of East Texas, 1985. Bruce Lyndon Cunningham Productions, Nacogdoches, TX.

3. Vines, Robert, A., Trees, Shrubs and Woody Vines of the Southwest, 1960. University of Texas Press, Austin, TX.

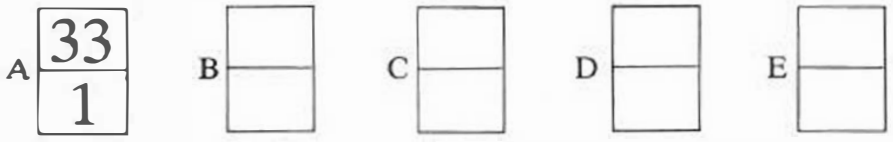
Woodland Clinic Example

In this event, the students will identify five browse plants that are tagged with lettered cards "A" through "E," and give the proper preference/utilization rating for each. Deer must be able to browse the plant; large trees with leaves and twigs above 4.5 feet from the ground are not permissible for this event. A numbered code is provided on the question sheet. The students will need to learn the preference ratings for each plant and express the rating as follows:

The number one (1) for first choice plants
The number two (2) for second choice plants
The number three (3) for low value plants.

For example, the browse plant marked with card "A" is a yaupon. The student will put number "33" in the top block of Question 5A. Yaupon is a first choice plant and so a "1" is placed in the bottom block of 5A. See figure below.

5. Timber-Forage-Wildlife Relationships



Timber- Forage Identification Key

1. Vine?
   Yes . . . . . Go to 2
   No. . . . . Go to 9 (trees or shrubs)

2. Are the leaves opposite?
   Yes . . . . . Go to 3
   No. . . . . Go to 4 (leaves are alternate)

3. Are the leaves evergreen, shiny and dark green, and is the bark on the stem smooth?
   Yes . . . . . **Carolina jessamine**
   Are the leaves semi-evergreen and hairy, and is the bark on the stem shreddy?
   Yes . . . . . **Japanese honeysuckle**

4. Are the leaves alternate and compound?
   Yes . . . . . Go to 5
   No. . . . . Go to 6 (leaves are simple)

5. Are the prickles generally found on the stems and are the leaves three or five foliated?
   Yes . . . . . **dewberry/blackberry**
   Prickles do not occur, and the leaves are palmately compound with five leaflets?
   Yes . . . . . Virginia creeper

6. Are the leaves alternate and simple and are the stems generally armed with spines?
   Yes . . . . . **greenbriar**
   No. . . . . Go to 7

7. Are the leaves alternate and simple, the stems without spines, the leaves parallel veined and are the leaf margins smooth?
   Yes . . . . . **Alabama supplejack**
   No. . . . . Go to 8 (leaf margins are toothed)

8. Are the leaves alternate and simple, toothed, and is the bark generally smooth?
   Yes . . . . . **muscadine grape**

9. Are the leaves scale-like and evergreen?
   Yes . . . . . **eastern redcedar**
   No. . . . . Go to 10 (broadleaf)

10. Leaves are broadleaf and evergreen or nearly evergreen?
    Yes . . . . . Go to 11
    No. . . . . Go to 16 (leaves are deciduous)

11. Leaves are armed with spiny teeth?
    Yes . . . . . holly
    No. . . . . Go to 12

12. Leaves are generally bristle tipped?
    Yes . . . . . Go to 13
    No. . . . . Go to 14

13. Leaves are wider at the tip than at the base and may be variable on the same tree?
    Yes . . . . . **water oak**
    Leaves are long and narrow
    Yes . . . . . **willow oak**

14. Leaves are 1.5 to 5 inches long, usually coarsely toothed only near the tip, dark green and aromatic when crushed?
    Yes . . . . . **southern waxmyrtle**
    No. . . . . Go to 15

15. Leaves are 1 to 2 inches long and obviously toothed, shrub?
    Yes . . . . . **yaupon**
    Leaves are 1 to 2 inches long and the margins are either smooth or barely toothed, shrub?
    Yes . . . . . **sparkleberry/huckleberry**

16. Leaves are deciduous and opposite?
    Yes . . . . . Go to 17
    No. . . . . Go to 22 (leaves are alternate)

17. Leaves are compound?
    Yes . . . . . **ash**
    No. . . . . Go to 18 (leaves are simple)

18. Leaves are lobed?
    Yes . . . . . **maple**
    No. . . . . Go to 19

19. Leaf margins are smooth?
    Yes . . . . . Go to 20
    No. . . . . Go to 21 (leaf margins are toothed)

20. Leaves are 3 to 5 inches long, 2 to 3 inches wide, and the twig tips are sometimes purple?
    Yes . . . . . **dogwood**
    Leaves are 4 to 8 inches long, 1 to 4 inches wide, and the twig tips are reddish-brown?
    Yes . . . . . **white fringetree**

21. Leaves are thick and leathery and finely toothed, shrub?
    Yes . . . . . **rusty blackhaw**
    Leaves are thin, coarsely toothed, hairy below and aromatic when crushed, shrub?
    Yes . . . . . **beautyberry**

22. Leaves are deciduous, alternate and compound?
    Yes . . . . . Go to 23
    No. . . . . Go to 24 (leaves are simple)

23. Twigs are armed with branched thorns, many leaflets?
    Yes . . . . . **honeylocust**
    Twigs without thorns, five to fifteen roughly oval shaped, finely toothed leaflets per leaf?
    Yes . . . . . **hickory**

24. Leaves are deciduous, alternate, simple and the leaf margins are smooth?
    Yes . . . . . Go to 25
    No. . . . . Go to 29 (leaf margins are toothed or lobed)

25. Tree bark has corky projections or bumps?
    Yes . . . . . **sugarberry/hackberry**
    No. . . . . Go to 26

26. Leaves end in a bristle tip?
    Yes . . . . . Go to 27
    No. . . . . Go to 28

27. Leaves are 3 to 7 inches long, 2 to 5 inches wide, and are bell or wedge shaped?
    Yes . . . . . **blackjack oak**
    Leaves are 2 to 4 inches long, 1 to 2 inches wide, wider at the tip than at the base and may be variable on the same tree?
    Yes . . . . . **water oak**

28. Leaves do not have a bristle tip, are 2 to 5 inches long, dark green and shiny, end in a blunt point and the branches are commonly perpendicular to the trunk?
    Yes . . . . . **blackgum**
    Leaves do not end in a bristle tip and are 4 to 6 inches long?
    Yes . . . . . **persimmon**
    Leaves are 1 to 3 inches long and some leaves may be very finely toothed, shrub?
    Yes . . . . . **sparkleberry/huckleberry**

29. Leaves are deciduous, alternate, simple and toothed?
    Yes . . . . . Go to 30
    No. . . . . Go to 38 (leaves are lobed)

30. Leaves are very finely and singly toothed?
    Yes . . . . . Go to 31
    No. . . . . Go to 32 (leaves are coarsely or doubly toothed)

31. Leaves are 2 to 6 inches long, teeth are incurve and there are rusty colored hairs long the midrib on the underside of the leaf?
    Yes . . . . . **black cherry**
    Leaves are 1 to 3 inches long, some leaves may have margins that are smooth, shrub?
    Yes . . . . . **sparkleberry/huckleberry**

32. Leaves are coarsely but singly toothed?
    Yes . . . . . Go to 33
    No. . . . . Go to 35 (leaves are doubly toothed)

33. Twigs are armed with thorns?
    Yes . . . . . **hawthorn**
    No. . . . . Go to 34

34. Bark is smooth and gray, twigs grow in a zig-zag pattern?
    Yes . . . . . **beech**
    Bark has corky projections or bumps
    Yes . . . . . **sugarberry/hackberry**

35. Leaves are doubly toothed and twigs are armed with thorns?
    Yes . . . . . **hawthorn**
    No. . . . . Go to 36

36. Leaves are doubly toothed, bark is bluish-gray, smooth and tight?
    Yes . . . . . **hornbeam**
    No. . . . . Go to 37

37. Leaves are doubly toothed, leaves may be variable on the same tree, 3 to 8 inches long, dark green above and hairy beneath, and has prominent veins?
    Yes . . . . . **red mulberry**
    Leaves are doubly toothed, fairly uniform in shape, 1 to 6 inches long and base may be asymmetrical?
    Yes . . . . . **elm**

38. Leaves are deciduous, alternate, simple and lobed and armed with thorns?
    Yes . . . . . **hawthorn**
    No. . . . . Go to 39 (no thorns)

39. Leaves are variable on the same tree?
    Yes . . . . . Go to 40
    No. . . . . Go to 41 (leaves are fairly uniform in shape)

40. Leaf margins are smooth and twigs are aromatic when crushed?
    Yes . . . . . **sassafras**
    Leaf margins are toothed?
    Yes . . . . . **red mulberry**
    Leaves have bristle tips, non-lobed leaves are wider at the tip than at the base?
    Yes . . . . . **water oak**

41. Leaves are palmately veined, star shaped (five lobes) and the margins are toothed?
    Yes . . . . . **sweetgum**
    No. . . . . Go to 42

42. Leaves end in a bristle point?
    Yes . . . . . Go to 43
    No. . . . . Go to 44

43. Leaves are bell or wedge shaped?
    Yes . . . . . **blackjack oak**
    Leaves have 3 to 7 pointed lobes?
    Yes . . . . . **southern red oak**

44. Lobes are rounded and generally are cross shaped?
    Yes . . . . . **post oak**
    Leaves are regularly Lobed with seven to nine lobes?
    Yes . . . . . **white oak**

Student Activity

The browse species in Question 2 can be grouped in two ways. One is by the characteristics a plant may have that make it similar to some plants and different from others. This grouping could be as shown below.

Vines

Leaves Opposite	Leaves Alternate	
	Leaves Compound	Leaves Simple
Carolina jessamine	dewberry /blackberry	greenbriar
Japanese honeysuckle	Virginia creeper	supplejack
		muscadine

Trees and Shrubs

Scalelike Leaves	Broadleaf Trees and Shrubs				
	Persistent Leaves	Deciduous Leaves			
		Opposite Leaves	Alternate Leaves		
			Compound Leaves	Simple Leaves	
				Entire Leaves	Toothed Leaves	Lobed Leaves
eastern redcedar	holly	ash	honeylocust	sugarberry	black cherry	hawthorn
	water oak	maple	hickory	blackjack oak	elm	sassafras
	waxmyrtle	dogwood		water oak	hawthorn	red mulberry
	yaupon	rusty blackhaw		blackgum	beech	water oak
	sparkleberry	beautyberry		willow oak	sugarberry	sweetgum
				persimmon	hornbeam	blackjack oak
				sparkleberry	mulberry	post oak
						white oak

Another way to group these plants is by their preference rating for deer, as shown in the text. Collect, press and mount as many plants in either grouping as can be found in the area.

TREE MEASUREMENTS AND VOLUME

Outline:

A. Purpose of tree measurements
B. How to measure tree diameter
C. How to measure tree height
D. How to determine tree volume
E. Glossary of terms
F. References (supply catalogs)
G. Woodland Clinic Example

Student Skills:

A. Measure tree diameter and height, determine the volume
B. Understand basic units of measure such as board feet, logs, and chains

Materials Needed:

A. Cruiser or Biltmore stick
    1. Students may make cruiser sticks using the table in the Handouts section
B. 100 foot tape
C. D-tape or linear tape measure
D. Stand of trees for study

Purpose for Tree Measurements

Volume has been the traditional measure of wood quantity. It will continue to be important even as the use of weight increases. The value is so closely connected with the volume that it is important to know how to determine a wood's worth. Although measures of volume may differ, such as cubic feet, cords and board feet, the principles of measuring trees are the same.

There are numerous measurements used as indicators for individual trees or stands of trees. Some common measurements are diameter, height, volume, rate of growth, basal area and form. Many different means have been developed to make these measurements. Some tools are simple such as the cruiser (Biltmore) or log stick, and some are complicated and quite expensive. This section will cover in detail those measurements that are used in the Woodland Clinic and not explained in other sections such as Site Index and Rate of Growth. The tools used in the clinic will be described.

How to Measure Tree Diameter

The diameter of a standing tree is the length of a line passing from one edge of the tree through the center to the other edge. Diameter is an important component in determining tree volume. It is measured 4.5 feet above the ground and is called diameter at breast height or DBH. This measurement is taken outside the bark. If the ground is level and the tree is straight, taking DBH is straight forward. If, on the other hand, the ground is sloping, DBH must be measured on the uphill side, or if the tree is growing at an angle, the measurement must be taken perpendicular to the length. A few species of trees such as baldcypress have pronounced butt swelling. Diameter measurements are usually taken 4.5 feet above the swelling. Another problem in measuring diameter is forking. If a tree is forked below DBH height, each stem is measured and considered a separate tree. Generally though, DBH measurements are not complicated. The most important thing for students to remember is to measure at 4.5 feet above the ground. There is a tendency when using a cruiser stick to take the measurement too low. Because trees tend to taper rapidly near the ground, measuring too low can result in a significant error. Another point for

students to remember is that trees are not usually perfectly round. Therefore, diameter measurements should be the average of two readings made at a right angle to each other.

The cruiser or Biltmore stick is, at best, a rough tool for measuring tree diameters. However, since most timber cruizes categorize diameters in even inches (as does this event in the Woodland Clinic), it's accuracy is acceptable. The stick's precision is increased by observing the following rules (Figure 6A).

1. On approaching the tree, estimate its DBH and hold the stick about midway between the estimated DBH and the zero end.

2. Hold the stick against the tree exactly 25 inches from the eye and perpendicular to the body. If a student's reach is not 25 inches, a customized stick can be made from the measurements table in the Handouts section.

3. Make sure the stick rests against the tree at 4.5 feet above the ground.

4. With one eye closed, align the left end (the zero end) of the stick with the left edge of the tree.

5. Without moving the stick or the head, read the diameter where the right side of the tree intersects the stick.

6. Take two measurements, at right angles, of the tree trunk at DBH height and average the two readings to determine diameter.

Diameter measurements to the nearest inch may be needed for events such as selective thinning, wood products and cull tree removal/TSI. However for this event, DBH measurements are taken to the nearest **even** inch (10", 12", 14", etc.). Therefore, if a tree's actual DBH is 16.75 inches, it would be tallied as a 16-inch tree, and if a tree measured 17.25 inches it would be tallied as 18 inches. Care should be taken to place the tree in the proper even inch DBH class because a small error here can result in a significant difference in tree volume.

The only DBH measuring tool allowed at the Woodland Clinic is the cruiser or Biltmore stick (either home made or bought, see Tables 6A & B). However, there is another way to measure diameter that is based on the principle of the diameter of a circle being equal to its circumference divided by 3.14 (pi). This method can be used by instructors to check the accuracy of the students. It can be done by using a linear tape measure to measure the circumference of the tree at DBH height and dividing by pi. There are commercially available tapes in which the diameter measurements are already marked at 3.14 inches and can therefore be read directly. These tapes are called Diameter Tapes. They can be bought through companies that supply forestry needs (see References).

How To Measure Tree Height

Tree height is the second factor needed to determine the volume in a tree. The ability to accurately determine height is important for this event. It is also needed for other events such as "Site Index" and "Wood Products." Measuring total tree height is described in the section on Site Index and Productivity.

Total tree height is just one of several height measurements that may be needed in forestry. Other height measurements include bole height, stump height, defective length and crown length. The one most often needed when determining tree volume is merchantable height. Merchantable height is measured from the top of an imaginary stump (usually one foot above the ground) to a point on the stem that marks the top end of the last usable portion of the tree. The units of usable portions depend on the intended use of the

tree. For example, pulpwood heights are measured in "sticks" ranging from 4 to 6 feet in length. For sawtimber and this event the traditional measure of usable portions is called the "log." A log is 16 feet in length and can be expressed as either full or half-logs (8 feet in length). The top of the last usable portion may be determined by several factors, again depending on the intended use of the wood. It may be determined by limb, defect, crook, or by minimum diameter. For the Woodland Clinic, the upper limit in merchantable height is set by a minimum diameter of 6 inches. So all height measurements are taken from the stump height to where the stem diameter reduces to 6 inches. The merchantable height to a 6-inch top is measured to the nearest, complete half- log. Tree height should be "rounded down" if the whole log or half-log is not there. For example, if a student determines the merchantable height to be between 3.5 and four logs, the tally should show 3.5 logs because the full four logs could not be measured.

Although there are several instruments available for measuring tree height, such as clinometers, Abney levels and Haga altimeters (the instructor may want to either purchase or borrow one of these to check the students' accuracy) the same cruiser or Biltmore stick used to determine DBH will be used to determine height in the Woodland Clinic. Although the cruiser or Biltmore stick is not as accurate as the instruments mentioned above, it is adequate for measurements to the nearest complete half-log. Its accuracy can be increased if the following rules are followed (Figure 6B).

1. Pace exactly one chain (66 feet) from the base of the tree to a spot that gives a clear line of sight to the top merchantable height.

2. Face the tree and hold the stick vertical, plumb position 25 inches from the eye. If a student's reach is not 25 inches, a customized cruiser stick can be made from measurements in the table in the Handouts section.

3. The hand holding the stick should be about one-fourth to one-third up the stick from the zero end.

4. Align the bottom of the stick with stump height (1 foot high).

5. Without moving the head, sight up the tree to a 6 inch diameter top and read the number of full logs or complete half logs from the stick where the line of sight to the 6 inch top intersects the stick.

To help students visualize a 6-inch top, find a 6-inch DBH tree and have the students pace 90 feet from it. At 90 feet the students will be about as far from the 6-inch tree as they would be from a 6-inch top in a four log tree. If the trees are shorter move about 10 feet nearer and if taller, about 10 feet farther.

How to Determine Tree Volume

Tree volume can be measured in cubic feet, cords, weight, and board feet. Board-foot volumes are common to sawtimber and are used in the Woodland Clinic. A board foot is a piece of lumber 1-inch thick, 12-inches wide and 12-inches long; or a combination of these. It is a measurement prior to surfacing and not what is actually bought as a finished product. Nevertheless, it is widely used.

The cord is the unit commonly used for pulpwood volume measures. It is defined as a stack of wood 4-feet high, 4-feet wide and 8-feet long or 128 cubic feet. Because this 128 cubic foot stack contains both wood and air spaces, it is not a precise measure. A common rule of thumb is one cord equals approximately 90 cubic feet of solid wood.

Weight is becoming more widely used for expressing saw-log or pulpwood amounts. Because weight can vary according to species, moisture content and log size, local weights per unit should be obtained from local wood buyers.

The only volume unit used in the Woodland Clinic is the board-foot measure. It is determined by plotting the diameter and the merchantable height on a volume table (Table 6C). Volume tables are derived from mathematical formulas called log rules. Log rules are formulas that use definite assumptions on tree taper and losses from the milling process. They give board-foot yields in terms of diameter and length. These formulas can be very complex and tables were developed to eliminate field calculations. A volume table will be provided at this event in the Woodland Clinic. Students should use only the volume table provided; not the tables that are often printed on cruiser sticks. There are three common log rules used in determining volume - the Scribner Rule, the International 1/4 Rule (used by the U.S. Forest Service) and the Doyle Rule, which is the most widely used rule and is used in the Woodland Clinic. The volume table is used by reading down the left column to the nearest even inch DBH and across to the nearest full log or half-log. Where these two lines intersect is the number of board feet in a tree of that DBH and merchantable height.

Glossary of Terms

Board Foot - The unit of measure used for saw logs; a rough piece of lumber 1-inch thick, 12-inches wide and 12-inches long, or a combination of these.
Chain - A unit of measure equal to 66 feet.
Cord - The unit of measure used for pulpwood; a stack of wood 4-feet high, 4-feet wide and 8-feet long.
DBH - Diameter Breast Height; The diameter of a tree measured 4.5 feet above the ground.
Diameter Tape - A tape measure designed to read diameters directly by marking each inch of diameter every 3.14 linear inches.
Log - The unit of usable portions of a tree measured in 16-foot lengths.
Log Rule - Volume tables that estimate the board foot content from logs based on mathematical formulas.
Merchantable Height - The length of stem in a tree measured as the distance from stump height to a designated top of the last usable portion (6-inch diameter top).
Pulpwood - Timber used in the making of paper.
Sawtimber - Timber used in the making of lumber
Timber Cruise - A survey or inventory of forest land to locate timber and estimate its quantity, species, products, size, quality and other characteristics.

References

Supply Catalogs:

Forestry Suppliers, Inc.
205 West Rankin Street,
P.O. Box 8397, Jackson, MS 39204.
601/354-3565 or 1-800-647-5368

The Ben Meadows Company,
553 Amsterdam Avenue, N.E.
P.O. Box 8377, Atlanta, GA. 30306.
404/455-0907 or 1-800-241-6401

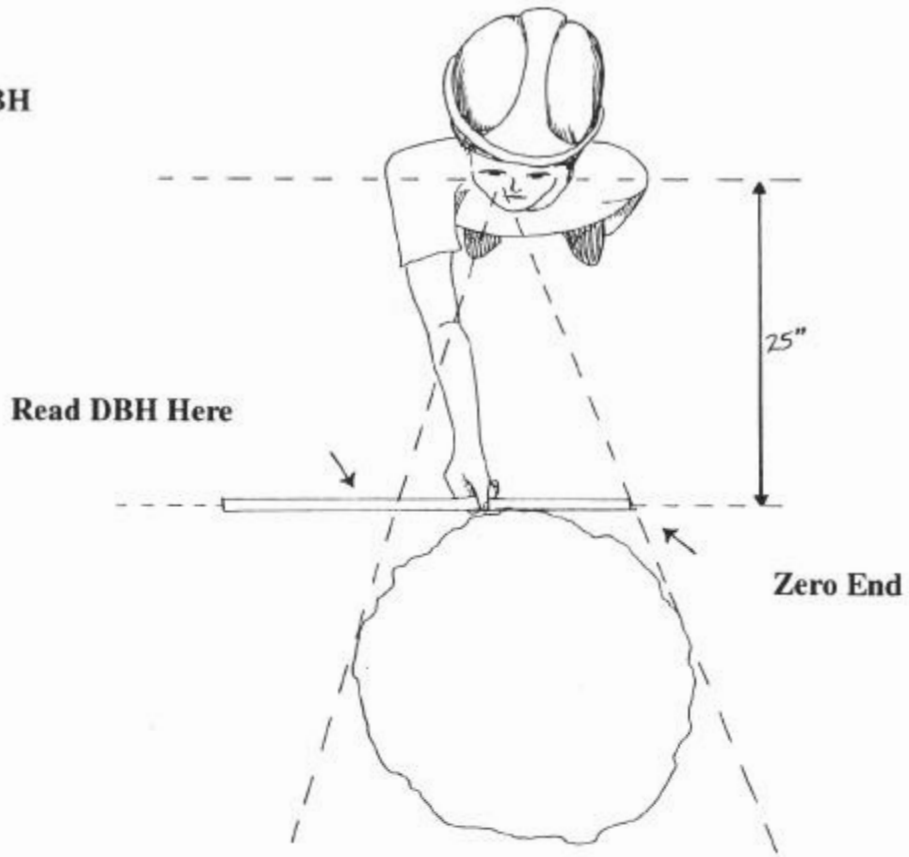
Construction Safety Products, Inc.,
359 Mt Zion Rd,
Shreveport, LA 71106
318-688-6483 or 1-800-592-6940

Woodland Clinic Example

In this event, students will determine the diameters of five tagged trees at DBH to the nearest, even 2-inch class (10", 12", 14", etc.) using a cruiser or Biltmore stick. Merchantable height, in numbers of full 16-foot logs or full half-logs, will also be measured. A Doyle Rule volume table will be provided. Using the volume table, the board-foot volumes will be determined for each of the five trees. These five volumes will be added and the total volume entered in the block on the answer sheet. Answers within 5% of the correct total will receive full credit (10 points). Answers within 10% of the correct total will receive half credit (5 points). Answers over 10% of the correct total will receive no credit (0 points). For example, the student measures the five designated trees that have the following DBHs and merchantable heights: (A) 18" and four logs; (B) 12" and three logs; (C) 10" and 2.5 logs; (D) 14" and 3.5 logs; and (E) 16 " and three logs. The respective volume in board feet for each tree is (A) 273; (B) 57; (C) 24; (D) 109; and (E) 161. The total volume is 624 board feet. This value is placed in the block on the answer sheet.
See figure below.

6. Tree Estimates and Volume: 624

Fig. 6A – Measuring DBH



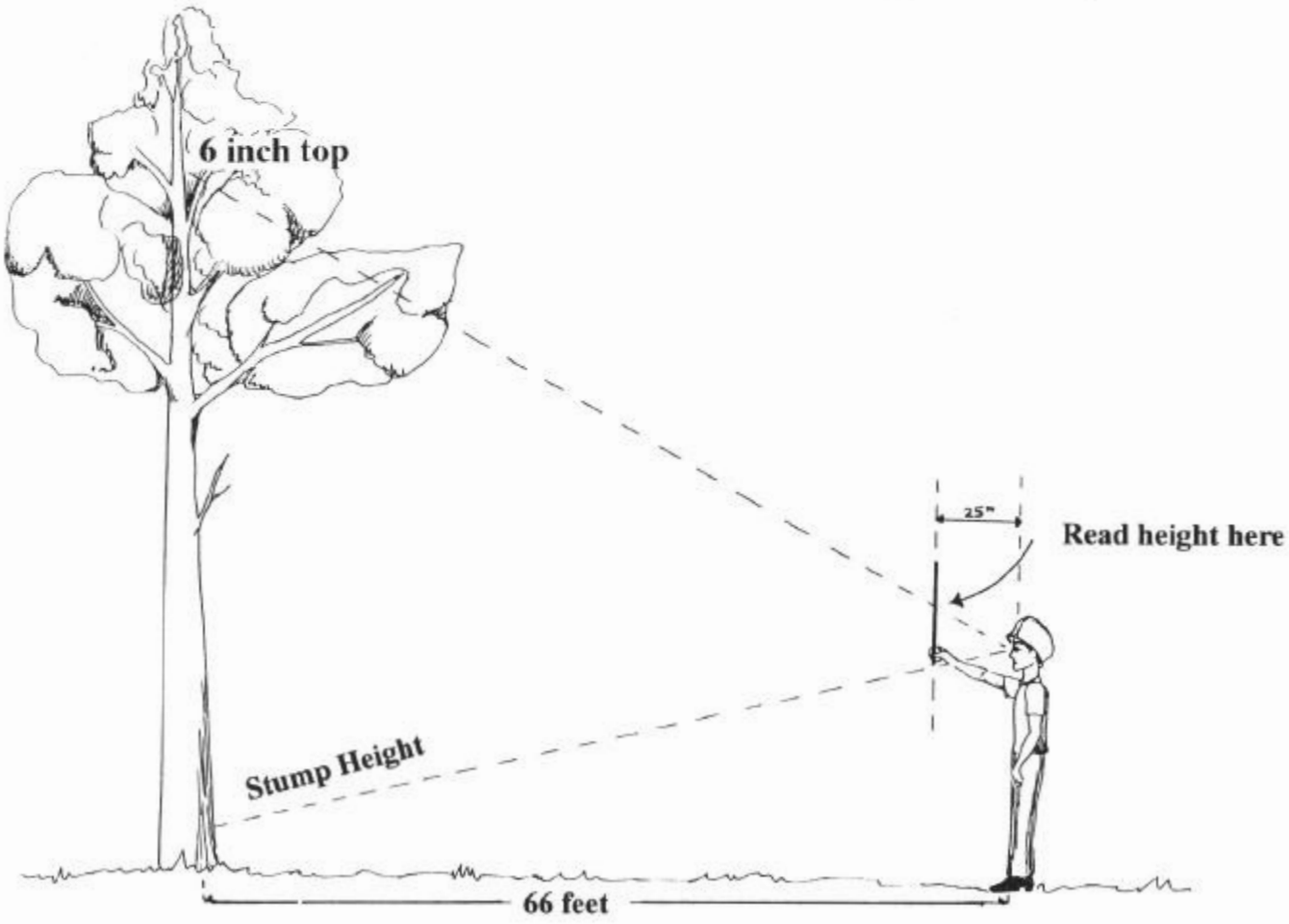


Fig. 6B – Measuring Height

Table 6A. Approximate measurements for making a cruiser stick for measuring tree diameters

Diameter	Position of Mark on Stick in Inches From Left End for a Reach of:		
	22 - 24 inches	25 - 27 inches	28 - 30 inches
4	3 11/16	3 11/16	3 3/4
6	5 5/16	5 3/8	5 7/16
8	6 7/8	7	7 1/16
10	8 5/16	8 1/2	8 5/8
12	9 3/4	9 15/16	10 1/16
14	11	11 1/4	11 1/2
16	12 1/4	12 9/16	12 13/16
18	13 7/16	13 13/16	14 1/8
20	14 5/8	15	15 3/8
22	15 11/16	16 3/16	16 9/16

For practice, measure the circumference of several trees and find the diameter by multiplying the circumference by 0.314 (or measure with a diameter tape) and check with stick.

Table 6B. Approximate measurements for making a cruiser stick for measuring tree heights.

Height in:		Position of mark (in inches) from bottom for reach of:				
Logs	Feet	22 inches	24 inches	25 inches	26 inches	28 inches
1/2	8	2 5/8	2 7/8	3	3 1/8	3 3/8
1	16	5 5/16	5 13/16	6	6 5/16	6 3/4
	20	6 5/8	7 1/4	7 9/16	7 7/8	8 7/16
1 1/2	24	8	8 11/16	9 1/16	9 7/16	10 3/16
	25	8 5/16	9	9 7/16	9 13/16	10 9/16
	30	10	10 7/8	11 5/16	11 13/16	12 11/16
2	32	10 5/8	11 5/8	12 1/16	12 9/16	13 9/16
	35	11 11/16	12 11/16	13 1/4	13 3/4	14 13/16
2 1/2	40	13 5/16	14 1/2	15 1/8	15 3/4	16 15/16
	45	15	16 5/16	17	17 11/16	19 1/16
3	48	16	17 7/16	18 1/8	18 7/8	20 3/8
	50	16 11/16	18 1/8	18 15/16	19 11/16	21 3/16
	55	18 5/16	20	20 13/16	21 5/8	23 5/16
3 1/2	56	18 5/8	20 5/16	21 3/16	22	23 3/4
	60	20	21 13/16	22 11/16	23 5/8	25 7/16
4	64	21 5/16	23 1/4	24 3/16	25 3/16	27 1/8
	65	21 11/16	23 5/8	24 9/16	25 9/16	27 9/16
	70	23 5/16	25 7/16	26 1/2	27 9/16	29 11/16
4 1/2	72	24	26 1/8	27 1/4	28 3/8	30 1/2
	75	25	27 1/4	28 3/8	29 1/2	31 13/16
5	80	26 5/8	29 1/16	30 1/4	31 1/2	33 15/16
	85	28 5/16	30 7/8	32 3/16	33 1/2	36 1/16
	90	30	32 11/16	34 1/16	35 7/16	38 3/16

Table 6C. Volume Table in Doyle Log Rule Form Class 80

DBH Inches	VOLUME (Board Feet) BY NUMBER OF 16 FOOT LOGS								
	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5
10	16	20	23	24	26	28	31		
12	31	39	47	52	57	60	62		
14	52	67	82	93	104	109	114	120	126
16	77	101	125	143	161	174	186	199	213
18	108	144	179	206	234	254	273	293	314
20	144	193	242	282	321	348	374	396	417
22	185	250	315	368	420	458	497	529	561
24	231	314	397	466	536	583	630	678	725
26	282	386	489	576	663	727	791	852	912
28	339	466	592	700	807	885	963	1040	1118
30	400	552	703	832	961	1055	1149	1248	1346

Source: U.S.D.A. Forest Service

TREE NO.	DBH	#16' LOGS	BOARD FEET

TOTAL _____

SITE INDEX AND PRODUCTIVITY

Outline:

A. Purpose of determining site index
B. How students can determine site index and productivity
C. How the NRCS determines site index and productivity
D. Glossary of terms
E. Woodland Clinic example

Student Skills:

A. Define site index
B. Understand how site index relates to the potential productivity of the site
C. Understand how site index is determined by the NRCS
D. Measure tree age, height and site index

Materials Needed:

A. Cruiser stick or yard stick
B. Tree cross section or increment core
C. Site index table

Purpose of Determining Site Index

Site index is a number that represents the height (in feet) the average dominant and co-dominant (fastest growing) trees on a particular site can be expected to reach in some given period of time. This time period for southern pines is 50 years. Therefore, if a particular site is said to have a site index of 80, then it is expected that trees growing on this site will attain a height of 80 feet in 50 years. Site indices for East Texas range from 50 or 60 feet on lands stripped for gravel and very deep sandy soils to 100 feet on well-drained bottomland soils.

Site index, therefore, is a function of tree height and age. Height is a reliable measurement because it is affected less by management than other measurements, such as DBH. Diameter is more sensitive to stand density and, therefore, more sensitive to the level of management the stand has received. In addition, this relationship of total height to age is popular because the two needed measurements (height and age) are easily determined.

The ability to predict an area's potential to produce wood allows foresters to utilize our limited soil resources in the most efficient way. Using site index ratings as a guide to productivity is important in understanding that area's production potential and its management needs. For example, sites with low production potential can be avoided in favor of more productive sites.

How Students Can Determine Site Index and Productivity

The first step in measuring site index is to determine the age of the tree. This will be done by counting the annual growth rings from a cross section of a tree or an increment core. Annual growth rings on southern pines are laid down in bands of two different colors (Figure 3A). The light colored wood is called springwood because it is formed during the cool, wet spring months. The growth is fast, and the cells tend to be large. As the hot, dry summer occurs, growth is slowed, and the cells tend to be smaller which produces the second part of the growth ring called summerwood. This summerwood is the darker part of the ring. This difference in color between springwood and summerwood allows the annual growth of a tree to be distinguished. By counting either the springwood growth rings or the summerwood growth rings (but

not both) in a section of the tree, the total age may be determined.

When using a cross section to determine the age, be sure to count only from the center of the cross section to the outside, not all the way across. If an increment core is used, the center of the tree will need to be determined to arrive at an accurate count. The total count from either a cross section or increment core equals the age of the tree. Do not add anything to this count.

The next step is to measure the total height of the tree. It is important to measure the total height and not just the merchantable height of the tree. The simplest way to measure tree height is to use a method involving proportions. In this method, any straight stick at least 30 inches long, such as the cruiser stick, is held in a vertical position with the length of the stick above the hand equal to the distance from hand to eye. This is done by holding the stick in an outstretched arm with the end of the stick resting on the cheek just below the eye. The stick is then turned to the upright, vertical position. The student then walks back or forward until the top of the tree is in line with the top of the stick and the base of the tree is in line with the student's hand. The distance from the student to the base of the tree then equals the total tree height which is measured by pacing to the tree. It is important to remind students to move only their eyes, and not their heads, when viewing the tree (Figure 7A).

The student then will determine the site index from Table 7C which represents site index ratings taken from the site index curve for loblolly pine. (Although site index curves differ from one species to another, the student will assume the tree measured is loblolly pine - even though the actual tree measured may not be). To use this table the student will look in the "Total Age" column to find the row that most closely matches the age obtained from the cross section or increment core. The student will then follow this row to the right and locate the number closest to the measured height. Following this column up to the top of the chart will give the site index rating for the site.

Once the site index is determined, the student will be required to identify the potential productivity. Adjective ratings will be used to describe the potential productivity based on the site index. The table below shows how the ratings correspond to site index.

Table 7A. Site index in relation to the Woodland Clinic adjective rating scale.

Site Index	Adjective Rating
96 and up	Very High
86 - 95	High
76 - 85	Moderate
66 - 75	Low
65 and below	Very Low

Again, this table represents ratings for loblolly pine. For the purpose of the contest, the student will assume the tree used for this event is a loblolly pine no matter what the actual species may be.

How the NRCS Determines Site Index and Productivity

Determining the site index of a particular site is normally done by a team consisting of a soil scientist and a forester. The soil scientist identifies the soil on the site and records particular characteristics such as slope, texture, wetness, position on the landscape (upland, bottomland, etc.) pH, and other factors that may influence the productivity.

The forester selects the species of trees to be measured. Five or six trees of the chosen species are then chosen. Many factors go into the selection of these trees. The trees should represent the entire stand in that they should not have been subjected to growing conditions which are not typical for the site. Thus, the selected trees shouldn't be growing beside road ditches and therefore receiving more water than the other trees in the

stand, or damaged by insects, disease, ice, lightning, etc. The trees should either be dominant or co-dominant. Trees that are excessively taller or shorter than the average should not be chosen. After five or six trees are chosen the forester determines the age and heights. The age is measured by boring into each tree with an increment borer and counting the growth rings from an increment core. The heights are measured by using an instrument specially manufactured for forestry work.

After all the soil and tree data are collected and recorded, the site index can be determined for the site. Site index curves are used to determine the site index. The average age and heights of the measured trees are plotted on these curves to arrive at a site index rating for the site.

Other information may also be recorded on the site that will give a numerical and verbal picture of the site. This information may include the measured DBH of the chosen trees, the measure of the stand density, a record of the understory vegetation and their relative abundance, and an estimate of the crown density.

Because different tree species respond to the same soil with different growth rates, it is necessary to have site index curves for each species and to separate site productivity by tree species. In addition, many soils have similar potential productivity and so can be grouped accordingly. The table below shows how this grouping can be made and how different species respond differently to the same soil.

Table 7B. Adjective site productivity ratings is relation to site index ratings and species.

Species	Very High	High	Moderate	Low	Very Low
cottonwood	106+	96-105	86-95	76-85	75 & below
loblolly pine	96+	86-95	76-85	66-75	65 & below
slash pine	"	"	"	"	"
sweetgum	"	"	"	"	"
water oak	"	"	"	"	"
shortleaf pine	86+	76-85	66-75	56-65	55 & below
longleaf pine	"	"	"	"	"
southern red oak	"	"	"	"	"

Glossary of Terms -

Annual Growth Rings - The growth layer of one year, as viewed on the cross section of a stem, branch or root.

Co-dominant Trees - Trees with crowns forming the general level of the canopy and receive full sunlight from above but little from the sides.

DBH - Diameter at Breast Height; the diameter of a tree measured at 4.5 feet above the ground.

Dominant Trees - Trees with crowns that extend over the general level of the canopy and receive full sunlight.

Increment Borer - Instrument used to extract a core of wood from a tree from which growth factors and age can be determined.

Increment Core - A thin column of wood removed from a tree with the use of an increment borer.

pH - A measure of acidity/ alkalinity.

Site Index - A number which represents the height (in feet) that the average dominant and co-dominant trees of a particular species can be expected to reach in a given time period.

Site Index Curve -A graph of age height over age used to determine the site index for a particular species of tree.

Site Productivity - The ability of a particular site to produce wood.

Stand - A group of trees occupying a specific area which are uniform in composition (species), age, arrangement and condition.

Understory - Trees, shrubs, grasses, forbs, vines, etc. which make up the vegetation below the height of the co-dominant trees in a stand.

Woodland Clinic Example

In this event, the student will be required to determine the site index of the site by determining the total age from either a cross section or an increment core and the total height of a single labeled tree. The student will use this information to arrive at the site index for the site from a site index table. The site will be written in the proper block on the answer sheet. Answers with the correct site index will receive full credit (7 points), answers that are five indices either way will receive 5 points, answers that are ten indices either way will receive 2 points and answers more than ten indices away will receive 0 points. For example, the student counts 45 rings from a cross section or increment core and measures the tree height to be 75 feet. Reading into the body of the body of the table, the student finds the closest height in the 45 year row to be 77 feet. Reading up the column on the top of the table reveals a site index of 80 feet, which is entered in the block on the answer sheet. See figure below.

Table 7C. Site index table for loblolly pine.

Total Age (years)	Site Index														
	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	Heights of Dominant Trees in Feet														
10	16	18	20	22	25	26	28	30	32	34	35	37	39	41	43
15	22	25	28	31	34	36	38	40	43	45	47	50	52	54	57
20	28	32	35	38	42	44	47	50	53	56	58	61	64	67	70
25	34	38	41	45	49	52	55	58	62	66	70	73	76	80	83
30	39	43	47	51	55	59	63	66	70	74	78	82	85	89	93
35	43	48	52	56	60	64	68	72	77	81	85	90	94	98	100
40	46	50	55	60	64	68	73	78	82	86	91	96	100	105	110
45	48	53	58	62	67	72	77	82	86	91	96	101	106	110	115
50	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
55	52	57	62	68	73	78	83	88	93	98	104	109	114	119	124
60	54	59	64	70	75	80	85	90	96	102	107	112	117	122	128
65	55	60	66	72	77	82	87	92	98	104	110	115	120	126	131
70	56	61	67	72	78	84	89	94	100	106	112	116	123	128	133
75	57	62	68	74	79	85	91	96	102	107	114	119	124	130	135
80	57	63	69	74	80	86	92	98	103	109	115	120	126	132	137
85	58	64	70	76	81	97	93	98	104	110	117	124	128	134	139
90	59	64	70	76	81	88	94	100	105	112	118	124	129	134	140
95	59	65	71	76	82	88	95	100	106	112	118	124	130	136	141
100	60	65	71	76	82	88	95	100	106	112	119	125	131	136	142

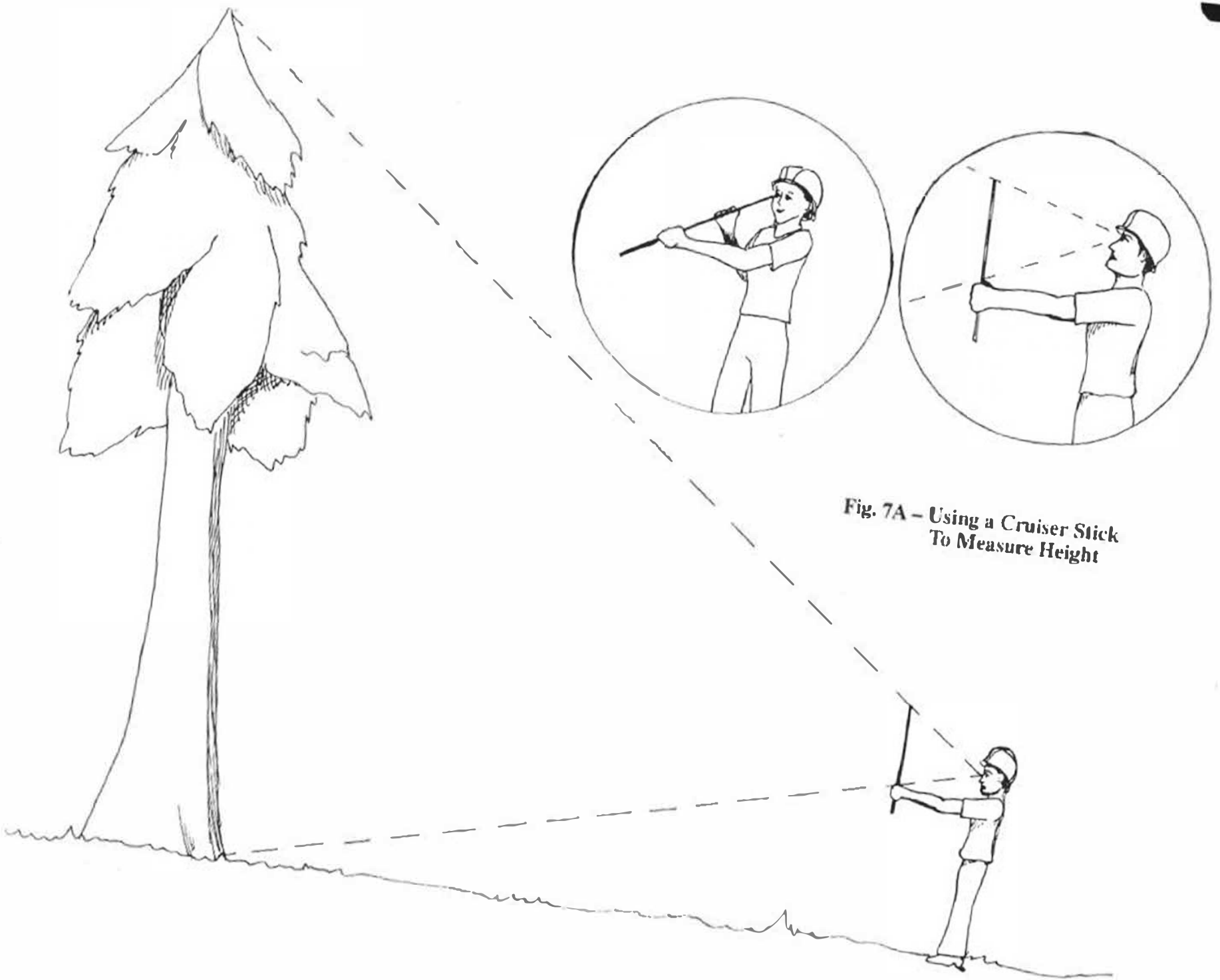


Fig. 7A – Using a Cruiser Stick
To Measure Height

RATE OF GROWTH

Outline:

A. Purpose of measuring rate of growth
B. Rate of growth's relation to management
C. Rate of growth's relation to lumber quality
D. How rate of growth is measured
E. Glossary of terms
F. Woodland Clinic example

Student Skills:

A. Determine the growth rate from annual rings
B. Relate the rate of growth to the tree's past management

Materials Needed:

A. Blocks of cut lumber (2x4 or 2x6) for study
B. Increment borer for study in the woods which may be borrowed from NRCS, TFS, a consultant or other foresters

Purpose for Measuring Rate of Growth

A tree can grow in two ways; in height and in diameter. Height growth is almost totally dependent on the quality of the site, and although diameter growth is also dependent on site quality, it is also greatly influenced by management. The most important management factor is stocking, or the number of trees per acre. As trees become crowded, the competition for sunlight, moisture and nutrients can lead to slower diameter growth. This characteristic gives a forester a method of checking the health and vigor of a stand. The method used for measuring the rate of growth is described below.

Rate of Growth's Relation to Management

The factors that affect the rate of diameter growth can be put into two groups: (1) site quality and (2) past management. Site quality is most easily expressed as site index. Site index is the height the dominant trees in the stand should attain in 50 years. Site index is a product of the site's soil, topography, and climate. Further discussion of these factors is found in the sessions on "Selective Thinning by D+6" and "Site Index and Productivity."

Five to eight years per 2 inches of diameter growth is a good rule-of-thumb for determining growth rates on almost all East Texas sites. On sites with high site indices, such as well-drained bottomlands, the time period for growing 2 inches of diameter should be about five years and on sites with low site indices, such as very deep sandy soils, the time period would be closer to eight years.

Although site quality can be used to predict the potential diameter growth rate, the stocking rate will determine what the growth rate actually will be. Trees that are crowded because the site is overstocked can have diameter growth rates of 12 to 20 years per 2 inches of diameter growth. Crowded trees do not have the room to produce full crowns, and since the amount of crown determines how much sunlight can be received from which to produce food, diameter growth will suffer. Forestry practices that solve this problem include selective thinning and control of hardwoods that may be competing with the pines. These practices are called Timber Stand Improvement or TSI. On the other hand, trees in stands that are under stocked may have so much room for crown development that only three to four years are needed to grow 2 inches of diameter. Although the amount of wood per tree is being rapidly produced, land may be wasted because the site is not growing the number of trees of which it is capable. So in general, if the trees are growing 2 inches of

diameter in five to eight years they are growing suitably for East Texas sites. If they take longer than eight years they are growing too slow (probably because of crowding), and if they take fewer than five years they are growing too fast (indicating wasted space).

Rate of Growth's Relation to Lumber

The rate of diameter growth in a tree from which lumber was cut can easily be determined by the annual rings at the end of the board. The faster the growth, the wider the distance between the rings. The slower the growth, the closer the rings are spaced. Fast growth lumber tends to warp, has more shrinkage, more knots, more sapwood, less density; and possibly less strength, depending on use. Generally, the slower the growth, the better the lumber. However, for the forest grower, managing for slow growth timber is uneconomical because timber buyers usually don't give a better price for slow growth.

How Rate of Growth Is Measured

Before growth rates can be measured, the students will need to understand a basic principle - the difference between radius and diameter. Because it is difficult to actually measure diameter growth from annual rings, radial growth (which is easily measured) is used. One inch of growth in radius is the same as 2 inches of growth in diameter. Therefore the rule of thumb of five to eight years per 2 inches of diameter growth is the same as five to eight years per 1 inch of radius growth.

Measurement of radial growth in living trees is commonly made from an increment core. A forestry tool called an increment borer is used to extract a thin column of wood from the trunk of the tree. An increment borer has three parts; (1) a hollow, screw-like shaft that bores into the tree by turning the (2) handle. The column of wood inside the shaft is removed with the (3) extractor (Figure 8A). The forester is usually most interested in the last inch of radius in determining the rate of growth, and the increment core will show him the annual rings just as a cross section would. By measuring the number of years that it took to grow the last inch of radius it can be determined if the trees are growing too fast (less than five rings per inch), too slow (more than eight rings per inch), or about right. This information can help in making of management decisions for the stand (Figure 8B).

In this event, students will be provided with either increment cores, cross sections or blocks of lumber from which to determine the rate of growth. Lumber is most commonly used because of the ease of acquiring different growth rates. Also, blocks are not as easily broken as increment cores. However, students should remember that they are not judging lumber quality alone. A 1-inch line will be marked on each sample. It may or may not be placed on the outer edge of the block, but students should remember that the outer most inch of radius is generally of most concern to foresters. By counting the rings within the 1-inch line, students can determine the growth rate (Figure 8C):

0 to 4 rings per inch =	Too fast
5 to 8 rings per inch =	About right
9 or more rings per inch =	Too slow

Glossary of Terms

Crown - That part of a tree that contains the leaves.
Diameter - The distance across a circle from edge to edge and passing through the center.
Increment borer - An instrument used to remove a core from a tree; made up of a hollow auger with screw-type threads, handle and extractor for removing the core.
Increment core - A thin column of wood removed from a tree by the use of an increment borer.
Radius - The distance from the center of a circle to the outer edge.

Rings (Growth or Annual) - The ring of wood on a cross section surface resulting from periodic growth.
Site Index - An indication of the potential productivity of a soil expressed as the height the dominant trees should reach in 50 years.
Stocking - A quantity; the number of trees per acre.

Woodland Clinic Example

In this event, students will examine three tagged increment cores, cross sections or blocks of lumber to determine if the trees from which they were taken were growing too fast, too slow, or about right. The area in which the rings are to be counted will be marked with a one inch line. The number that corresponds with the rate of growth on the question sheet will be placed in the appropriate block on the answer sheet. For example, if upon examining the wood sample tagged with the letter "A," the student decides there are 10 rings per inch, he or she will put the number "2" in block "A" on the answer sheet. See figure below.

8. Rate of Growth

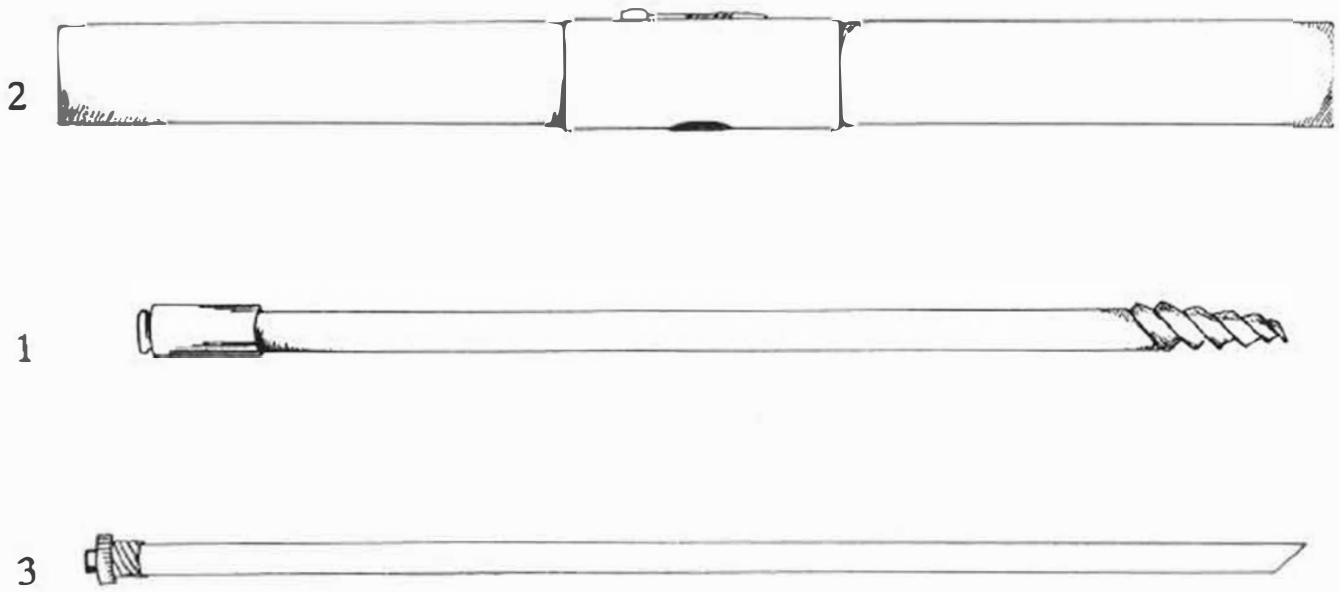


Fig. 8A – Increment Borer

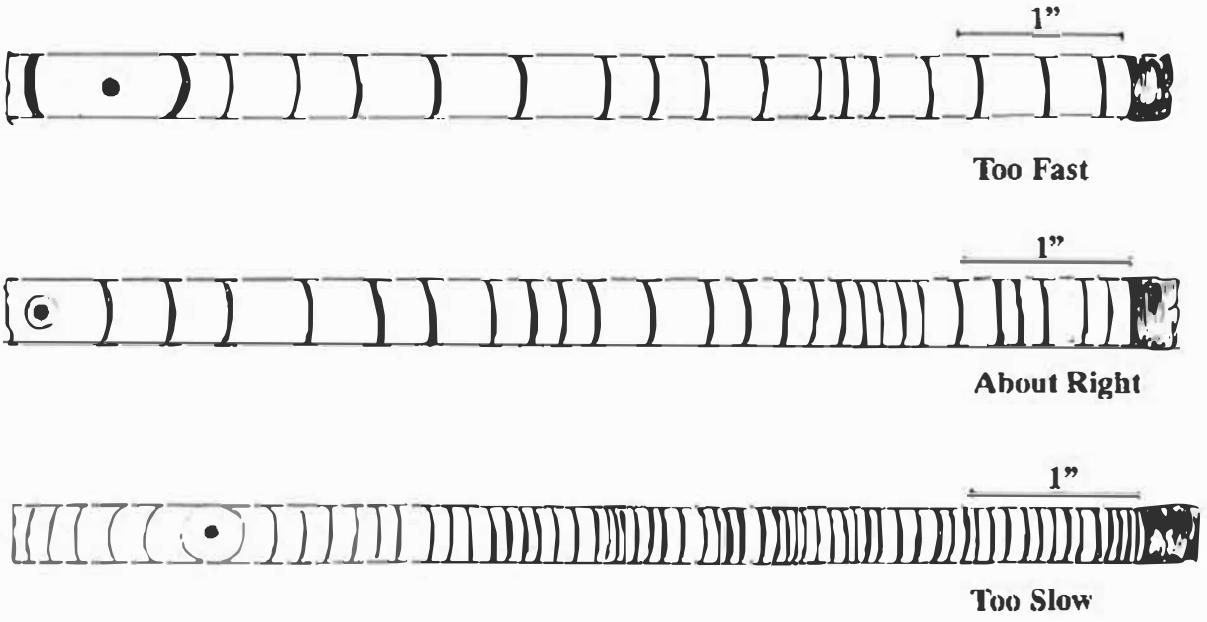
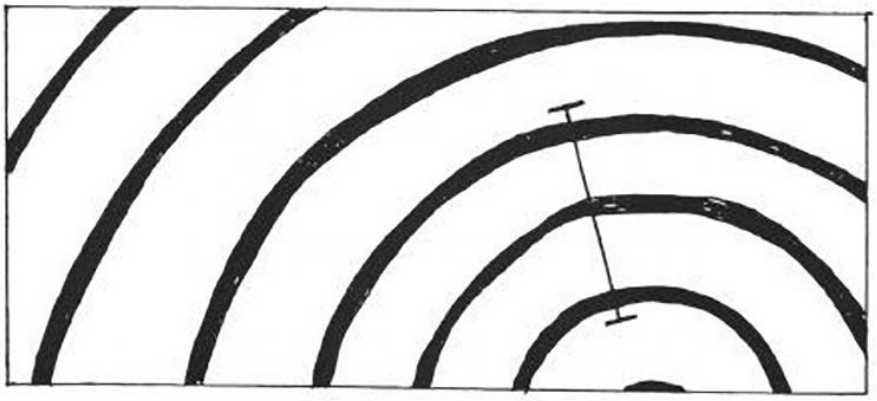
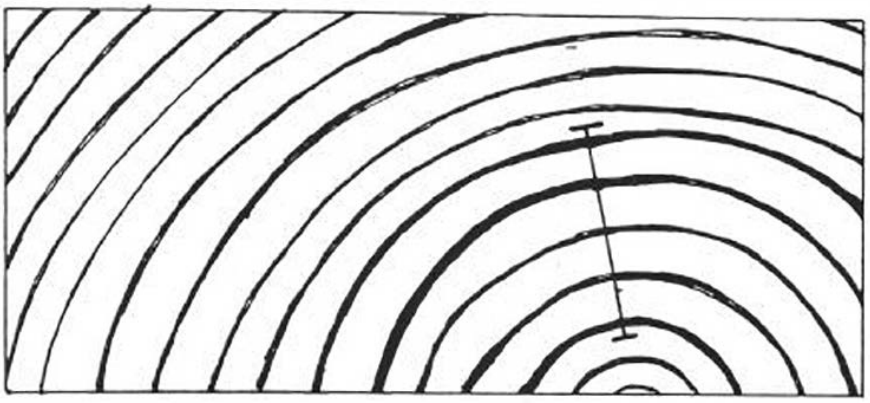


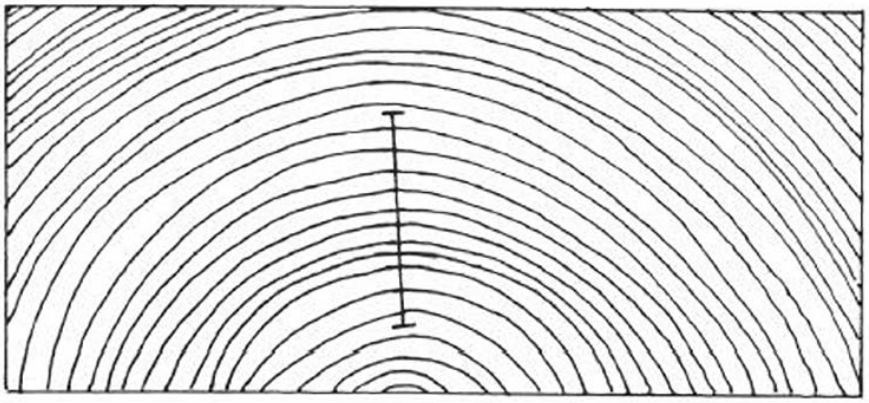
Fig. 8B – Increment Core



Too Fast



About Right



Too Slow

Fig. 8C – Lumber Growth Rates

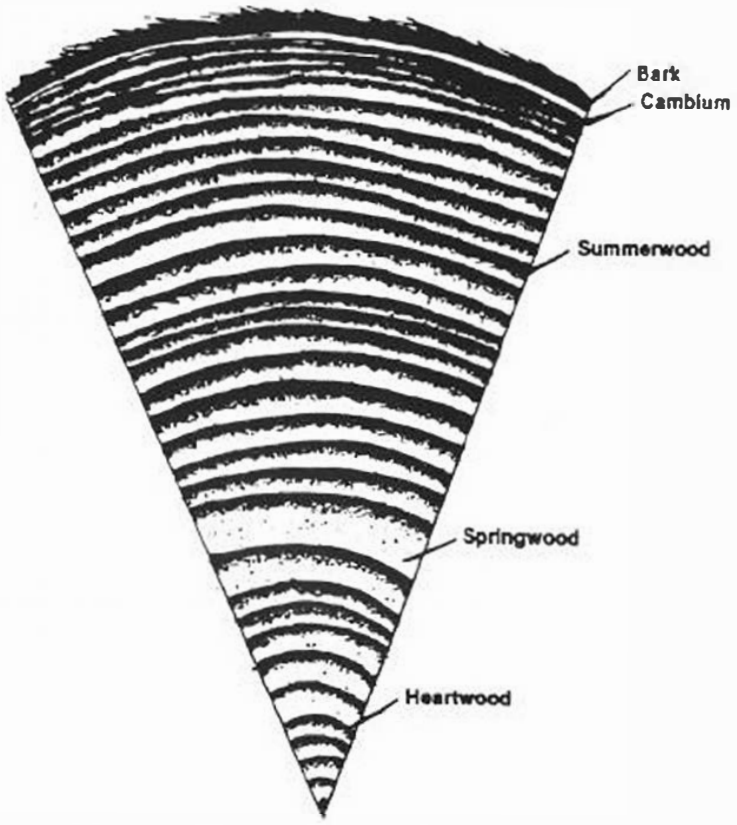
Student Activity 1

1. Collect several different pine cross-sections from either the woods or a sawmill.

   Each annual ring is made up of a light colored band and a dark band. The light band is called "springwood" and is produced when the tree is growing fast during the cool, wet spring weather. As the hot, dry summer progress, growth slows and the dark colored band is formed. This band is called "summerwood".

   As shown in the figure below, there are many reasons for a slowing of a tree's growth, but probably the biggest reason is overcrowding.

   Examine the cross sections for signs of damage and the effects of overcrowding (if any).



2. Compare the growth rings with potential growth.

   Almost all East Texas soils have the potential of growing pines at the rate of 5 to 8 years (annual rings) per inch of radius, when managed. Check the last inch of the cross sections and compare their growth rates with this 5 to 8 year rule-of-thumb. What does the growth rate say about the management the trees received?

Student Activity

Either borrow an increment borer or take along a forester or NRCS employee and go to a stand of pines. After receiving instructions on the use of an increment borer, take cores from several pines that are about the same height. In addition, record each tree's height and DBH (diameter at breast height). The methods for taking these measurements are explained in "Site Index and Productivity" for heights and "Tree Measurements and Volume" for DBH. Record this information along with each tree's age and the number of annual rings in the last inch of radius in the table below.

Tree Number	Total HT. (Feet)	DBH (Inches)	Age (Years)	Rings in last inch of radius

Answer the following:

1. Is there any relation between total height and the age of the trees?
2. What is the relation between crown size and rate of growth?
3. What is the relation between rate of growth and crown position (dominant, suppressed, etc.)?

SELECTION THINNING BY D+6

Outline:

A. Definition and reasons for thinning
B. Growth factors and thinnings
C. Stocking
D. Why D+6?
E. How to use D+6
F. Applying thinning in the woods
G. Glossary of terms
H. Woodland Clinic example

Student Skills:

A. Explain factors that affect tree growth
B. Understand how stocking is related to average DBH
C. Understand how a system like D+6 can be applied to maintain proper stocking

Materials Needed:

A. Cruiser or Biltmore stick
B. 50 foot tape measure
C. A site with wellstocked trees for inventorying and practicing D+6

Definition and Reasons for Thinning

Thinnings are partial cuttings made in stands in order to maintain or increase the diameter growth of the trees that are left and to improve the overall quality and value of the stand.

Growth Factors and Thinnings

To understand how thinnings work, the students need to have a basic understanding of how a tree grows and the factors that affect its growth. There are many factors that affect growth, but the common ones are:

1. The soil's potential to grow trees as expressed by the site index (how tall the trees should grow in 50 years). The higher the site index, the better the potential.

2. The amount of rainfall, as well as how it is distributed through the year.

3. Climatic factors such as length of growing season, the occurrences and severity of droughts, etc.

4. The site's location on the landscape or topography.

5. The stocking or number of trees per acre.

Understanding how these factors work together can give a good picture of the growing potential of a site. For example, a site located on a well-drained, loamy creek bottom in an area that receives 48 inches of rainfall evenly distributed throughout the year, should be a better site than one that occurs on the top of a deep sandy hill located in an area that receives only 38 inches of rainfall yearly. Although these factors can be compared

from one site to another, they cannot be changed. However, how well trees grow on any given site can be affected by management of the fifth growth factor - stocking.

Stocking

The reason for thinning is to take advantage of the ability to change stocking in order to give high quality trees enough space for optimum growth. The rate of growth can be determined by examining a tree's growth rings. Have the students do Activity 1.

The number of trees that can be grown on an acre and have room for growth while not wasting space, depends on the type of trees and the average size (DBH) of the trees. The following graph shows how average DBH affects the stocking of the dominant trees of a natural stand of southern pine.

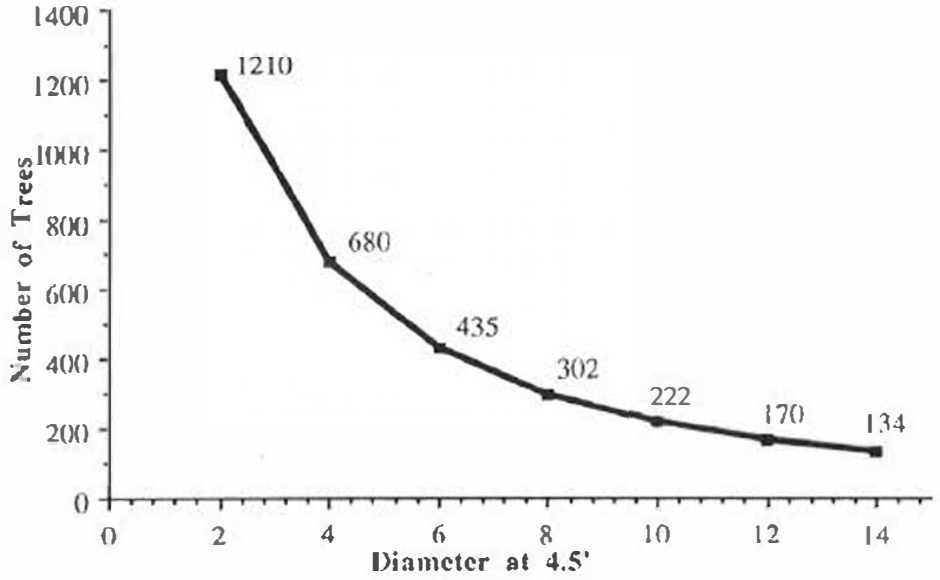


Figure 9A. The number of dominant pines an acre can support for any given average DBH.

The larger the DBH, the fewer the trees. If we assume the trees to be evenly spaced, the distance between dominant trees is described by the equation D+4. "D" stands for the average DBH, expressed in feet. So a natural stand of 222 10" DBH trees averages 14 feet between trees. When spacing falls below D+4, mortality may occur. An inventory is used to determine stocking. The students can inventory a stand using Activity 2.

Why D+6?

If the dominant trees in a stand have a minimum spacing requirement of D+4, it naturally follows that a wider spacing is needed if those trees are to have room to grow and not just maintain themselves. Otherwise this spacing requirement will have to be met naturally through "natural mortality." A tree lost to natural mortality cannot be utilized for products later and its value is lost to the landowner. D+6 is useful in spacing southern pines because its basis is to thin to D+6, let the trees grow back to D+4 spacing, thin again to D+6, and so on. This method helps establish a timetable for thinnings based on tree growth. Most East Texas sites can support a timetable of five to eight years between thinnings in managed stands.

How to use D+6

Three things D+6 will help accomplish are (1) proper stocking, (2) improved stand quality, and (3) a timetable for management activities.

The graph below shows proper stocking for trees of any given average DBH class. For example, the proper stocking for a stand that average 10 inches DBH is about 170 trees per acre.

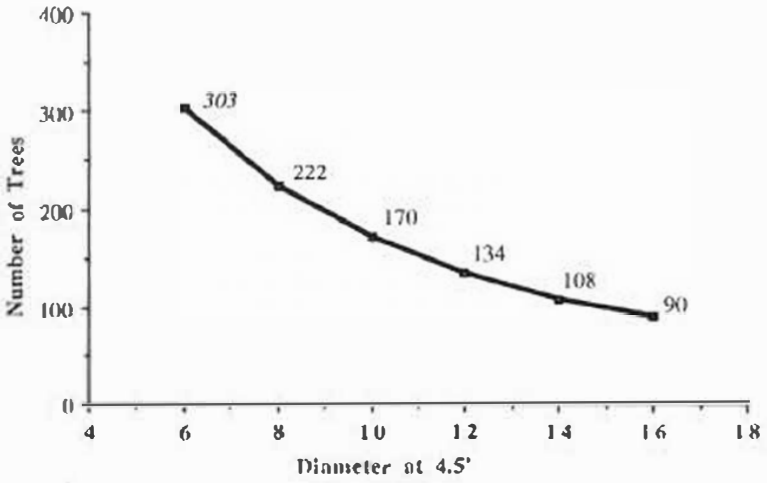


Figure 9B. Proper stocking level per acre by average DBH class.

Knowing that proper stocking for trees averaging 10 inches DBH is about 170 trees per acre is important, but how can 170 trees per acre be visualized? Getting the stocking right on a smaller area would help. There are many ways to do this, but using D+6 triangles is an easy way. The steps in using D+6 triangles is as follows.

Step 1 Select a starter tree that is a dominant or co-dominant.
Step 2 Determine the DBH of this tree and select two trees that are about D+6 feet away (16 feet for an 10 inch tree) and form a triangle.
Step 3 Measure the diameters of these other two trees, average them with the first, and check the sides of the triangle to see if they average close to D+6. It is often unlikely that three trees will be exactly D+6 feet apart. So students should concentrate on making triangles among dominant and co-dominant trees that average approximately D+6. At first, students will need to measure DBHs and distances, but with practice, triangles can be formed mentally with occasional measuring for checking.
Step 4 This triangle has made an area small enough that it can easily be checked for stocking. The number of trees inside the perimeter of the triangle is the number of excess trees that need to be cut to achieve proper stocking.
Step 5 The triangle tells the students how many trees to remove - IT DOES NOT TELL WHICH ONES. Remove the excess number of trees based on quality. Take the worst first. Sometimes taking the worst first may leave two or more trees closer than D+6 feet apart, but these trees have the entire triangle to grow into. Remember: D+6 tells how many to cut, quality tells which ones.
Step 6 The triangle is then moved by flopping it over on one of its sides. In other words, keep two corners and find a new third by the steps above.

Students should not remove more trees than are found inside the triangle. A single thinning should never try to remove all the cull trees in a stand. If there are no trees inside a triangle, that triangle is properly stocked and none should be cut. If the distance to the next prospective corner tree is much greater than D+6 feet, the area is understocked. Students should not try to force distances. If necessary, start a new triangle. If a corner tree is taken because of poor quality, it is still used in selecting adjacent triangles.

Thinning by this method will improve the quality of the stand because quality is the factor used to decide which trees are to be cut. If the quality in the triangle is nearly equal, it would be best to leave the corner trees for better spacing.

Thinning to give trees room to grow means additional thinnings will be needed in the future. Knowing the quality of the site and past growth rates of the trees makes it possible to predict when the trees thinned to D+6 stocking will grow to a D+4 stocking and need another thinning.

Applying Thinnings in the Woods

Once a system of thinning such as D+6 is learned, a method must be used that clearly marks the trees to be cut. Usually the trees to be cut are marked with paint. A special paint and paint gun are used for this purpose. The tree to be cut is marked with a big splotch of paint at eye level so that it can be easily seen by the cutter (Figure 9C). A second splotch is applied at the base of the tree so that the landowner or forester can come back after the cutting operation and make sure only the marked trees were actually cut. Timber marking may be done in pairs. As one person marks the trees, another measures it and tallies the volume. Marking and tallying is the best way of making sure a proper thinning job is done.

Glossary of Terms

Codominant -Trees with crowns forming the general level of the canopy and receive full sunlight from above but little from the sides (Figure 9D).
DBH -Diameter at breast height; The diameter of a tree measured 4.5 feet above the ground.
Dominant - Trees with crowns that extend over the general level of the canopy and receive full sunlight (Figure 9D).
Natural Mortality - The loss of trees from a stand, through death, caused by competition.
Site Index - A measure of the productivity of a soil defined as the height the dominant tree will reach in 50 years.
Stand - A group of trees occupying a specific area which are uniform in composition (species), age, arrangement and condition.
Stocking -A quantity; the number of trees per acre.

Woodland Clinic Example

In this event, all the trees within a designated area will be considered, but only the tagged trees will be considered on the score sheet. Since D+6 is difficult to find in some stands, it may not be used in the contest. Students will determine which trees should be cut by considering crown friction, tree quality, dominance and spacing. On the score sheet and at the site, 10 trees will be tagged with letters "A" through "J." The student decides which of the tagged trees would be cut from the designated area and circles the letters on the score sheet that correspond to the cards on the trees. This means that trees tagged with letters that are not circled will be left. For example, the student decides trees with cards bearing the letters "B," "E," "G," and "I" should be cut. These letters would be circled on the answer sheet. See figure below.

9. Selective Thinning

A (B) C D (E) F (G) H (I) J

Fig. 9C – Marking

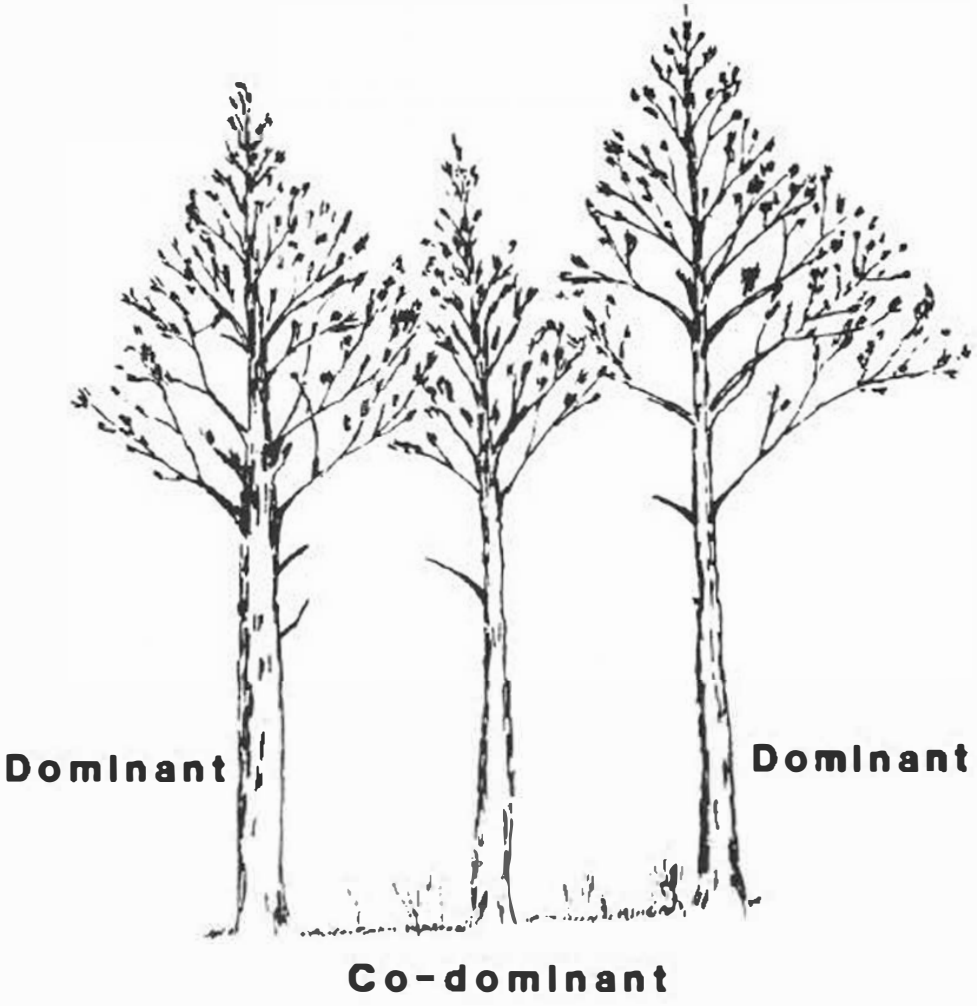
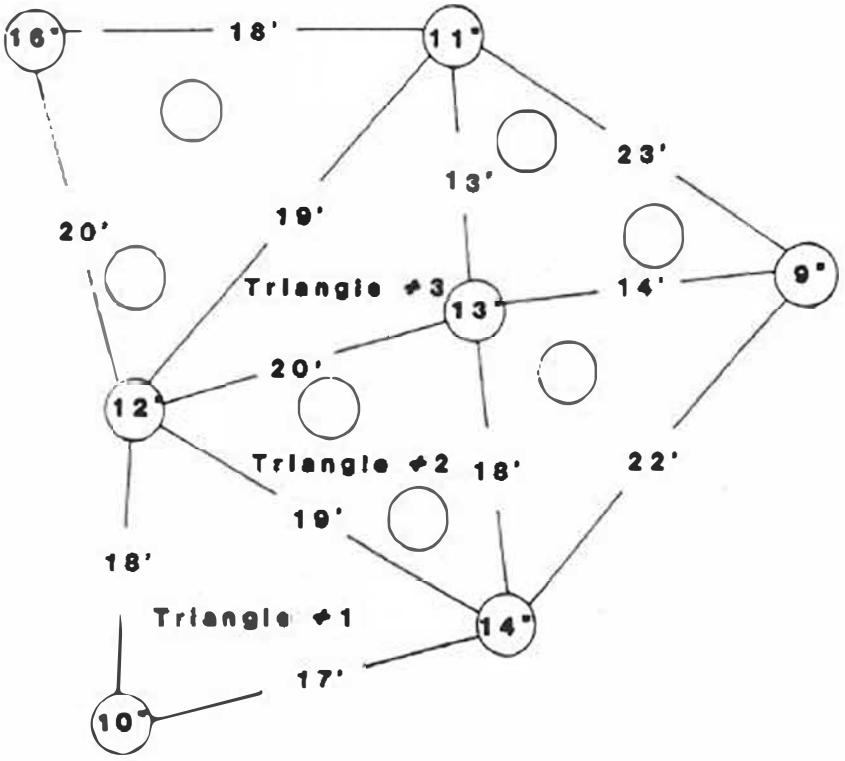


Fig. 9D – Dominant & Co-Dominant

Student Activity

D + 6 Triangles



Beginning at the "Start Tree" two additional trees are chosen at about D+6 distance (D=10, so 10+6=16) to form Triangle #1. The diameters and distances are checked. The three corner trees average 12 inches DBH and 18 feet apart. There are no trees inside the triangle so the stocking in this area is right, and it's time to move to the next triangle.

This is done by flopping Triangle #1 on its side to a new third corner. Again diameters and distances are checked. There are two trees inside Triangle #2 and so two must be cut. The quality of the five trees helps decide which two to cut. If the three corner trees are as good or better than the inside trees, they should be left. But if any of the corner trees are of a poorer quality than the inside trees, they should be cut. The important point to remember is that we want to stock this small area within the triangle by the three best trees.

The process is continued through Triangle #3 and so on. If one of the corner trees in Triangle #2 (12" or 13") were cut when thinning Triangle #2, they would still be used in forming Triangle #3.

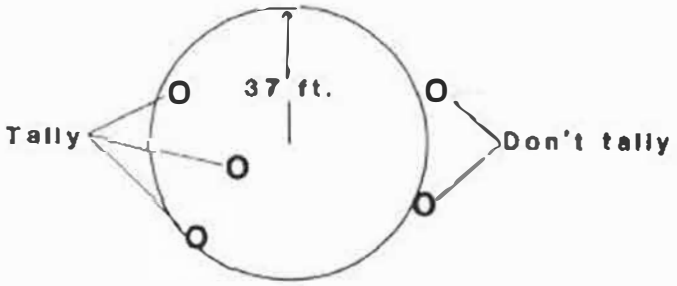
Student Activity 2

Visit a stand of pines.

An inventory is an itemized list of current assets and their approximate worth. But a woodland inventory can also tell something about the management needs of a stand - particularly about the stocking. Checking the number of trees per acre and their average DBH with the graphs in this section can tell whether the stand is understocked, overstocked, or stocked about right.

The steps in making a simple inventory are listed below:

1. Choose an area that looks average for the woods and lay off a tenth acre plot.



2. Using the sheet below, tally all the marketable pines that are 4" DBH and larger.

DBH	Tally	Total Tally	Multiply Total By	Equals
4			4	
6			6	
8			8	
10			10	
12			12	
14			14	
16			16	
Total			-	

Average trees per acre = Total Tally X 10
Average DBH = Total of equals column/total tally

3. Check with the graphs in this section to determine the stocking level.

CULL TREE REMOVAL / TSI

Outline:

A. Purpose of cull tree removal/TSI
B. Definition of cull tree removal/TSI
C. Landowner's objectives
D. Environmental concerns
E. Methods of cull tree removal/TSI
F. Criteria for choosing the best method
G. Description of methods
H. Glossary of terms
I. Woodland Clinic example

Student Skills

A. Understand why cull tree removal or TSI is needed
B. Understand when cull tree removal or TSI is needed
C. Identify the best methods of controlling undesirable vegetation in forest stands

Materials Needed:

A. Cruiser stick
B. Identification keys (if needed)

Purpose of Cull Tree Removal/TSI

Of the 6.6 million acres of pine forests in East Texas, 2.4 million acres are classified as a pine/hardwood mix. This sharing of a site by both pine and hardwoods often means a reduction in the production of marketable wood products. Many times, cull hardwoods can take up one-third of the growing space in a pine/hardwood mix. After considerations for wildlife and aesthetics are made, many of these pine/hardwood acres can be improved to increase their production. Therefore, it is important to be able to recognize the need for improvement and then prescribe the best method.

Definition of Cull Tree Removal/TSI

Timber Stand Improvement or TSI is the most commonly accepted term used to describe forest management activities such as controlling cull trees and unwanted vegetation in a stand sometime between regeneration and harvesting. The intent of TSI is to make growing space available for more desirable crop trees.

To understand the need for TSI, students should understand how succession occurs in the forest. Excluding site adaptability and the ability to withstand fire, the most important plant characteristic that determines that plant's place in succession is its tolerance to shade or, in other words, its ability to grow and reproduce in shade. It is usually true that the less desirable, lower value trees tend to be more shade tolerant than the more desirable, more valuable trees. For example, trees such as hornbeam and hophornbeam are very tolerant of shade, species such as elm and blackjack oak are moderately tolerant, and trees such as pine are intolerant of shade. Over time, the more tolerant species can develop under the canopy of the more desirable and less tolerant trees, and although tolerant species can grow in the shade, they can also grow in direct sunlight. If something should happen to the canopy such as harvesting, death, etc. and these shade tolerant species have not been controlled, they are in place and ready to dominate the stand. The result is that they will either over-top the more desirable species in the stand or develop a dense enough canopy so that the more desirable, shade intolerant species cannot develop.

Landowner Objectives

For a TSI program to be successful, it must be consistent with the objectives the landowner has for the forest. These objectives can range from improving the condition of the woods for maximum fiber production from pine, to maintaining a highly aesthetic condition in the woods. For the purpose of the Woodland Clinic, it will be assumed that the owner has wood production as his intent for his forest resource. The two objectives that may apply in this situation are:

1. Maximum fiber production from pine

2. Optimum pine production with consideration of wildlife as a secondary objective.

The general guidelines to be considered for each objective are as stated below.

Maximum fiber production from pine - All competing vegetation, except pine, will be controlled. In many cases where pine has established complete dominance in a stand, it may not be necessary to control any of the hardwoods. This is particularly true when the hardwoods are small brush size and are not in serious competition with the pine for sunlight, moisture or nutrients. These types of plants include sumac, dogwood, redbud, rusty blackhaw and sparkleberry. These species rarely reach a stature or density that they will ever present much competition or shading. Some low growing species such as yaupon can grow so dense that they will choke out young pines, and so will need to be controlled. Control methods will be described below.

Optimum pine production with consideration of wildlife - This objective includes all game and non-game wildlife and should not be limited to the browse species listed in the Timber/Forage/Wildlife section. In other words, fruit producing and den trees also are to be considered. Trees should be left if they are above average in wildlife food or den potential. The species and its condition should be considered, remembering that optimum pine production is desired. In forest management, leaving all high value wildlife species is impractical because pine production would be sacrificed. The species and its condition must be considered because species alone will not always make a tree valuable for wildlife. For example, oaks are generally considered to be high value food trees; but if a small oak is suppressed and has not developed a large full crown, it may be of less value to wildlife than a large healthy pine. Usually, leaving 10% to 20% of the total area of the forest in high value wildlife trees in scattered groups or along streams will result in a high level of wildlife habitat and pine timber production. Control of undesirable plants will be described below.

Environmental Concerns

Whenever TSI is planned for a stand, consideration must be given to environmental concerns such as erosion and pollution. Sensitive areas such as those along streams, rivers, gullies, etc. should be protected and exempt from TSI. Generally, a strip called a stream-side management zone (SMZ) is retained in its natural condition along or around sensitive areas. These SMZs help filter and trap sediments before they reach the stream. They also protect the sensitive area from erosion or bank caving. If chemicals are used in TSI, the label instructions concerning their use near water must be followed.

Methods of Cull Tree Removal/TSI

The choice of control methods is dependent upon the landowner's objectives, the size of the tree to be controlled and market conditions. Although there are many alternatives available, four will be used in this event. These are:

1. Leave (The tree should be left in the stand)
2. Cut (Harvest and sell the tree)
3. Deaden the tree with the use of chemicals
4. Deaden the tree with the use of chemicals and/or fire (prescribed burning)

Criteria for Choosing the Best Method

As stated above, choosing the best method depends on the objectives and desires of the landowner, the size of the tree to be controlled and the available markets in the area. The criteria students should use when choosing one of the four alternative methods are described below.

1. Leave - A hardwood tree should be left if wildlife is a secondary objective and if the tree has high potential as a food or den tree as described above. Another reason to leave a hardwood is if it presents no real competition to pine such as dogwood, redbud, sumac, rusty blackhaw, and sparkleberry.

2. Cut - Often low grade or undesirable species of hardwood can be sold. This approach should be considered with the assistance of a forester before TSI work is started. Although there are several, varied markets for hardwoods in East Texas, only two will be considered in this event. These are sawlogs and pulpwood. The requirements for each are:

Sawlogs - The most common market for hardwood saw timber is cross-ties and pallet material. In order for a hardwood to be sold for cross-ties, it must be at least 14 inches DBH and have a merchantable height of one log. Treatment of the stump with chemicals may be needed to prevent resprouting.

Pulpwood - The minimum DBH is 6 inches for hardwoods sold as pulpwood. The tree should have the equivalent of at least one log (16 feet) length of merchantable trunk (free of large or heavy limbs and forks) and a minimum top diameter of 4 inches. Treatment of the stump may be needed after cutting to prevent resprouting.

In this event, students will be provided with information about the available markets, if any, for hardwoods.

3. Deaden with chemicals - Trees larger than 3 inches DBH can resprout after cutting but cannot be adequately controlled by prescribed burning. Therefore the use of chemicals (herbicides) is needed for control. Application of chemicals is described below.

4. Deaden with chemicals and/or fire - Trees smaller than 3 inches DBH will readily resprout, but they are small enough to be controlled by prescribed burning. Therefore both fire and the use of chemicals are effective methods of controlling smaller hardwoods (less than 3 inches DBH). Prescribed burning is described below.

Description of Methods

Chemicals, or herbicides, can be used in several different ways in the forest. Herbicides make up a group of pesticides used for the control of vegetation. These herbicides are either sprayed on the foliage, absorbed by the roots, or are injected directly into the trunk. They may work by interfering with the photosynthesis process of the tree, producing abnormal growth, or by blocking normal growth processes.

Herbicides can be applied in several different ways. These include aerial spraying, aerial application of granules, mist blowing, injecting and spot applications of soil activated chemicals. Although all these methods have been used, the most common method used is injection.

Tree injection is commonly used to control hardwoods with stems larger than 2 inches DBH. The usual methods of application employ a tubular tree injector, or Hypo-Hatchet, or the hack 'n squirt method. A tree injector is a self-contained unit using a chisel type blade at the end of a tubular pipe that cuts through the tree bark (Figure 10A). A measured amount of chemical is then released into the cut. The Hypo-Hatchet consists of a hatchet that has a

chemical delivery system connected to a container carried on the belt (Figure 10B). When the hatchet strikes a tree the blade penetrates the sapwood and injects a measured amount of herbicide into the cut. The hack 'n' squirt method requires no special equipment. It involves using a hatchet to cut into the sapwood; the squirt bottle is then used to apply the herbicide into the cut. In all three methods of injection, the number of cuts per tree depends on the herbicides used and the species being controlled. Herbicide labels provide this information and must always be followed for safe and successful application.

Spot application of soil activated herbicides involves the use of a special spot gun that delivers a measured amount of chemical (Figure 10C). The herbicide is spotted on the soil surface in a grid pattern through the woods. The amount of chemical needed depends on the soil surface and the species to be controlled. Again, label instructions must be followed.

Prescribed burning is defined as fire applied in a skillful manner under exacting weather conditions in a definite place for a specific purpose to achieve certain results. Important factors that must be considered whenever a prescribed burn is planned and applied include wind velocity, relative humidity, temperature, rainfall, moisture content of the fuel, and the type and amount of fuel. Although one of the benefits of prescribed burning is managing understory hardwoods, there are other benefits such as reducing wildfire hazards by reducing the fuel on the ground, improving the wildlife habitat by causing browse species to resprout; and, in this way be more accessible for use; and improving accessibility to the site. Prescribed burns are usually done in the winter when the temperature is fairly low, when wind speeds are between 2 to 10 mph and constant, and the relative humidity is between 30 to 50 percent. Because of the exacting factors needed and the potential dangers associated with fire, trained personnel should always be consulted before attempting any kind of prescribed burn.

Harvesting undesirable hardwoods for pulpwood and firewood has grown into viable option during the past few years. The decision to use this option should take into consideration the volume that can be cut (is it large enough to attract buyers), local market needs, and the potential for damage to the trees not cut.

Glossary of Terms -

Cull Hardwoods - Hardwood trees that have no value either commercially, aesthetically or for wildlife. They normally compete with desirable species for space, sunlight, nutrients and moisture.

Shade Tolerance - A measure of a plant's ability to grow and reproduce under the shade of an overhead canopy.

Succession - An orderly process of development that involves changes in species with time.

Timber Stand Improvement (TSI) - A forestry practice that involves control of some vegetation in order to favor another.

Woodland Clinic Example

In this event, five hardwood trees will be tagged with letters from "A" through "E." The landowner's objectives and available hardwood markets will be posted. The students will determine the best method (if any) for removing each tagged tree. The coded number from the question sheet that corresponds with the chosen method will be placed in the appropriate block on the answer sheet. Only hardwood species are to be considered for this event (no pines). For example, an 8-inch DBH post oak is tagged with the letter "A." The landowner has an objective of maximum fiber production from pine and there is a market for hardwood pulpwood. The student would place the number "2" in the block for "A." See figure below.

10. Cull tree Removal/TSI

A	B	C	D	E
2				

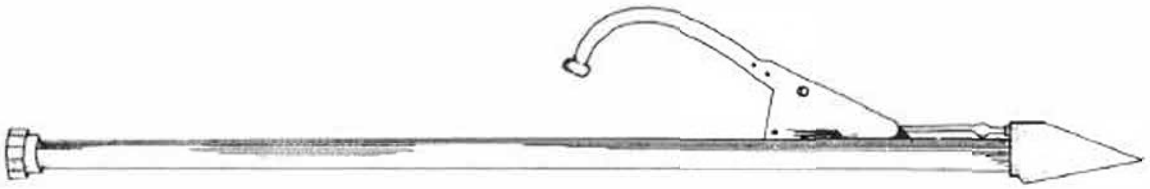


Fig. 10A – Injector

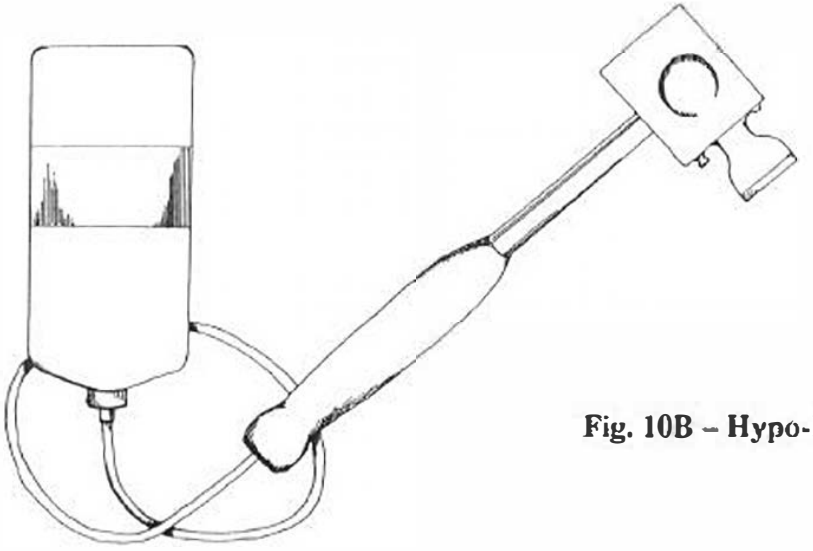


Fig. 10B – Hypo-Hatchet

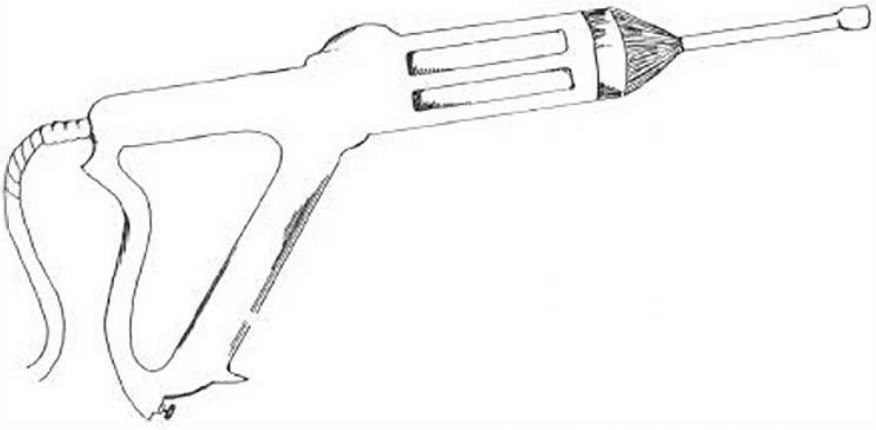


Fig. 10C – Spot Gun

PINE REGENERATION

Outline:

A. Purpose of pine regeneration
B. Types of regeneration areas
C. Landowner objectives in relation to regeneration
D. Methods of regeneration
E. Guidelines for regeneration
F. Glossary of terms
G. Woodland Clinic Example

Student Skills:

A. Explain the purpose of pine regeneration
B. Explain methods and guidelines for regeneration
C. Correctly choose the appropriate method based upon guidelines

Materials Needed:

A. Areas for study that have forest situations similar to those stated below

Purpose of Pine Regeneration

Southern pines represent a large economic market in East Texas. To take advantage of this market and to preserve a forest or stand in perpetuity, regeneration must be understood. Each year thousands of acres of private non-industrial lands are harvested with no consideration of re-establishing the pine forest. Due to this, the harvesting of pine forests has exceeded the growth rate. Regeneration should be achieved on a site and stand characteristics must be considered to determine the appropriate method of regeneration.

Types of Areas

There are any number of scenarios in which a landowner might want to regenerate his land. The Woodland Clinic will focus on four types of areas.

1. Open field or pasture
2. Cutover stand
3. Hardwood stands
4. Old, mature, or decadent stands or low quality mixed pine/hardwood stands

Landowner Objectives and Site Conditions in Relation to Regeneration

Landowner objectives play a large role in determining what method of regeneration will be chosen. These objectives can range from desire for wildlife and/or aesthetics to maximum timber production. In addition, limited financial resources may be a concern that affects the owners choice of regeneration methods.

Site conditions can include the potential productivity of the site and possible future use of the land. However for the Woodland Clinic, the potential for excessive erosion will be the only site condition to be considered.

The landowner's objectives and concerns as well as the site condition will be provided to the students.

Methods of Regeneration

There are two important parts in successfully regenerating a stand. These are

1) preparing the site and 2)establishing the new growing stock. Site preparation generally involves: controlling vegetation that will be in competition with the new growing stock; preparing the land for the "seed catch" in natural reseeding efforts by exposing mineral soil ; removing undesirable trees; if the site is to be regenerated, by planting seedling; and, removing obstacles such as logging slash to make planting easier. There are several methods available to achieve these goals including:

Harvesting and logging the existing trees
Chemically controlling undesirable vegetation with herbicides
Mechanical means such as mowing, shearing, dozing, etc.
Prescribed burning

For the woodland clinic, the students will need to recognize that control of herbaceous weeds and /or trees and brush is or is not needed. They will not be required to identify a specific site preparation method.

Establishing the next generation of growing stock involves either relying on natural reseeding or actually planting young seedlings. When regeneration by natural reseeding, the landowner is depending on the residual trees in or near the stand to produce enough seed and disburse it to regenerate the area naturally. In this method, there is no associated cost. However, there must be sufficient seed source. Silvicultural methods that can be used for natural regeneration are explained in the Forest Management section at the front of this manual. In the woodland clinic, the student need only recognize the need for natural reseeding and not the specific silvicultural method.

Planting is the other method of establishment. Planting can be done either mechanically or by hand. When regenerating by planting, the landowner purchases seedlings and hires crews of planters. This method is obviously more expensive than natural reseeding. However it does give the landowner the opportunity to use genetically improved trees, control the spacing of the new stand, and choose the species he intends to manage. This is not possible with natural reseeding. For the clinic, the student must only recognize the need or opportunity for planting, and not which method of planting to use.

Guidelines for Regeneration

The following options will be considered:

Site Preparation Method	Establishment Method
Herbaceous Weed Control	Plant Seedlings
Control hardwood brush &/or trees	Natural Reseeding
Selectively harvest pines for reseeding	
Harvest all trees	

Combinations of any of these methods may be possible. See Table 11A.

Description of Methods

Site Preparation Methods:

Herbaceous weed control - Grasses, weeds, vines and forbs can provide severe competition to pine seedlings, especially during the first growing season. They can draw moisture and nutrients from the young pines and may grow over the seedlings. Control can include mowing of burning, but these methods do not kill the vegetation.

Mechanical measures such as disking and scalping are not recommended because the organic matter on the surface of the soil is very important to the seedlings. The use of chemicals is becoming more popular for the control of herbaceous cover. Herbicides are available for use before and after planting. Killing vegetation with herbicides before planting allows for a broader selection of chemicals. But there are several herbicides available that can be sprayed over the top of pine that will kill the unwanted vegetation while not harming the seedlings.

Harvest all trees - Often times stands may not be manageable in their present condition or the landowner chooses not to manage the existing stand. The decision is then made to start the stand from scratch. Before seedlings can be established the existing stand must be removed. Markets for pine and hardwoods have become profitable enough to remove almost all of the trees from a stand. However some control of hardwood brush and/or trees may become needed in addition to this harvest.

Control hardwood brush and/or trees - As is explained in Question 10 cull tree removal/TSI, young pines require full sunlight for development. Controlling brush and trees, therefore, becomes very important in re-establishing pines on cutover lands, former hardwood stands of low quality mixed pine/hardwood stands. The methods described in Question 10 are applicable in site prep. These include cutting, use of herbicides (including aerial applications), prescribed burning, and harvesting. In addition to these, mechanical methods are available. These include dozing and windrowing, roller chopping and shearing. Dozing and windrowing is used very infrequently due to its high cost and to the disturbance it causes to the site. Roller chopping is generally confined to brush and small trees, and is equipped with a special saw-like blade projecting from the pushing blade. It "cuts" the trees and leaves them in place. As with chopping, burning is a usual follow-up to the method.

Selectively harvest pines for reseeding - When suitable and sufficient numbers of pines are available to serve as a seed source for natural reseeding, any of the regeneration harvesting methods described in the Forest Management section of this manual can be used. These methods include seed tree, shelterwood, and clearcutting harvest methods.

Establishment Methods:

Plant seedlings - Pine seedlings are started in nurseries in the spring preceding the planting season, which is during the winter months. They are "lifted" from the nursery beds, bagged and either shipped to the site or available for pick-up. They must be kept cool until they are planted and should not be stored on the site for very long. Pine seedlings can be planted either by hand or mechanically. In either case only quality seedlings should be used and planting must be done correctly. Seedlings should be planted 1 to 2 inches deeper than they grew in the nursery, and the roots must be straight and untangled. The soil must be firmly packed around the roots. The number of seedlings planted per acre depends on the spacing used. Generally between 545 (8' x 10' spacing) to 726 (6' x 10' spacing) seedlings per acre are planted.

Natural reseeding - Natural reseeding as a result of using one of the regeneration harvesting methods described earlier in the book can be successfully used to re-establish a stand.

Glossary of Terms

Cut-over lands - Stands that have had all the merchantable timber harvested.
Natural reseeding - Re-establishing a stand of trees by relying on natural reseeding of the area.
Regeneration - Re-establishing a forest either by planting or seeding an area where forest vegetation has been removed.
Site preparation - Preparing an area of land for planting or seeding by mechanical or chemical means.
Seed source - Trees of a desirable species either on or near the area to be regenerated that will serve as the source of seed for natural reseeding.

Woodland Clinic Example

Students will examine a site and will determine the best methods for site preparation and securing pine establishment based upon stated landowner objectives and site concerns. An area will be flagged, and contestants will be asked to choose the best regeneration management system. Information will be given on assumption cards that will state the landowner's objectives, the stand's conditions, and the site's conditions. The contestant will select out of the following choices:

I. Regeneration is needed:
   A. Prepare site by: (more than one answer may be chosen)
      1. Control herbaceous weeds
      2. Harvest all marketable trees
      3. Control hardwood brush &/or trees
      4. Selectively harvest pines for reseeding
   B. Establish seedlings by:
      1. Natural reseeding
      2. Plant seedling

For example, a stand of low quality mixed pine and hardwoods is flagged. The student is informed that the landowner is not concerned about esthetics or wildlife but is financially limited to what he can do. Potentially, the site is not likely to erode.

The student would select: "Selectively harvest pines for reseeding" and "control hardwood brush &/or trees" for his site prep methods and "natural reseeding" for his establishment method. See figure below.

II. Pine Regeneration

Site Preparation:	Establishment Methods
____ Control herbaceous weed	__X__ Natural reseeding
____ Harvest all trees	____ Plant Pines
__X__ Control hardwood brush &/or trees	
__X__ Selectively harvest pines for reseeding	

Table 11A - Regeneration Methods Guidelines

Situation/Scenario	Site Prep Method	Establishment Method
1. Open field or pasture	Herbaceous weed control	Plant seedlings
2. **Cutover stand**		
2A. With heavy grass, weed and/or vine cover	Control hardwood brush and/or trees Plus Herbaceous weed control	Plant seedlings
2B. Without heavy grass, weed and/or vine cover	Control hardwood brush and/or trees	Plant seedlings
3. **Hardwood stand**	Control hardwood brush and/or trees	Plant seedlings
4. **Low quality mixed pine/hardwood or Mature pine stands**		
4A. With erosion, wildlife, esthetics or limited financial resources concerns	Selectively harvest pines for reseeding Plus Control hardwood brush and/or trees	Natural reseeding
4B. Without any of the above concerns	Harvest all trees Plus Control hardwood brush and/or trees	Plant seedlings

SITE MANAGEMENT CONCERNS

Outline:

A. Purpose of recognizing management concerns
B. How students can recognize site factors that affect management operations
C. Description of management concerns
D. Soil Surveys
E. Glossary of terms
F. Woodland Clinic example

Student Skills:

A. Recognize site factors such as soil texture, slope, wetness, and shallow rooting depth that affect planned silvicultural operations
B. Understand how these factors relate to management concerns such as erosion hazard, seedling mortality, and equipment limitations
C. Understand the management implications of these concerns

Materials Needed:

A. Field locations that can be visited and have different site factors for study
B. A published soil survey of the county or nearby county

Purpose of Recognizing Site Factors That Affect Management Operations

A site is an area that has common climatic conditions and soil types. Different sites have unique factors which influence their management for the production of wood. These factors indicate the site's limitations and the management hazards that may be encountered. For example, sites with steep slopes or excessive wetness will have limitations for equipment use. A steep site may require specialized equipment for planting and logging operations. Equipment operation on excessively wet sites may have to be restricted to periods when the site is dry. Other factors that may also affect management are the texture of the soil and any restriction to the rooting depth of the trees. Therefore, any planning of silvicultural practices on a site must take into consideration these and other factors as they can have a real impact on the success of the management of the site.

How Students Can Recognize Site Factors that Affect Management Operations

There are four basic factors students will need to identify that have an effect on planned silvicultural operations. These are (1) soil texture, (2) restriction to rooting depth,(3) excessive wetness, and (4) an excessively steep slope. Characteristics to look for in each of these factors are listed below:

Soil Texture (excessively sandy or clayey)

Sandy Soils - Sandy soils feel gritty when rubbed between the fingers and will not ribbon when pinched. If a sandy surface layer is more than 20 inches thick, soil texture (sandy) will be a site factor for consideration

Clayey soils - Clayey soils, when moist, will form a ribbon of soil that extends for more than an inch when pressed between the thumb and index finger. They tend to form hard clods when dry and are sticky when wet. If a clayey layer occurs less than 10 inches below the surface, soil texture (clayey) again is a site factor that must be considered.

Soil texture may be important if the sandy layer is thicker than 20 inches or clay is less than 10 inches from the surface. On the other hand, it may not be a site factor if: (1) the texture is neither excessively sandy or clayey, such as loamy soils, (2) the depth of the sand is less than 20 inches, or (3) the clay layer is greater than 10 inches from the soil surface.

Restricted Rooting Depth

Rooting depth can be restricted by any impervious layer that prohibits root growth and development. This restriction may be due to rock, a high water table or a very dense layer of clay found within 10 inches of the soil surface. If any of these occur, restricted rooting depth will be a site factor that needs consideration. If, on the other hand, no such restrictive layer occurs, it is not a concern.

Excessive Wetness

Excessive wetness may be caused by frequent flooding, a high water table, or poor drainage. Usually the soils on such a site are gray within the top 30 inches of the profile. The site may occur on a river bottom or a poorly drained depression area. Information on flooding frequency, water tables and drainage, along with the site's location on the landscape (such as bottomland, upland, or depression) will be provided to the students in this event. If excessive wetness occurs on the site, this is a site factor for consideration. If, on the other hand, excessive wetness does not occur, it is not considered.

Excessively Steep Slopes

Although the slope's effect on management operations may vary according to soil texture, rockiness, etc., an excessively steep slope for this event will be defined as any slope greater than 15%. Students will need to be able to visually distinguish between slopes greater than 15% and those less than 15%. When appropriate, slope stakes will be used at the site. If the slope at the site should exceed 15%, excessive steep slopes will be a site factor that must be considered.

Relating Site Factors to Management Concerns

If any of the above site factors are recognized on the site, they must then be related to their effects on management operations. For this event, three management concerns will be addressed. These are: (1) erosion hazards, (2) seedling mortality, and (3) equipment limitations. These concerns will be described later. If none of the above site factors are recognized on the site, the site has none of the three management concerns that need to be addressed. How the site factors and the management concerns are related is shown in the table below.

Table 12A. Management concerns as related to site factors.

Management concern	Soil texture	Restricted rooting depth	Excessive wetness	Excessive slopes
Erosion hazard				X
Seedling mortality	X	X	X	
Equipment limitations	X	X	X	X

For any of the management concerns to apply to the site, only one of the site factors has to be present. For example, if the only site factor to be recognized on the site is excessive slope, then both the erosion hazard and equipment limitations are management concerns that need consideration, but not seedling mortality. If, however, soil texture is recognized to be a site factor either because the sand is deeper than 20 inches or a clay layer is shallower than 10 inches, then seedling mortality and equipment limitations are concerns and erosion is not.

Description of Management Concerns

A site may have more than one management concern based on soil and other factors. The following is a detailed look at each of the three concerns above.

Erosion Hazard

1. *Definition* - Erosion hazard is the probability that damage may occur as a result of site preparation and following cutting operations where the soil is exposed along roads, skid trails, firebreaks and log handling areas. Forests that are abused by fire or overgrazing are also subject to erosion.
2. *Management Implications* - There may be a need for special road, trail, firebreak, and landing construction and maintenance, specialized equipment, and specialized operations such as hand planting, cross-slope operation or skidding uphill.
3. *Factors Causing Erosion Hazard* - Erosion hazard can be predicted from factors such as slope length and percent slope. It becomes more severe as slopes increase in steepness and length.

Seedling Mortality

1. *Definition* - Seedling mortality refers to the probability of the death of naturally occurring or planted tree seedlings, as influenced by kinds of soil or topographic conditions.
2. *Management Implications* - To offset this hazard, it may be necessary to use special planting stock that is larger than usual, containerized or is genetically selected for the site factors that affect mortality (such as drought hardy loblolly pine seedlings). Special site preparation such as bedding, furrowing or surface drainage may be needed. Replanting may be needed to replace mortality loss.
3. *Factors Causing Seedling Mortality* - Seedling mortality is caused mainly by too much or too little water. Too much water is caused by high water tables, flooding during a significant part of the growing season, or poor soil drainage. Too little water is caused by several factors: a lack of rainfall at the right time, low water holding capacity of the soil, shallow rooting depth, high evaporation, or a combination of these factors.

Equipment Limitations

1. *Definition* - Equipment limitations are restrictions on the use of equipment either year round or seasonally, as a result of soil and site characteristics.
2. *Management Implications* - Restrictions on equipment use indicates the need for the right equipment to be chosen and the need for proper timing of operations to avoid seasonal limitations. The more severe the limitation, generally the more costly are harvesting and cultural operations. There may also be the need for altering the method of an operation. For example, machine planting of seedlings may have to be changed to hand planting.
3. *Factors Causing Equipment Limitations* - Several soil and topographic factors affect equipment use. The most obvious is slope. Soil textures may also have an effect at the extremes. Loose sands and clays present problems. Wetness is another limiting factor which is more severely limiting when in combination with clayey soils. Rockiness or stoniness limit the use of most equipment, particularly mechanized tree planters.

There are two other concerns that may enter into a silvicultural management plan. These are windthrow, or the likelihood of trees being blown over due to shallow rooting and plant competition to the desirable seedlings by undesirable vegetation such as grass, brush, vines, etc. Because these are either uncommon in East Texas or require a site by site determination, they have not been included in this event.

Soil Surveys

Because these management concerns are so important to the successful management of a forest, a forest manager must have this information available to him for all the soils on the site. A reliable source of this information is the published Soil Survey for the county or counties in which the site is located. A soil survey is a collection of soil maps and soil descriptions, including potential productivity and limitations for that county. It contains a table for forest management that includes each soil's site index, management concerns, commonly found trees and a list of trees best suited for management (Table 12B). In addition, many times site factors are not as obvious as it may seem from this event and can only be recognized by trained soil scientists and foresters. Soil Surveys are available from local NRCS offices.

Glossary of Terms -

Equipment Limitations - Restrictions on the use of equipment either year round or seasonally as a result of soil or site characteristics.
Erosion Hazard -The probability that damage may occur when soil is exposed long roads, skid trails, firebreaks, and log handling areas.
Loamy Soils - A loose soil of mixed clay, sand, and silt.
Plant Competition - The likelihood of the invasion of undesirable species when openings are made in the canopy.
Seedling Mortality - The probability of death of naturally occurring or planted tree seedlings, as influenced by kinds of soil or topographic conditions.
Silviculture - The theory and practice of managing forest establishment, composition and growth.
Windthrow - The likelihood of trees being uprooted by the wind as a result of insufficient depth of soil to give adequate root anchorage.

Woodland Clinic Example

In this event, the student will be required to identify the management concern(s) affecting a designated site. For the purpose of this activity, only three management concerns will be considered: erosion hazard, seedling mortality and equipment limitations. A hole will be provided for the student to determine soil factors such as texture, rooting depth, etc. Information will be provided on factors relating to wetness, such as position of the site on the landscape, drainage, flooding, etc. When appropriate, slope stakes will be set 100 feet apart for the determination of slope. The student will circle the management concern(s) that apply to the site. If none of the site factors are found on the site, the student will circle "None." For example, the student determines that excessive wetness is the only site factor that characterizes the site because the site is described as being on a frequently flooded bottomland, he or she will circle "Seedling mortality" and "Equipment limitation" on the answer sheet. See figure below.

12. Site Management Concerns

Erosion hazard | (Seedling mortality) | (Equipment limitations) | None

Table 12B - Woodland Management and Productivity.

Soil name and map symbol	Woodland suitability group	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
2---------- Alto	3o7	Slight	Slight	Slight	Slight	loblolly pine shortleaf pine southern red oak	80 70 70	loblolly pine slash pine
3,4---------- Alto	4c2	Slight	Moderate	Moderate	Slight	loblolly pine shortleaf pine	70 60	loblolly pine slash pine
6,7---------- Attoyac	2o7	Slight	Slight	Slight	Slight	loblolly pine shortleaf pine sweetgum southern red oak	90 80 90 80	loblolly pine slash pine American sycamore black walnut
9---------- Bernaldo	2o7	Slight	Slight	Slight	Slight	loblolly pine shortleaf pine sweetgum southern red oak	90 80 -- --	loblolly pine slash pine sweetgum
10---------- Bernaldo	2o7	Slight	Slight	Slight	Slight	loblolly pine shortleaf pine sweetgum southern red oak	90 80 -- --	loblolly pine slash pine sweetgum
Besner--------	2o7	Slight	Slight	Slight	Slight	loblolly pine shortleaf pine sweetgum southern red oak	90 80 -- --	loblolly pine slash pine sweetgum
11---------- Betis	4s3	Slight	Moderate	Severe	Slight	loblolly pine shortleaf pine	63 70	loblolly pine slash pine
12---------- Bienville	3s2	Slight	Moderate	Moderate	Slight	loblolly pine shortleaf pine	80 70	loblolly pine slash pine
13---------- Bowie	3o1	Slight	Slight	Slight	Slight	loblolly pine shortleaf pine	83 74	loblolly pine slash pine shortleaf pine
14---------- Briley	3s2	Slight	Slight	Moderate	Moderate	loblolly pine shortleaf pine slash pine	80 70 --	loblolly pine slash pine
15---------- Chireno	4c2	Slight	Moderate	Moderate	Moderate	loblolly pine shortleaf pine	75 65	loblolly pine
16---------- Cuthbert	4c2	Moderate	Slight	Slight	Slight	loblolly pine shortleaf pine	70 60	loblolly pine shortleaf pine
17,18---------- Cuthbert	4r2	Moderate	Moderate	Slight	Moderate	loblolly pine shortleaf pine	70 60	loblolly pine shortleaf pine
19, 20---------- Darco	4s3	Slight	Moderate	Severe	Moderate	loblolly pine shortleaf pine	70 65	loblolly pine shortleaf pine
23,24---------- Etoile	4c2	Slight	Moderate	Slight	Moderate	loblolly pine shortleaf pine	65 74	loblolly pine slash pine
25---------- Hannahatchee	1o7	Slight	Slight	Slight	Slight	loblolly pine sweetgum southern red oak white oak	110 100 90 --	loblolly pine sweetgum American sycamore black walnut

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicated that information was not available. Site index was calculated at 30 years for eastern cottonwood, at 35 years for American sycamore, and at 50 years for all other species.)

COMPASS AND PACING

Outline:

A. Purpose of compass and pacing
B. How the skill is done
C. How a compass works
D. Using a compass
E. Determining distances by pacing
F. Glossary of terms
G. References
H. Woodland Clinic example

Student Skills

A. Explain how a compass works
B. Use a compass to find direction
C. Understand the difference between azimuths and bearings
D. Know their pace distance
E. Understand the length of a chain

Materials Needed:

A. Compass
B. 100 foot tape
C. Location for practice
D. Description of practice courses

Purpose of Compass and Pacing

A basic understanding of the elements of surveying is essential to foresters to determine the boundaries of a tract and/or set up cruise lines through the tract to make a timber inventory. Although foresters would rarely have to be responsible for original boundary lines, they may have to retrace old lines, find boundary corners and determine land areas. Often times, this information is recorded on surveyor's notes, but the actual boundaries on the land are not well marked. The forester then must follow the notes to re-establish and mark the boundary lines and corners. Once the tract boundaries are established, a method of inventorying the timber must be developed. Most often, a series of lines are established with enough sample points along the lines to give the percentage of inventory needed. These lines and plots are drawn on a map, the directions and distances calculated, and the forester must then interpret these calculations into locations on the land. To adequately perform these tasks, the forester should know how to pace and read a compass.

How a Compass Works

The Earth acts as a huge magnet, and as such, has two opposing poles; a North Pole and a South Pole. Although these poles do not exactly correspond with the true north and south poles, they do provide reliable points for determining direction. The basic part of a compass is either a magnetized needle or dial on a pivot point that points toward the northern magnetic pole (when it is in the northern hemisphere). This needle or dial is enclosed in a circular housing that has been graduated in degrees. There are 360 degrees in a circle, and north is designated as 0 or 360. If there is some form of sighting device attached to the compass housing, it is possible to determine the angle between the line of sight and north. Because magnetic and true north are not the same, correction factors are made in surveying to compensate for this difference. This difference is called magnetic

declination and, in East Texas, the declination is about 4 to 5 degrees east. It is important to remember that for the Woodland Clinic, magnetic declination will not be considered.

There are two general types of compasses. In the first, a magnetized needle is free to spin inside the housing. Generally there is a printed arrow inside the graduated housing. The housing is free to turn to align any desired calibration on the housing with a direction of travel marker. The entire compass is then rotated until the magnetized needle matches the printed arrow inside the housing. The line of travel marker is then pointed towards the desired direction. Some compasses may have sights or mirrors to improve precision.

Another type of compass has a free spinning dial instead of a needle. With these the entire compass is moved until the desired direction aligns with a direction of travel mark or sight. These also may have sights to help improve precision.

The angle between the direction of travel or line of sight and the north magnetic pole can be expressed as either azimuths or bearings. Azimuths are the clockwise angles measured from north. They are measured in degrees from 0 to 360. North is either 0 degrees or 360 degrees, east is 90 degrees, south is 180 degrees, and west is 270 degrees. Bearings, on the other hand are the number of degrees a direction is measured east or west from the north-south line. They are measured from the north and south to either the east or west, dividing the compass into quarters of 90 degrees each. The way in which azimuths and bearings corresponds can be see in the following table.

Table 13A. Relationship between azimuths and bearing based on compass direction.

Direction	Azimuth (in degrees)	Bearing
North	0 or 360°	North
Northeast	45°	N45E
East	90°	East or N90E or S90E
Southeast	135°	S45E
South	180°	South
Southwest	225°	S45W
West	270°	West or N90W or S90W
Northwest	315°	N45W

Because compasses may measure in azimuths or bearings (quadrant compasses), directions in both azimuths and bearings will be provided to the students. They will not have to convert from one to the other.

Using a Compass

Hand compasses vary in construction, and the directions that come with the compass should be followed. To use any compass successfully requires simultaneous sighting, leveling and reading of bearing or azimuth. The desired line of travel is set by either of the methods described above in "How a Compass Works." The compass should be held in both hands, with elbows supported against the body. It must be far enough from the body to avoid the magnetism of knives, keys, etc. Allow the compass dial or needle to settle, but do not delay the reading too long. Either determine the line of travel by looking across the compass dial and looking straight up, or by use of sights attached to the compass. In either case, find a landmark to walk toward. Students should never try to walk and keep the compass aligned at the same time. Once the landmark is reached, repeat the process.

Determining Distances by Pacing

Pacing is the least precise method of determining distances in the field. Nevertheless, the ability to pace is an obvious asset because measuring with a tape requires too much time and often is too precise for most forestry work. With practice and frequent

measured checks, students can attain a high level of accuracy. The pace is the length of two natural steps. In other words, a pace is counted every time the same foot touches the ground. A natural walking gait should always be used. Students should not try to artificially stride 3 feet per step because a natural pace can best be maintained over rough terrain or through thick brush.

A student's pace should be measured in both feet and chains. A chain is 66 feet in length. Chains are popularly used because areas measured in chains can easily be converted into acres (10 square chains = 1 acre). Students will need to know their pace in feet for measuring tree heights in Question 7 (Site Index and Productivity), and for determining distances in Question 9 (Selective Thinning by D+6). On the other hand, cruiser and Biltmore sticks are calibrated to read the number of logs in a tree from one chain away. In the Compass and Pacing event, distances will be given in both feet and chains. No conversion from one system to another will be needed.

In learning to pace, a practice course of either a chain or 100 feet should be measured on typical terrain and cover. At a minimum, the students should pace both directions and average their paces.

Glossary of Terms

Azimuth - An angle measured clockwise from north.
Bearing - An angle measured east or west from the north-south line.
Chain - A unit of distance equal to 66 feet.
Cruise - The act of inventorying a forest resource according to a planned method.
Declination - The angle between true north and magnetic north at any given place.
Magnetic North - The direction at which the needle of a compass points which differs from true north.
Pace - The length in two natural steps.
Quadrant Compass - A compass that measures bearings.
True North - The line or direction to the north pole, which differs from the direction toward the magnetic north pole.

References

The Boy Scout Handbook

Woodland Clinic Example

In this event, students will travel a compass course that will be set up of three stakes of unknown distance (between 50 and 200 feet) with a change in direction between the first and second leg. Students will determine the azimuth and distance between the first and second stakes, make the turn at the second stake and determine the azimuth and distance between the second and third stakes. The student must give the correct azimuth and correct distance. Scoring will be as follow:

i. Azimuth
   a) full credit for the correct azimuth within 3 degrees either way - 4 points (2 points per leg)
   b) half credit for the azimuth 4-5 degrees either way - 2 points (1 point per leg)

ii. Distance
   a) full credit for the correct distance within 5% either way - 6 points (3 points per leg)
   b) partial credit for distance between 5 - 10% either way - 4 points (2 points per leg)

Student Activity 1

COMPASS

Bearings are the number of degrees a direction is measured east or west of a north-south line.
For example line Oa is given the bearing of N25°E because it is a line 25 degrees east of the north-south line.

Azimuths are the clockwise angles measured from North. They range from 0° to 360°.
For example line Oc is given the azimuth of 220 because it is 220 degrees from North. This is found by adding the 40 degrees that the line is west of South to the azimuth of South (180 degrees). Thus 40 + 180 = 220.

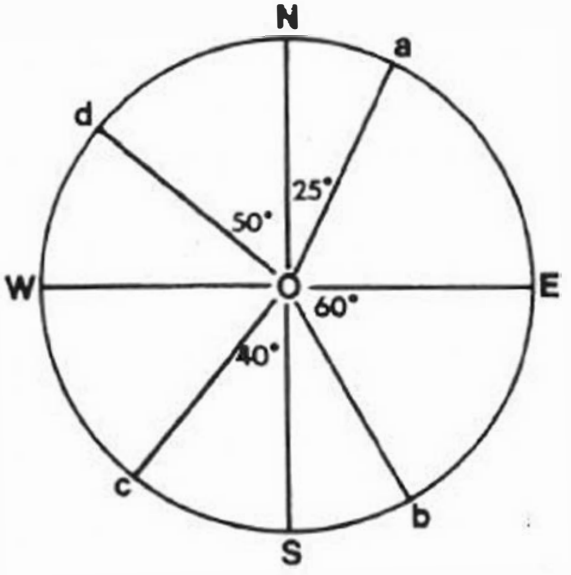


Figure 13 A. Directional Compass

Find the Bearing and Azimuth for

line Oa _____ _____

line Ob _____ _____

line OS _____ _____

line Oc _____ _____

line OW _____ _____

line Od _____ _____

Student Activity 2

COMPASS AND PACING PRACTICE

The compass and pacing part of the State Woodland Clinic will consist of two distances and one turn. The following practice problems consist of three distances and two turns. This is more than the state contest and local contests but can be helpful in training because it is easily set up. Set up a starting point, and if the course is run correctly, the student will finish at the starting point.

Course 1	1 - N45°E	(45°)	99 feet (1.5 chains)
	2 - N75°W	(285°)	99 feet (1.5 chains)
	3 - S15°E	(165°)	99 feet (1.5 chains)
Course 2	1 - S30°W	(210°)	132 feet (2 chains)
	2 - N30°W	(330°)	132 feet (2 chains)
	3 - East		132 feet (2 chains)
Course 3	1 - S50°E	(130°)	99 feet (1.5 chains)
	2 - N10°E	(10°)	99 feet (1.5 chains)
	3 - S70°W	(250°)	99 feet (1.5 chains)
Course 4	1 - N60°W	(300°)	132 feet (2 chains)
	2 - South		132 feet (2 chains)
	3 - N60°E	(60°)	132 feet (2 chains)
Course 5	1 - West		132 feet (2 chains)
	2 - S30°E	(150°)	132 feet (2 chains)
	3 - N30°E	(30°)	132 feet (2 chains)

It is suggested that a short pacing course be set up also because an error in pacing can lead to incorrect direction of travel for each leg that follows.