Forestry CD Activity Guide

Mid-Atlantic Forestry Education Project

Forestry CD
Activity Guide

Acknowledgments:
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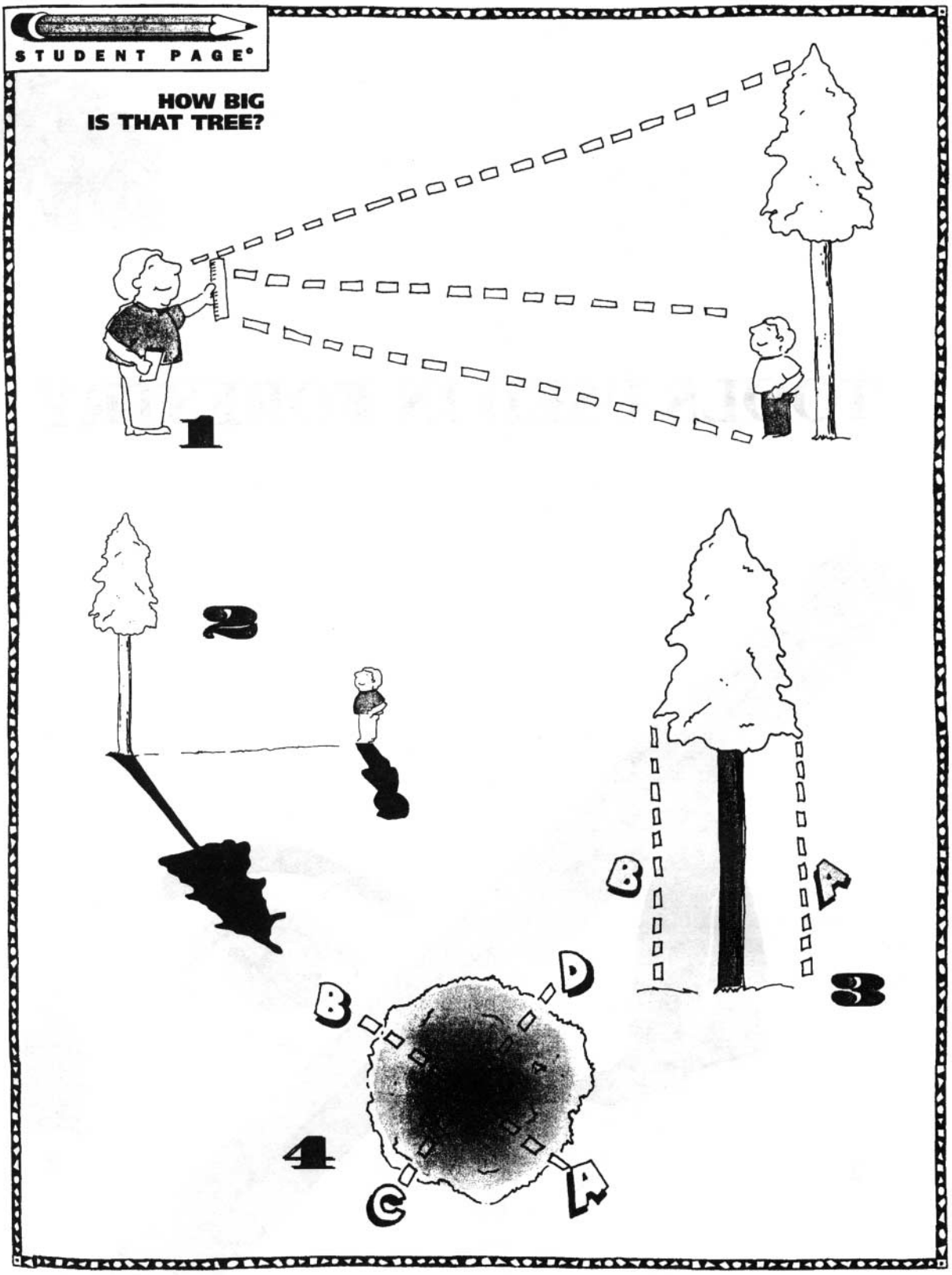


Source: Project Learning Tree K-8 Activity Guide: page 243

TOOLS USED IN FORESTRY

Biltmore stick – Clinometer – Diameter Tape – Increment Borer – Wedge Prism

Throughout history, the need for measurement has been a necessity for each civilization. In commerce, trade, and other contacts between societies, the need for a common frame of reference became essential to bring harmony to interactions. The universal acceptance of given units of measurement resulted in a common ground, and avoided dissension and misunderstanding.

In the early evolvement of standards, arbitrary and simplified references were used. In Biblical times, the no longer familiar cubit was an often-used measurement. It was defined as the distance from the elbow to a person's middle finger. Inches were determined by the width of a person's thumb. According to the World Book Encyclopedia, "The foot measurement began in ancient times based on the length of the human foot. By the Middle Ages, the foot as defined by different European countries ranged from 10 to 20 inches. In 1305, England set the foot equal to 12 inches, where 1 inch equaled the length of 3 grains of barley dry and round."[1] [King Edward I (Longshanks), son of Henry III, ruled from 1272–1307.] Weight continues to be determined in Britain by a unit of 14 pounds called a "stone." The origin of this is, of course, an early stone selected as the arbitrary unit.

The flaw in this system is apparent; the differences in items selected as standards would vary.

In an attempt to standardize forestry methods and measurements, tools and practices were developed which became the universal common reference for all foresters. In the first three of the following activities, students are asked to use measurement techniques in situations which they have not previously encountered. For example, people have not always had tapes to measure distance. Earliest methods used the length of one's own stride or pace as a unit of measure. Today, foresters still use their pace when cruising timber or determining the height of trees in the field. However, they determine the length of their pace to standardize their work in the field. The length of their pace is used as an aid to determine the height of a tree. Other activities give students an opportunity to work first hand with tools and practices used by foresters.

Earliest methods for measuring the height of trees used what we recognize today as simple trigonometric functions. For example, to measure height, it has been recorded that some groups of Native Americans would walk away from an object (and facing away from it) until they could sight the top of the object while holding their ankles and viewing through their legs. When the top was just visible through their crotch, they turned around and paced the distance back to the object. The distance they paced was equal to the height of the object, assuming that the angle formed by this sighting is equal to 45 degrees.[2]

The purpose of this segment is to acquaint the student with the specialized tools and measurement practices employed by foresters in collecting forest data. In addition to the primary purpose of making the students familiar with the names, form, function, and purpose of each tool, these

activities are designed to reinforce and make relevant for students basic skills and values that they have learned or are now learning.

The emphasis placed on the tools activities is for “hands-on” employment of skills and practices, which add not only to the student’s skill level but also to the integration of the skills as a relevant and valued part of their functioning.

The opportunity to exercise skills in different situations provide a series of “teachable moments” that attract students.

1. *The World Book Encyclopedia, 1996 Edition, Volume 7, p. 352*
2. *“Trees as a Crop,” in Our Wonderful World, Aims Education Foundation, Fresno, CA, pp. 17–26*

Subjects:
Math, Science, Social Studies

Objectives:
1. Students will determine their own individual measurements using two methods: (1) individual criteria, (2) standardized measuring devices
2. Students will realize that different results occur from individual criteria and standardized norms
3. Students will examine the possible economic and societal implications of non-standardized criteria.

Skills:
Measuring, estimating and predicting, inference, recording data, interpreting data, addition, subtraction, multiplication, circle/diameter concepts

Materials:
- Yard stick or meter stick for each group
- Student Worksheet 1 (Appendix A)

ACTIVITY 1
EARLY MEASUREMENTS

A. Set the stage

How many students have ever heard the phrase "this horse is 15 hands high?" Before there were standardized measuring tools like rulers and tape measures, people determined the height of horses by counting how many times the width of their hands would go from the ground to the top of the horse. As the students will discover, it was not a truly accurate measurement since people's hands vary in size, but it was an early effort to have a uniform system of measurement. The use of the term "hands" (with an assigned standardized value) continues to be used as a measurement for horses.

B. Procedure

1. Divide students into groups of five.
2. Distribute Student Worksheet 1 and yardstick or meter stick to each group.
3. Using yardsticks have each student measure:
   a. their hand span with their fingers stretched out as far as possible;
   b. the distance from the tip of their nose to the tip of their thumb;
   c. their arm span;
   d. their cubit (elbow to middle finger).
4. Have students determine the group average of each measurement.
5. Collect the yardsticks.
6. Using only the information that they have gathered in step 3, have each group determine the following:
   a. the length of the classroom;
   b. the length of one side of their desk;
   c. the height of the classroom door;
   d. the height of the classroom ceiling.
7. Redistribute the yardsticks and have each group measure 6 a., b., c., and d. again.
8. In a discussion ask each group:
   a. What was the length of the classroom in step 6? Step 7?
   b. What was the length of the side of the desk in step 6? Step 7?
   c. What was the height of the classroom door in step 6? Step 7?
   d. What was the height of the classroom ceiling in step 6? Step 7?
   e. What are some of the difficulties they encountered in making these measurements?
   f. Did everyone have the same hand span? Arm span? Cubit?
   g. Did the yardstick make the measurements more consistent?

h. If you were selling cloth in a fabric store, would you allow customers to use the early method of determining yards by measuring a length of cloth from the tip of their nose to the tip of their thumb? Why or why not?

9. Take students outdoors to a pre-selected tree. Ask them to work in groups and again use the yardstick to:
   a. measure the circumference of the trunk; (*Note: The circumference is defined as the distance around the trunk*.)
   b. measure the height of the tree;
   c. compare results;
   d. Ask why there were significant differences in the results. (Note: The trunk of a tree is smaller as you move up – therefore the circumference will vary depending upon where on the trunk the measurement is made.)

Subjects:
Math, Social Studies

Objectives:
1. Students will become aware of the cultural diversity that can be examined through the use of methods used in earlier/different societies.
2. Students will realize that group results reflect multiple influences and factors.
3. Student will compare/contrast the results of each group.

Skills:
Visualization, measurement, addition, multiplication, comparison, contrasting, tabulation.

Materials:
- Student Worksheet 2 (Appendix A)

ACTIVITY 2
THE NATIVE AMERICAN METHOD OF MEASURING TREE HEIGHT

Procedure:
1. Have the students stand with their back against the tree.
2. Have them walk away from the tree, stopping at intervals to bend over and sight the tree by looking through their legs while holding their ankles.
3. When the top is just visible through their crotch, they will turn around, and walk back to the tree while counting the number of steps they have to take to return. The distance paced is assumed to be equal to the height of the tree.
4. Compare the results of each group and discuss difficulties and the accuracy of the method. (*Inaccuracies will result from the fact that each person's pace varies and the angle of view may vary from 45 degrees*.
5. Have students determine their pace (*Activity 4*).

Activity 2 is adapted from: "Trees as a Crop," in Our Wonderful World, Aims Education Foundation, Fresno, CA

Subjects:
Math, Economics, Science

Objectives:
1. Students will become aware of the cultural diversity that can be examined through the use of methods used in earlier/different societies.
2. Students will realize that group results reflect multiple influences and factors.
3. Student will compare/contrast the results of each group.

Skills:
Tabulation, calculation, inference, deductive reasoning, systematic processing

Materials:
- Student Worksheet 2 (Appendix A)
- Pencil or other straight object.

ACTIVITY 3
USING A PERSON OF KNOWN HEIGHT TO MEASURE A TREE

Procedure:
1. Stand a person whose height is known against the tree that the students are measuring.
2. In order to calculate the number of "persons" to the top of the tree, you'll need a pencil or other straight object.
3. Move away from the tree until the pencil, when it is held at arm's length, fits exactly the length of the person against the tree.
4. Multiply the number of pencil lengths from the ground to the top of the tree by the actual height of the person standing against the tree.
5. Have students compare this height calculation to the height calculations in activities 1, 2, and 3.
6. Explain that if a forester knows the height of a tree and the diameter of a tree he/she can determine how many board feet a tree will yield.

The diameter of a circle is a straight line passing through the center of a circle. The diameter of a tree is a straight line passing through the center of the circle formed by the trunk.

7. Ask students the following:
   a. Why is it important to know the size of trees? (*Trees are an extremely valuable crop with many uses. Economically, they are valued in terms of board feet of lumber. A board foot is a board 1 inch thick, 12 inches wide, and 12 inches long.)*
   b. How can foresters and loggers be more accurate than the methods described above in determining the size of trees and therefore the economic value of trees? (*By using specialized tools and practices designed for accurate measurement.)*

Activity 3 is adapted from: "Trees as a Crop," in Our Wonderful World, Aims Education Foundation, Fresno, CA

Subjects:
Math, Science

Objectives:
1. The student will learn that relatively accurate measurements of distance can be made without measuring tapes.
2. The student will be able to determine the distance between two points by counting the number of steps or paces taken between the two points.
3. The student will be able to walk a predetermined distance to locate a given point.
4. The student will be able to compute the length of his/her average step given a pre-measured 100-foot distance.
5. The student will be able to compute the length of his/her average pace (2 steps) given a pre-measured 100 foot distance.
6. The student will be able to use pacing to measure tree height.

Skills:
Measurement, computation, recording data, interpreting data

Materials:
- Chalk or wooden stakes (two stakes per course)
- Bright colored paper/ribbon
- 100 ft. tape measure or 100 ft. pre-measured rope or clothes line
- Student Worksheet 3 (Appendix A)
- Student Worksheet 4 (Appendix A)

ACTIVITY 4
LEARN YOUR PACE

A. Preparation
Place a stake in the ground or make a mark on the sidewalk with chalk using a long tape measure, make another stake or mark 100 feet from the first mark. Be sure to measure in a straight line on relatively level ground. Make one course for each five people to reduce delays.

B. Procedure
1. Distribute Student Worksheets 3 and 4.
2. Refer to the stakes: The distance from the first to the last stake is 100 feet.
3. Walk an even, normal step all the way down, then all the way back.
4. Count the total number of steps you take on the way down and on the way back.
5. Using Student Worksheet 3, determine the length of your step.
6. Repeat steps 1–4. Use Student Worksheet 4 and determine the length of your pace.
7. In a discussion, ask:
   a. What is your length of step? Your pace?
   b. How did you determine your length of step? Your pace?
   c. How many steps would you have to take to go 100 feet?
   d. What might make it difficult for a forester to determine the number of steps between one point and another?

Activity 4 is adapted from: "Activity: Measure the Length of Your Step," in Measuring, in Investigating Your Environment, USDA Forest Service, Odgen, UT.

Subjects:
Math, Science, Language Arts

Objectives:
1. Students will recognize that there are specialized tools used in the forest.
2. Students will identify different tools used in forestry.
3. Students will identify the specific purposes of individual forestry tools.

Skills:
Measurement, reading, interpretation

Materials:
- Forestry CD

ACTIVITY 5
"TOOLING ON" THROUGH THE CD

Procedure:
1. Have the students play the tools section of the Forestry CD.
2. Ask them which tools are used to estimate:
   a. The height of trees? *(Biltmore Stick (hypsometer) and the Clinometer.)*
   b. The diameter? *(Biltmore Stick and Diameter tape.)*
   c. The age of the tree? *(Increment Borer)*
   d. The volume of timber in a stand of trees? *(Wedge Prism)*
3. Have a local forester demonstrate examples of each tool mentioned. *(Contact your state's NRCE coordinator for information on available personnel.)*

Subjects:
Math, Art

Objectives:
1. Students will identify and construct a specialized forestry tool.

Skills:
Dexterity, following directions

Materials:
- Student Worksheet 5a (Appendix A)
- Student Worksheet 5b (Appendix A)
- Yardstick

ACTIVITY 6
MAKE A BILTMORE STICK

Procedure:
1. Cut out the Biltmore Stick pattern on Student Worksheets 5a and 5b.
2. Glue pattern together according to directions.
3. Glue side one and side two to opposite sides of a yardstick or heavy strip of cardboard.
4. Use the Biltmore Sticks in Activity 7.

Note: Side 2 of the Biltmore Stick is a hypsometer (a device for measuring height). For purposes of these activities, the term Biltmore stick will be used generically.

Activity 6 is adapted from: "Trees as a Crop," in Our Wonderful World, Aims Education Foundation, Fresno, CA

Subjects:
Math, Science, Economics

Objectives:
1. Students will recognize the importance of specialized tools to determine forest measurements.
2. Students will compile data gathered from personal use of forestry tools.
3. Students will demonstrate the use of the Biltmore stick.
4. Students will employ multiple measurement techniques.
5. Students will equate measurable product with economic impact.
6. Students will read conversion charts to reclassify results.

Skills:
Measuring, estimating, inferring, tabulating, calculating, converting, reading conversion charts, comparing/contrasting, reaching economic conclusions from raw data

Materials:
- Biltmore Stick
- Gunther Chain or 66 ff. rope
- Student Worksheet 6 (Appendix A)
- Using the Biltmore Stick to Measure Diameter (Appendix B)
- Using the Biltmore Stick to Measure Height (Appendix B)
- Board Feet Conversion Chart (Appendix B)

ACTIVITY 7
USING THE BILTMORE STICK TO ESTIMATE THE BOARD FEET IN A TREE

Divide the students into groups of five and designate a tree for them to measure with their Biltmore Sticks as follows:

A. Determining the diameter of the tree:

■ Historically, the diameter measurement was taken at breast height and therefore was known as the DBH (diameter breast height). Just as hand spans vary, breast height varies from person to person.

■ To standardize their measurements, foresters determined that this measurement would always be made at 4.5 feet above the ground.

1. Have the students hold their Biltmore stick (Side 1) sideways against the tree, at arms length, 4.5 feet above the ground and 25 inches from the eye.
2. They should shift the stick right or left until the zero end of the stick coincides with the left edge of the tree trunk.
3. Have them read the diameter figure that coincides with the right edge of the tree trunk without moving their head.
4. For accuracy, take a second measurement on a different side of the tree by moving around the trunk approximately 90 degrees.

B. Determining the height of the tree:

■ For standardization, height measurements are taken at a distance of 66 ft. from the tree. (One Gunther chain or surveyors tape (used by forestry workers) equals 66 ft.) The Biltmore stick has been calibrated so that if you stand 66 ft. away an accurate height can be determined. (In the absence of a Gunther chain, a 66 ft. rope will suffice.)

1. Have the students stand 66 feet from the tree while holding their Biltmore stick vertically at arms length and shoulder height with side B facing them. Line up the bottom of the stick with the base of the tree. Count the number of logs illustrated on the stick. The logs illustrated on the stick are 16 ft. logs. (Note: It is important not to move the stick when taking a measurement, therefore, tilt your head back slightly so that it does not have to move when reading from ground to top of tree.

Note: *A forester standing in a forest often has to estimate the top of the tree if it is not easily seen.)*

C. Determining the number of board feet in the tree:

1. Make a second height measurement. This time, instead of measuring from the ground to the top of the tree, measure from the stump height to the cutoff point in the top. The cutoff diameter will vary with locality, with product being produced, and with excessive limbs, but is usually between 4–10 inches. The minimum diameter log that can be used in the sawmill determines the cutoff diameter. The height is the merchantable height of the tree. Merchantable height refers to the length of commercially usable tree.

2. Use the Board Feet Conversion Chart in Appendix B to find board feet in the tree.

Note: *The conversion chart takes into consideration the sawdust that is lost in typical sawing methods. The sawdust may be used for animal bedding, fuel, etc.*

3. Ask: Why is it necessary to use the merchantable height to determine the number of board feet?

4. Solve the following problem:
   How many trees like the one measured in *Step C* would it take to build three average U. S. homes?

Note: *An average U. S. home contains approximately 16,900 board feet of lumber in the structural portions of the house.*[3]

Note: *If you refer to the Forestry CD Activity Guide cover, you will see a forester demonstrating the correct technique to determine DBH with a Biltmore Stick. She is holding the stick with an outstretched arm (25 inches from her eye) at approximately 41/2 feet above the ground.*

3. Facts and Figures U.S. Forests 1995, American Forest & Paper Association, Washington, DC.

Subjects:
Math, Art

Objectives:
1. Students will construct a forestry tool
2. Students will accurately plot measurement points

Skills:
Measurement, following directions

Materials:
- Cardstock paper (heavy A4)
- Rulers
- Protractors
- Cotton string
- Small washers
- Diagram for making a clinometer (Appendix B)

ACTIVITY 8
MAKE A CLINOMETER

Procedure:
1. Fold a piece of heavy A4 (cardstock) paper in half lengthwise, as shown.
2. Draw a quadrant with radius of 10 cm and center at **A** as shown in diagram, mark every 5 degrees around the quadrant starting at **B**, and label the points.
3. Carefully attach a 20 cm length of cotton string at **A** so that it hangs freely.
4. Tie a small weight (washer) to the end of the string.
5. Use the clinometer in Activity 9.

Subjects:
Math, Science

Objectives:
1. Students will measure trees using a clinometer
2. Students will employ formulae and computations to collect data

Skills:
Interpreting charts, using math formulae, observation, estimation, recording data, determining angle of elevation

Materials:
- Clinometer
- Tangent chart
- Student Worksheet 7 (Appendix A)

ACTIVITY 9
"INTRIGUING TRIG"
FIND THE THREE TALLEST TREES ON THE SCHOOL GROUNDS USING A CLINOMETER

Procedure:
1. Divide students into pairs and give them a copy of Student Worksheet 7.
2. Have students observe all of the trees on the school yard and estimate which three trees are tallest.
3. Measure the height of selected trees as follows:
   a. Have one student stand far enough from the tree so that he/she can clearly see its top.
   b. Using the paper clinometer, have the students **determine the angle of elevation** between his/her eye level and the top of the tree as follows:

(1) Point the end with the weight towards the tree.
(2) Sight along the top edge of the paper and angle the clinometer up or down until you are looking at the very **top of the tree.**

(3) Hold the clinometer steady. Have your partner **record the number where the weighted string crosses the scale** on the clinometer. This number represents the **angle of elevation.**

(4) Use the clinometer conversion chart in Appendix B to find the **tangent of the angle of elevation.**

c. Using the pace method, have the partner measure the distance from the tree to where the student holding the clinometer is standing.

d. Using the information gathered in a, b, and c, determine the height of the three trees using the following formula:

tree height = (tangent of angle of elevation × your distance from the tree) + your height

Subjects:
Math, Science, Language Arts

Objectives:
1. Students will compare, contrast, and evaluate trees in their area
2. Students will employ math processes to determine selected tree measurements
3. Students will research comparative species' measurements
4. Students will demonstrate mastery of forestry tools [Biltmore Stick, Clinometer, Diameter Tape (optional)]

Skills:
Observation, measurement, evaluation, comparison, research, estimation, recording data, determining angle of elevation

Materials:
- Copy of state's big tree information or the *National Registry of Big Trees*
- Biltmore Stick
- Clinometer
- Diameter tape or non-stretching rope
- Tangent chart
- Student Worksheet 8 (Appendix A)
- Big tree measurements diagram (Appendix B)
- Graph paper (optional)

ACTIVITY 10
CHAMPION TREE FINDERS

A. Set the stage.

Explain to the students that there is a National Registry of Big Trees and that most states also maintain a Big Tree List. The same criteria are used by all states to measure the trees which they nominate for consideration as Big Trees. Trees are judged as big trees if they earn the highest number of points for their species. The three measurements which are considered in determining a tree's total points are:

(1) the **Circumference,** (2) the **Height,** and (3) the **Average Crown Spread.**

B. Procedure

1. Select a tree or trees on the school yard or nearby street to be measured by groups of students.
2. **Measure the Circumference of selected tree**
   This measurement is also known as **CBH (Circumference at Breast Height.)** This measurement is made in inches at a point on the tree trunk 4.5 feet above the ground. If a tree is growing on a slope, the 4.5 foot point is determined from a point on the uphill side of the tree. The tree **must have a single trunk for at least 4.5 feet to be considered a single tree**. If abnormal swelling on the trunk prevents the measurement being taken at 4.5 feet, then the measurement should be taken at a point lower on the trunk where the measurement will reflect the normal size of the tree. The height at which the measurement is taken should be noted. The measurement may be taken with a tape measure or a forester's diameter tape.

<u>One point is given for each inch of circumference.</u>

a. Wrap a tape measure around the tree trunk at a point 4.5 feet above the ground. Record the measurement on Student Worksheet 8.
b. If a tape measure is not available, a non-stretching rope or cord may be used as follows:

(1) Use a **non-stretching** rope or cord;
(2) Lay the rope flat;
(3) Wrap the rope around the tree;
(4) Measure the length of the rope **in inches**, using a yardstick as a guide;
(5) Note the measurement- this is the circumference of the tree.

c. A **forester's diameter tape** may be used to measure the circumference. It is a special measuring device used by foresters that has the **inches expanded by the constant pi. pi = 3.14.** The formula for determining the circumference using a diameter tape is as follows:

$$\textbf{Circumference} = \textbf{pi} \times \textbf{Diameter}$$
$$\textbf{or}$$
$$\textbf{C} = \textbf{pi} \times \textbf{D}$$

(1) **Wrap** the diameter tape around the tree at a height of **4.5 feet above the ground.**
(2) Note the measurement- this is the diameter.
(3) **Multiply** the measurement by 3.14 (pi) – this is the circumference of the tree.
(4) **Sample problem:**

A diameter tape wrapped around an oak tree at 4.5 ft. above the ground indicates a diameter of 11.5 inches. What is the circumference of the tree?

Solution:

$\textbf{C} = \textbf{pi} \times \textbf{D}$
$\textbf{C} = \textbf{3.14} \times \textbf{11.5 inches}$
C = 36.11 inches

3. <u>Measure the height of selected tree</u>

To determine champion trees, the height is measured from the ground line to the highest point determined from the uphill side. The measurement may be taken with a Biltmore Stick or a clinometer.

<u>One point is given for each foot of height.</u>

4. <u>Measure the average crown spread of selected tree</u>

To determine this finding, two measurements are taken at the outer edges (drip line) of the spreading crown. Measurements are recorded in feet at the widest point of crown spread, and then recorded at the narrowest point of crown spread. These two measurements are then averaged together and divided by two to get the average crown spread.

One-fourth of a point is given for each one foot of average crown spread (or one point for each four feet of spread.)

5. **Determine the total point value,**
   Add the points from all three measurements together. A co-champion tree is named if a tree is within five points of the champion.

6. **American Forests formula to determine if a tree is a champion:**
   Total points = Circumference (inches) + height (feet) + 25% of average Crown spread

7. **Three other items are needed to complete the Big Tree nomination.** They are:
   (1) The landowner's name and address.
   (2) The nominator's name and address.
   (3) The exact location of the tree.

8. **Nominations for a Big Tree may be sent to:**
   Your State Forest Service
   Street
   City, State, Zip

9. **Optional Math Activity:** Have the students graph the results of their calculations. They may graph total point values, or results of each of the three individual measurement components.

Information for "Activity 10: Champion Tree Finders" was adapted from the following sources:

Big Trees of Delaware, First Edition, 1995, Delaware Department of Agriculture Forest Service;
Newlon, Charles J., "Gentle Giants," Outdoor Delaware, Winter 1995, pp. 4–9.

ASSESSMENT ACTIVITY
TOOLS USED IN FORESTRY SECTION

Give the students copies of Student Worksheet 8. Ask the students to locate and record information on five trees of their choice. Remind them that they may discover a champion tree through their findings. If students are uncertain as to the species of the trees they select, ask them to ask permission of the owner to take a leaf to be identified. If permission is denied, ask the students to draw the leaf and note any characteristics of the tree (bark, color, etc.) which will aid in identification. Remind the students that accurately recording the location of the tree will enable the measurements to be verified, and positive identification to be made.

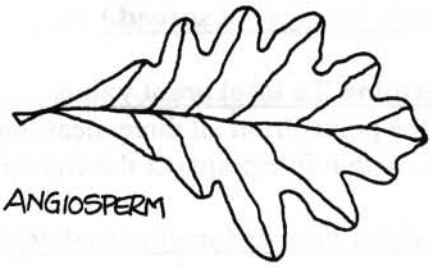
LEAVES

The best clue to a tree's identity. Leaves range from the impressive 30-inch bigleaf magnolias to the tiny scales of cedar.

Needles are leaves. Trees with needles are commonly called softwoods, conifers, or evergreens. Some, however, are not always "ever" green; the needles of larch, or tamarack, are shed each winter, fooling some owners into thinking the tree has died.

The broad leaves of *deciduous* trees are usually shed each autumn. Some, however, like holly and the live oaks, remain green year round.

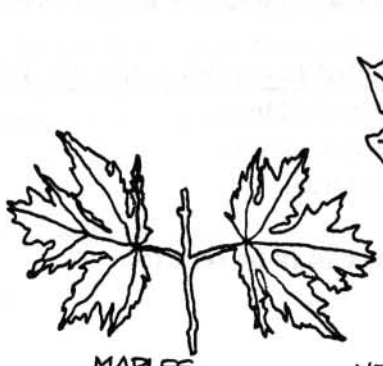
GYMNOSPERM



ANGIOSPERM

What else to look for:

OPPOSITE OR ALTERNATE ARRANGEMENT ON TWIGS



MAPLES

YELLOW-POPLAR

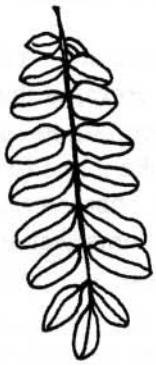
SIMPLE OR COMPOUND

SWEETGUM

BUCKEYE

KINDS OF COMPOUND LEAVES

PALMATELY COMPOUND (BUCKEYE)



PINNATELY COMPOUND (BLACK LOCUST)

BIPINNATELY COMPOUND (HONEYLOCUST)

Source: The Woodland Steward, p. 15

"Nature's first green is gold, Her hardest hue to hold."
Robert Frost

Capture the Beauty of Autumn: Enjoy A Forest

Tuliptree
L. tulipifera

Fall is an ideal season for enjoying and exploring the outdoors.
As trees display their autumn colors, plan to visit one of our beautiful state parks and forests. Take along this leaf color guide to identify the many trees you will see.

Red oak
Q. rubra

Timing is everything

Autumn color usually starts in late September and ends in early November. The peak leaf viewing occurs around the first two weeks of October. Leaf color depends on many environmental factors, such as: weather, exposure to sunlight, soil conditions, and elevation. These factors are constantly changing the leaf color intensity. Timing is essential since peak color lasts only three to four days.

The main factor in leaf color change is the length of daylight. Around September 22nd, the autumnal equinox, both day and night will be approximately 12 hours. Towards the end of September, the daylight decreases at a rate of about two minutes per day. As the daylight decreases, the leaves of deciduous trees start to turn color and eventually fall off, preparing the trees for dormancy. Although temperature and moisture do not play a role in initiating the fall color change, they do affect their brilliance. The most brilliant colors occur when warm sunny fall days combine with crisp cool nights.

Sugar maple
A. saccharum

Black gum
N. sylvatica

Autumn display of color

In fall, the green leaves turn to brilliant shades of yellow, orange and red. The green pigment in leaves is chlorophyll, which harnesses sunlight to convert carbon dioxide and water into sugars. This food-making process is photosynthesis. As the daylight decreases, the chlorophyll levels decline and other pigments are revealed. Those pigments are carotenoids and anthocyanins. Within the cells of the leaves, the carotenoids give the yellow to orange fall color. In late summer bright sunny, dry days with cool nights enhance anthocyanin production in the sap of the leaves. Anthocyanins provide the brilliant reds and purples. High quantities of tannins are responsible for the brown colors.

Sweetgum
L.styraciflua

Red maple
A. rubrum

The combination of chlorophyll, carotenoids, and anthocyanins with variable weather conditions leads to a range of leaf color. A leaf color time log is below:

Type of Tree	Leaf color	Date of observation
Tuliptree, Green ash, Black birch, Hickory	yellow	
Basswood	yellow to brown	
Black gum, Sweetgum, Dogwood Red maple, Black cherry	red	
Sugar maple, Sassafras	yellow, orange, red	
Oaks	yellow, red, brown	

Flowering dogwood
C. florida

Sassafras
S. albidum

TREE IDENTIFICATION

Trees are the largest and some of the most impressive plants in the world. But it is not only their size, but their age, shape, dominance in their community, beauty of flowers, fruits, or leaves, and potential uses by man that inspire a feeling of wonder and excitement in all of us. … To learn their identity, relationships, life history, habitats, and distribution adds to the appreciation of these giants of the plant kingdom.[1]

The development of a universally accepted system for identifying trees has eliminated the language barriers and resulted in more effective communication among scientists. A significant benefit of the naming and classification of trees has been the opportunity to research and explore the origins and methods of the various individuals and countries who contributed to this system.

The features used in tree identification are leaves, bark, twigs, flowers, fruits, habitat, and taste or aroma. The leaves are the most recognizable feature, and the easiest aid to identification. Because of the advantage in using leaves in identification, the key presented in the Forestry CD is a summer key.

The hands-on opportunity presented by the collection (when possible) and identification of leaves enables the teacher to reinforce valuable skills that are transferable and multi-disciplinary. Classification and grouping enable students to sharpen their observation and discrimination skills. The actual identification of trees lends credence to discussions of pollution, environmental ethics, land use, and other environmental concerns.

Students should be guided to achieve mastery of the use of a key to identify tree species. The student should be introduced to keys that are of various formats, so that they are able to follow the layout of any key with which they come in contact. It is essential that the students are familiar with the accepted botanical naming of trees and the rationale for the practice. This naming process eliminates the language barrier, and ensures a universal frame of reference. Students should also be familiar with the terminology used in the description and classification of trees.

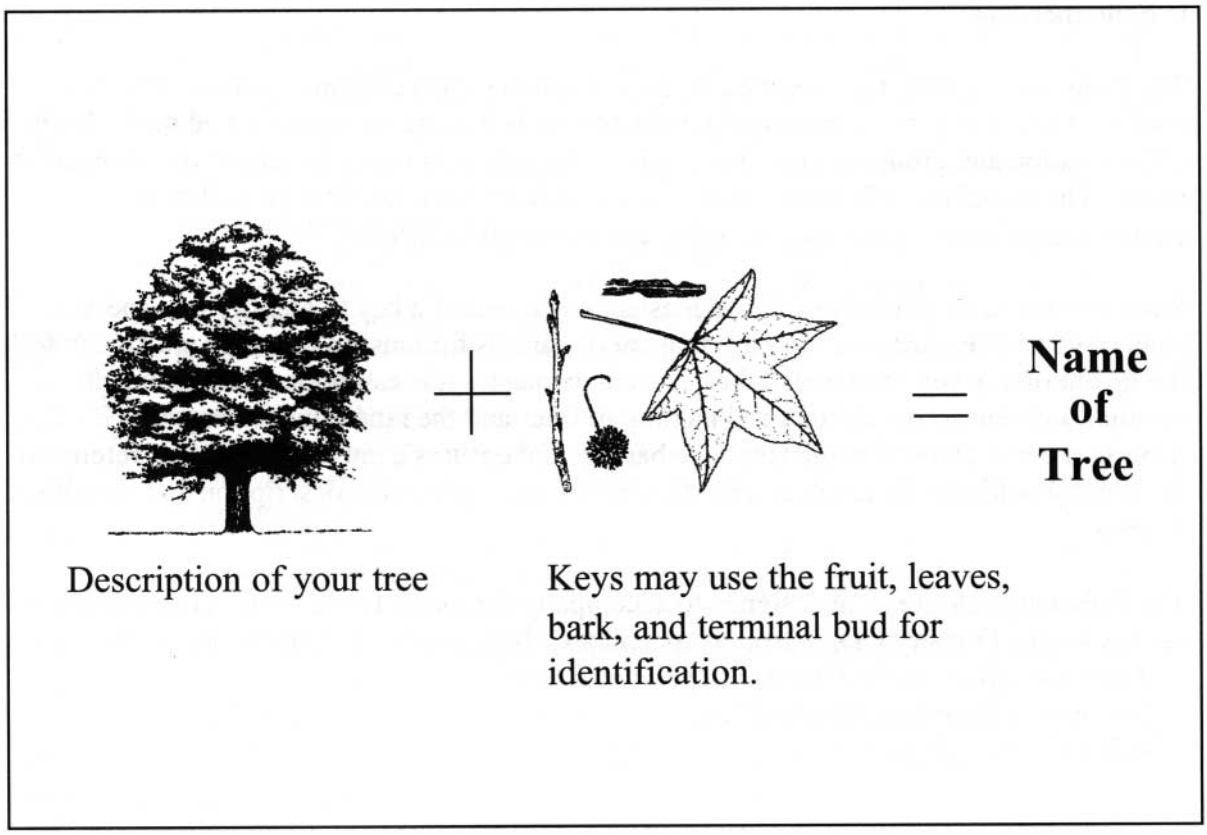
The following activities are designed to accompany the topics found in the Tree Identification section on the Forestry CD. Also, in Appendix C there is a tree list that contains the following:

Trees Identified on the Forestry CD Summer Key;
Envirothon Tree Identification List;
4-H Tree Identification List.

1. *Hardin, James W., et al., Textbook of Dendrology, p1.*

TREE IDENTIFICATION

One way to identify trees is to use keys. Keys ask a series of questions. Your answers lead you to one or several possibilities. The key on the Forestry CD-Rom helps identify trees commonly found in parts of the eastern United States. It is a summer key and requires leaves and buds from the tree. To begin, get a branch with several leaves and a terminal bud. Then refer to the key found on the CD-Rom.



Subjects:
Science, Art

Objectives:
1. Students will learn the reasons for the use of universally accepted scientific names for trees.
2. Students will master the procedures for use of key to identify leaves.
3. Students will learn to discriminate between different identifying characteristics of trees.
4. Students will learn (and spell correctly) the common and scientific names of the trees listed in the Forestry CD.
5. Students will determine the different uses of individual species of trees.

Skills: verifying, analyzing, comparing, contrasting, identifying, evaluating, classifying, categorizing, identifying attributes.

Materials:
- Forestry CD
- Student Worksheet 9 (Appendix A)
- Student Worksheet 10 (Appendix A)

ACTIVITY 1
USING A SUMMER KEY

Preparation:
1. Pre-key the school yard or nearby community to find and map trees identified by the summer key on the Forestry CD.
2. Have students bring leaves from home. If no trees or leaves are readily available, consider field trips, library books, or contact the local forester's office for pictures of leaves. Also, it is possible to use the Tree Concentration leaf pages found in Appendix B.

Procedure:
1. Discuss why it is important to be able to identify trees.
2. Give each student copies of Student Worksheet 9.
3. Divide the class into four groups.
4. Give each group an equal number of leaves or leaf pictures to identify using the summer key on the CD. If they bring in a leaf that is not identified on the CD, have them use other available keys.
5. Have students sketch each identified leaf and write its common and scientific name on Student Worksheet 9.
6. On a separate sheet, have them list two uses for each tree identified.
7. Have groups exchange pictures and continue to use the CD until each group has successfully identified and sketched each leaf picture.
8. Have student groups take their sketches and Student Worksheet 10 into the school yard or nearby community to identify pre-selected trees. Or send students on an in-school scavenger hunt and have them identify hanging leaf collections in halls.
9. Have students research their state tree. Is it on the CD?
10. Have students draw a picture of their state tree. Identify with common and scientific (botanical) names.

Subject:
Science

Objectives:
1. Students will learn to discriminate between different identifying characteristics of trees.
2. Students will reinforce tree identification skills.

Skills: analyzing, representing, comparing, contrasting, evaluating, classifying, categorizing, identifying attributes and components.

Materials:
- Yarn or rope (full skein or at least 100 feet of rope)
- Clothes pins
- Index cards with question mark-?
- Index cards with the common and botanical names of trees represented in the Forestry CD
- Pictures of leaves (indoors)
- Area with a variety of tree species (outdoors)

ACTIVITY 2
INSTANT TREE TRAIL

Procedure:
1. The purpose of this activity is to reinforce tree identification. This activity may take place inside or outdoors.
2. Divide students into teams of six to eight. Each team is responsible for constructing one trail.
3. Students construct a "trail" by outlining an area with the yarn.
4. Using the clothespins, they then attach pictures of leaves (if indoors) to the trail and add question marks **OR** attach cards to leaves (outdoors) and add question marks at different points along the "trail."
5. The other teams follow the trail and identify the leaves by attaching the index card with the correct botanical and common names.
6. Each team can follow every trail and identify all of the leaves represented.

Subject:
Science

Objectives:
1. Students will match names, characteristics, and uses of trees with pictures of leaves
2. Students will reinforce tree identification skills

Skills: evaluating, comparing, contrasting, categorizing, identifying attributes and components, verifying, analyzing, classifying.

Materials: for each group
- 1 set of Tree Concentration sheets (Appendix B)
- Scissors
- 3 by 5 index cards (optional)

ACTIVITY 3
TREE CONCENTRATION

Procedure:
1. Have students cut out the squares of (a) leaf pictures, (b) identifying characteristics of trees, (c) common names, and (d) scientific names. Squares may be pasted to index cards to make them more durable.
2. Students then place the squares face down as follows:

— ***Two rows of leaf picture squares only;***

— ***All other squares placed in as many randomly mixed rows as necessary.***

3. Each player, in turn, is to pick one leaf picture square and try to match the leaf with either of the following squares:
   common name;
   identifying characteristic; or
   the scientific (botanical) name.
4. If there is not a match, the student replaces the squares face down in rows and the next student has a turn.
5. If the student matches the leaf to the common name, he puts the pair in his pile and has scored **one point for the match**, and the next student takes a turn.
6. If the student matches the leaf to the scientific name **<u>or</u>** the identifying characteristic of the tree, the puts the pair in his pile and has scored **two points for the match**, and the next student takes a turn.
7. In the second round and subsequent rounds, each student again chooses one leaf picture square and tries to match it. If he does not match the new leaf picture square, but does select a square that matches an existing pair in his pile, he adds the match to his pile and scores accordingly. It is possible to score 5 points for each leaf picture by accumulating a full set of squares for each:

   (<u>Leaf</u> + <u>common name</u> + <u>identifying characteristic of tree</u> + <u>scientific name</u> = 5 points)
   1 point ***2 points*** ***2 points***

8. If all leaf picture squares have been matched at least once, the game continues until all remaining squares have been matched and added to students' piles.
9. Students total their points to determine the winner.

Subjects:
Science, Social Studies

Objectives:
1. Students will select and identify, by common and scientific names, a leaf of their choice.
2. Student will recognize the inherent beauty of an object of nature as a decorative item.
3. Students will recognize the chemical properties of salt and baking soda as fixatives.
4. Students will research botanical facts about selected leaves.

Skills: Classifying, identifying attributes and components, analyzing, organizing, researching

Materials:
- flat-headed hammers
- masking tape
- plywood or other hard surface boards
- newspapers
- waxed paper
- fabric pen
- tee shirt or pieces of cloth on which to print (100% cotton works best).
- tree leaves (tulip poplar, red or white oaks work well)
- construction or other heavy – weight paper
- stamp pad

ACTIVITY 4
LEAF PRINTS

Part I: Cloth Dyeing

Procedure:
1. For best results, be sure that leaves collected are fairly fresh and green.
2. Have each student select leaves which he then identifies by their common and botanical names.
3. Place several layers of newspaper on a flat board.
4. Spread the cloth, right side up, on the newspaper.
5. Place the leaves on the cloth in the desired pattern.
6. Put waxed paper over the leaves and tape the edges carefully.
7. Use the hammer to pound the leaves until the leaf pattern has been transferred to the cloth. The process will result in the leaf's chlorophyll leaving a design or "print" on the cloth.
8. If the leaf design does not imprint evenly, crumble up another leaf, dip it in water, and use it to fill in the imprinted areas.
9. Use the fabric pen to write the common and botanical names under each leaf.
10. To help retain the natural colors, the finished product may be soaked in one of the following solutions:

    1/2 cup of salt added to 2 gallons of water and soaked for ten minutes.

    OR

    3 tablespoons of baking soda added to 1 gallon of water and soaked for ten minutes.

11. Rinse the fabric in clean, cold water and air dry it away from direct sunlight.
12. Optional: Social Studies/Language Arts extension activity.
    Have students research how Native Americans and early settlers dyed and decorated their clothing with natural dyes and objects from nature. The use of walnuts and other forest products as a source of dyes, and the use of feathers, etc., as decoration can be explored.

Part II: Stationery

Procedure:

1. Have each student "buy" one leaf. As the "price" of purchase of the leaf, they must provide one fact about their leaf.
2. Have the student ink the leaf on the stamp pad, and impress the leaf on the paper in the position of their choice.
3. They then write the fact about the leaf at the bottom of the page.
4. Extension Activity:
   Have students follow steps 1–3 using twigs.

Subject:
Science, Language Arts, Social Studies

Objectives:

1. Students will select and identify by common botanical names the leaves of their choice.
2. Students will mount and identify specimen by approved botanical methods.
3. Students will acquainted with the range of species in their selected areas.
4. Students will employ the Forestry CD Summer Key to identify leaves.
5. Students will become familiar with other keys and reference materials as needed to identify leaves.

Skills: evaluating, comparing, contrasting, categorizing, identifying attributes and components, verifying, analyzing, classifying, and researching.

Materials:

- Forestry CD
- Street identification keys and field guides as available
- Plant press (if unavailable, use large telephone books, or catalogues, or other large book)
- Newspaper sheets
- Leaf mounting sheets (Appendix B)
- Glue
- Paper and writing materials
- Leaf Mounting Sheet and Botanical Collection Procedures (Appendix B)
- Student Worksheet 11

ASSESSMENT ACTIVITY 1
TREE IDENTIFICATION SECTION
CLASS LEAF COLLECTION

Procedure:

1. Have each group of students be responsible for collecting a minimum of 15 different leaves during their travels and bring them into class.
2. Have students identify the leaves using the Forestry CD summer key.
3. If the leaf is not identified using the Forestry CD, use additional keys and field guides.
4. Discuss the linguistic and cultural roots of the words and terms used in tree identification.
5. Have the students press and mount the leaves. Instructions for mounting are on page 26.
6. Display the class leaf collection in the school library.
7. Have students research the accomplishments of one of the following botanists/naturalists:
   George Engelmann (1809–1884)
   David Douglas (1798–1894)
   Robert Fortune (1812–1860)
   Johann Georg Gmelin (1709–1755)
   William Jackson Hooker (1785–1865)
   Richard Maack (1825–1886)
   Pierre Magnol (1638–1715)
   Thomas Nutall (1784–1859)
   Jean Robin (1550–1629)
   Vespasien Robin (1579–1662)
   Charles Sprague Sargent (1841–1927).
   David Thomas (1776–1859)
   Thomas Albert Williams (1865–1900)

a. Using Student Worksheet 11 have them map routes traveled by the botanist while doing research.
b. Have them identify two plants discovered by their botanist and locate the discovery on the map.

8. **Extension activity:** Define the term *restoration forestry* and have the students research areas in their state where a restoration project may be proposed, or in process.

9. For **closure**, discuss with the students the following:
   - Leaves exhibit certain characteristics that allow the species of the tree to be identified.
   - Identification keys are a systematic way to examine tree, and especially leaf, characteristics and identify the species.
   - There are specialized terms and characteristics used in tree identification.
   - There is a universally accepted system of naming trees, which uses a Latin botanical name, and eliminates a language problem and provides a world-wide frame of reference.
   - There is certain information that accompanies a specimen in a leaf collection.
   - There are procedures to be followed to insure a properly collected, preserved, and mounted leaf collection.
   - There are "Environmental Ethics" to be followed when collecting leaves or engaging in any outdoor activity.
   - Trees have aesthetic, environmental, historical, and economic value. Discuss with students some of the trees which have historical and cultural significance in our country's history, especially those native to their state.

Method A.
1. Decide where on the mounting sheet the leaf is to be placed. Try to be as artistic as possible.
2. When mounting leaves, always turn one leaf upside down so that both sides are visible.
3. Brush glue (60% white glue to 40% water) on the surface of the leaves.
4. Place leaves on mounting sheet in pre-determined position.

Method B.
1. Follow steps 1 and 2 above.
2. Spread glue evenly on a washable surface.
3. Lay leaves on glue and press down to ensure glue coverage.
4. Lift leaves up gently and place on mounting sheet.

Subjects:
Math, Science, Geography, Language Arts, Art

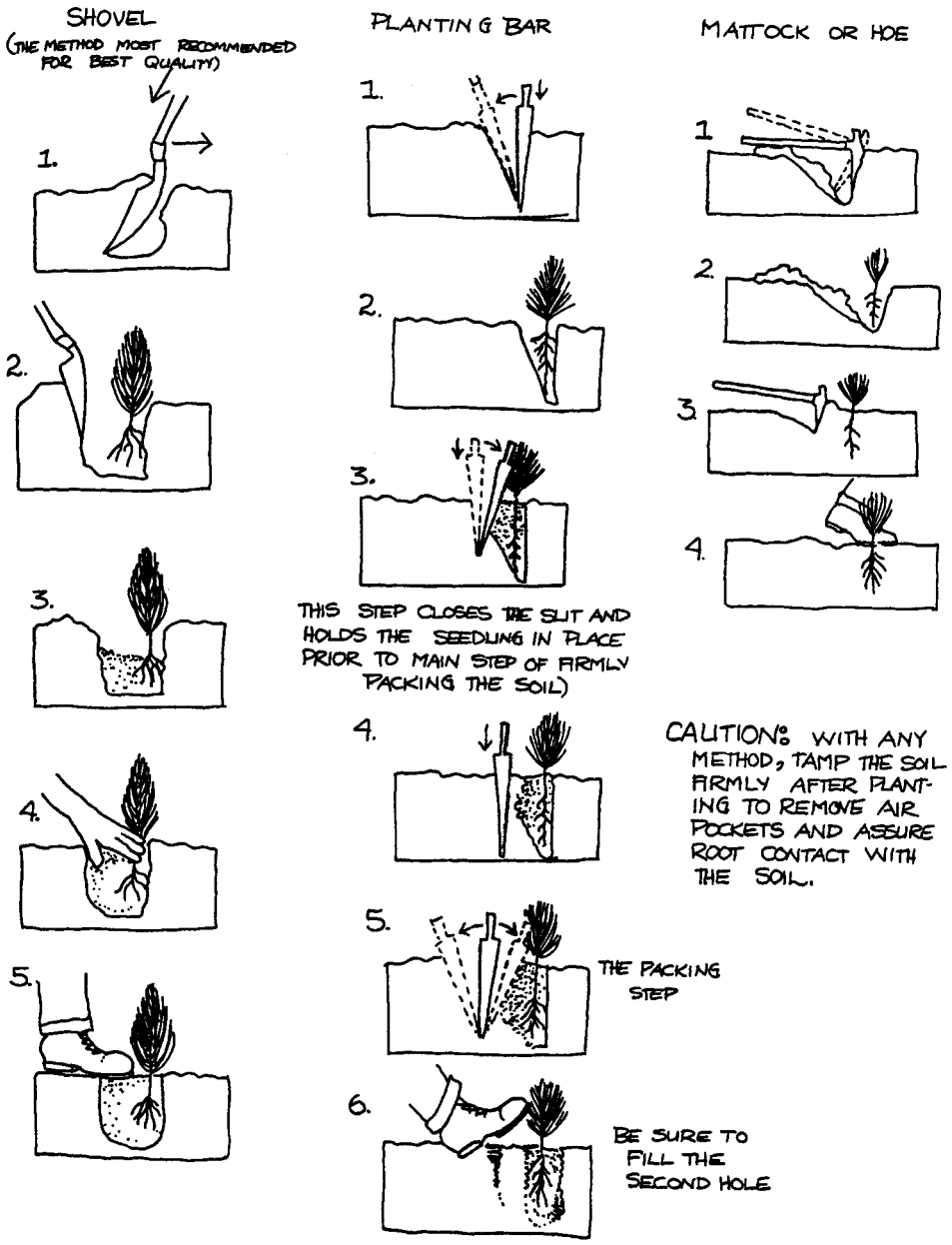
Objectives:
1. Students will interpret a public area and identify, by common and scientific names, the trees on that site.
2. Students will provide identifying characteristics and interesting facts about their selected trees.
3. Students will present their material in well-written grammatically correct formats.
4. Students will employ appropriate geographic and statistical information to create their map.
5. Students will utilize appropriate art and graphic techniques to create their brochure.

Skills: Identifying, classifying, identifying attributes and characteristics, team building, researching, mapping, and writing

Materials:
- Forestry CD
- art supplies
- field guides and keys
- sample Tree Trail (Appendix B)

TREE IDENTIFICATION SECTION
ASSESSMENT ACTIVITY 2
TREE TRAILS

Procedure:
1. Review the sample tree trail (Appendix B) with the class.
2. Divide the class into groups and have each group select a public area in which they will design and interpret a tree trail.
3. Each tree trail should have a minimum of 12 different tree species.
4. Have each group work with computers (if possible) or by hand, to design a tree trail brochure which should contain the following information:
   - *Common and scientific names of each tree*;
   - *Identifying characteristics of each tree*;
   - *Interesting facts about each tree*;
   - *Precise location of each tree*;
   - *Map (complete with legend) of the tree walk.*
5. Place copies of completed brochure(s) in the school library for use by other students.
6. (Optional) Send copies of brochures to appropriate state, county, or municipal agency so that they may be shared with the public.



Source: The Woodland Steward, p. 61

FOREST MANAGEMENT PRACTICES

The United States has 731 million acres of forestland that make up about one third of the total land base. Everyone uses and benefits from forest products each and every day of their lives. Forests are a resource which offers many benefits: wood products and byproducts, food, clean water, air quality, erosion prevention, noise abatement, habitat (human and wildlife), energy conservation, recreation, and aesthetics. Much of the world's population depends on the forest for fuel for heating and cooking.

Old growth forests, though important for some species of wildlife, recreation, and aesthetics, do not offer the same environmental benefits as second growth forests. **Second growth forests** grow more rapidly and offer a broader range of benefits in the long run. In this more active growth, second growth forests produce more oxygen and take in more carbon dioxide than old growth forests, thus benefiting air quality more. Second growth forests absorb more nutrients than old growth forests, thus purifying water more completely. Second growth forests provide a wider variety of wildlife habitats and are often managed for the many wood products needed by society.

Through use of the Forest Management Practices section on the Forestry CD and this accompanying activity guide, the student will be introduced to various forest management practices, terminology, and systems which encompass the methods used to manage forests to maximize their benefits and promote a conservation and stewardship land use ethic.

Silviculture is that part of forest management that deals primarily with the biological aspects of growing trees. Social, economic, and philosophical considerations are also involved. The context of forest management always involves multiple, sometimes competing, needs and ecological awareness. The purposes of the following activities are to give students the opportunity to (1) compare a well managed forest with a poorly managed one, (2) examine ways natural and man-made change in the plant community relate to desired goals and resources, (3) become better stewards of our future forests, and (4) better understand our connections to the natural world.

Silviculture has been practiced for hundreds of years. Forests are constantly growing and changing, passing through several stages such as: new, static, growing, old, changing, or dying. Forest managers attempt to imitate nature by creating conditions that also may occur naturally in the forest. Through acquaintance with some of these forestry practices, it is hoped that the student will be led to realize the necessity of planning, and the effectiveness of educated responses for sustaining forests. The multiple benefits of forests – economic, environmental, recreational, and numerous others – are protected, renewed, and enriched through sustainable forest management.

Sometimes wind, fire, ice storms, or infestations by insects or disease can severely damage or even kill a forest in a short time. When the forest regrows, the new trees are all about the same age, even

*though size may vary with growth rates. This type of forest is called "**even-aged.**" A forest may grow for many years with only small groups or individual trees dying. This provides open spaces that soon will be filled by young trees. These forests are called "**unevenaged**."*

Different cutting practices (management practices) are used to imitate nature's methods of regenerating a forest:

Even-aged
Clear-cutting: *the removal of all trees larger than one inch in diameter from a specific area.*
Shelterwood cutting: 40–60% of the trees are removed, allowing new trees to become established in partial sunlight, under the shelter of the remaining older trees. Once the new trees have gotten established, the removal of the remaining older trees may take place. **Seed tree cutting**: removal of most of the trees in one cut, leaving a few, well distributed, good seed producers over the area.

Uneven-aged
Group selection: *small groups of trees are cut in selected areas. This creates openings for regeneration of trees that require partial sunlight.*

Individual tree selection: *trees of various sizes, dispersed throughout the forest, are individually selected for cutting. This creates small openings for the establishment of shade-tolerant species.*

Some trees that grow best in an even-aged forest, because of their need for direct sunlight are Aspen, Black Cherry, Oak, Hickory, Douglas-fir, White Pine, Red Pine, Loblolly Pine, and Lodgepole Pine.

Some trees that thrive in the shaded environment of an uneven-aged forest are Maple and Beech. (Some coniferous trees that may be found in the understory of an uneven-aged forest are Balsam Fir, White Cedar and Hemlock.)

Each type of forest provides differing wildlife habitat. Different birds and animals are found in the different forests.[1]

Not all forests are "in the woods." In urban communities, trees also have many values. These values may be aesthetic, social, historic, or environmental. Trees have been of aesthetic importance to people since the earliest civilizations. The term "urban forestry" is relatively new (Jorgensen, 1970). However, certain practices and disciplines that make up the field of urban forestry have been long established and valued.

Urban and community foresters specialize in managing the many acres of forests that grow in and around metropolitan communities. They pay close attention to factors that affect those forests, such as limited growing space, polluted air, lack of water, poor soil quality, utility line maintenance, and vandalism. Tree selection is a critical part of urban and community forest management. A forester must be knowledgeable about which trees can withstand the various stresses and limitations present in the urban environment.

Urban and community foresters may work with real estate developers to save existing trees, and with municipal governments in establishing tree boards or commissions. Urban and community foresters may be trained in traditional forestry schools or may come from other disciplines, such as horticulture or landscape architecture.

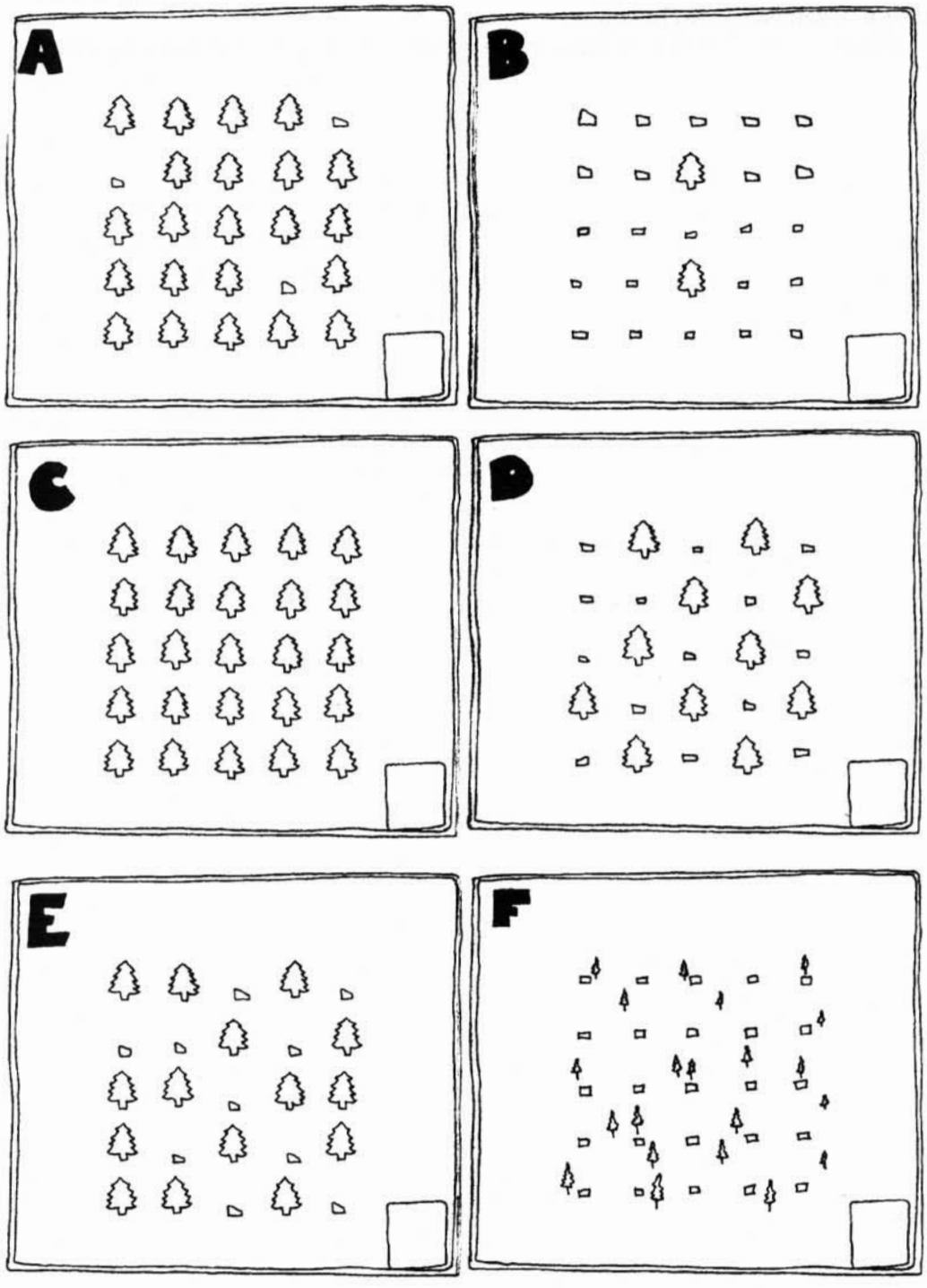
1. *"Silviculture: A Forest Gem," in Spruce Up America, Teacher Assistance Packet Grades K-6, Adirondack Teacher Center.*

STUDENT PAGE

FOREST STAND PUZZLE

Please number boxes A to F in a logical sequence.

On back of this page, describe the sequence of events and what actions were taken in each box.



Source: Project Learning Tree K-8 Activity Guide: p. 251

Subjects:
Science, English, Art, Geography, Social Studies, Career Exploration

Objectives:
1. Students will be challenged by the many decisions involved in the management of natural resources.
2. Students will describe the forest as a manageable natural resource and identify **the** process as silviculture.
3. Students will describe purposes or goals in managing a forest.
4. Students will compare managed forests with ones that are natural (unmanaged) or poorly managed.
5. Students will be able to identify general management approaches by which forests and tree stands are renewed or established.
6. Students will learn the dynamics of a forest system.
7. Students will learn how they are connected to the forest/natural resources.
8. Students will learn how to seek the facts before making decisions.

Skills: Observing, discussing, evaluating, researching, interpreting, predicting, comparing and contrasting, formulating questions, identifying relationships and patterns, identifying attributes and components

Materials:
- ♦ Forestry CD

ACTIVITY 1
FORESTRY CD/FORESTER'S VISIT

Procedure:
1. Discuss the benefits of forests with the class. Ask them how they personally benefit from forests. Discuss silviculture with the class.
2. Divide students into groups and have them play the Management Practices section on the Forestry CD.
3. Contact your local forester. Invite them to your classroom to discuss forest management. Let the forester know that your students are researching even-aged and uneven-aged forest management. If possible, they may be able to accompany your class to sites in your area where forest management practices have been used.

Subjects:
Science, Language Arts

Objectives:
1. Students will be challenged by the many decisions involved in the management of natural resources.
2. Students will describe the forest as a manageable natural resource and identify the process as silviculture.
3. Students will describe purposes or goals in managing a forest.
4. Students will compare well managed forests with ones that are poorly managed.
5. Students will be able to identify a well managed area and contrast it to a poorly managed area.
6. Students will be able to identify general management approaches by which forests and tree stands are renewed or established.
7. Students will learn the dynamics of a forest system.
8. Students will learn how they are connected to the forest/natural resources.
9. Students will learn how to seek the facts before making decisions.

Skills: Observing, predicting, comparing and contrasting, classifying and categorizing, identifying attributes and components, interpreting, composing, formulating questions, team building, problem solving, fact finding.

Materials:
- Forestry CD
- Picture of Well Managed Stand of Trees (Appendix B)
- Picture of Poorly Managed Stand of Trees (Appendix B)
- Student journal
- Question list for board (see procedure)

ACTIVITY 2
LOOKING AT FOREST STANDS

Procedure:
1. Divide students into groups.
2. Discuss well and poorly managed stands of trees.
3. Give each group a copy of the pictures of the well managed and poorly managed stand of trees or make transparencies of the pictures to be shown to the class.
4. If possible, take students outside to a nearby woods or stand of trees and ask them to compare it to the stands in the pictures.
5. Ask questions to focus students on comparing stand characteristics. Example: "How does it compare with the characteristics we discussed in a well managed stand of trees?
6. Have the students write and/or draw their observations in their journal as a data recording activity.
7. Have the students review the "Forest Management Practices" section of the Forestry CD. Ask students to respond to the following questions using their information in the CD. Write the questions on the board.
   a. What tree characteristics do you see in these pictures that represent good management of the forests for a specific purpose?
   b. Can multiple benefits be achieved?
   c. What characteristics do you observe in this stand that may be important to manage for the potential use of these trees for (1) aesthetic purposes (2) diversity of wildlife, (3) manufacturing construction lumber, and (4) other purposes?
   d. What would a forester need to do to maintain such a forest?
   e. What silvicultural practices might a forester incorporate to help produce the best possible forest for a specific purpose?

Activity 2 is adapted from: "Managing Our Forest Resources," in Natural Resources Education Series, USDA Forest Service.

Subjects:
Science, Art, Language Arts

Objectives:
1. Students will be challenged by the many decisions involved in the management of natural resources.
2. Students will describe the forest as a manageable natural resource and identify the process as silviculture.
3. Students will describe purposes or goals in managing a forest.
4. Students will compare well managed forests with ones that are natural (unmanaged) or poorly managed.
5. Students will be able to identify a well managed area and contrast it to a poorly managed area.
6. Students will be able to identify general management approaches by which forests and tree stands are renewed or established.
7. Students will learn the dynamics of a forest system.
8. Students will learn how they are connected to the forest/natural resources.
9. Students will learn how to seek the facts before making decisions

Skills: Analyzing, classifying and categorizing, comparing and contrasting, composing, interpreting, representing, projecting future needs, team building, problem solving.

Materials:
- Forestry CD
- Brown construction paper
- Green construction paper
- Toilet paper or paper towel rolls (empty, of course!)
- Clay
- Cardboard (for base of diorama)
- Poster board
- Scissors
- Markers/crayons/paint
- Glue/paste

ACTIVITY 3
MANAGEMENT DECISIONS

Procedure:
Students can do the following individually or in cooperative groups:

1. Have students review the Forestry CD and choose a forest management technique that they would like to illustrate using a poster or diorama.
2. Once they have decided, hand out the materials they will need and allow them ample time to complete their project. (You may choose to assign different techniques, to ensure that all are represented.)
   Students can paint the toilet paper rolls and paper towel rolls brown or cover them with brown construction paper to make tree trunks. These can be cut to different sizes for trees and tree stumps. The leaves or needles can be made from green construction paper that has been cut into the desired shapes and attached to the top of the "trunk." Students can use the clay to hold the "trees" and "stumps" onto a piece of cardboard.
3. After they have completed their projects, they will write a short report about the forest management technique that they chose to illustrate. Some questions they may want to answer are:
   a. Which silviculture technique did you choose?
   b. Describe what the forest manager did to this site.
   c. Which type of trees grow best in your managed area?
   d. What do you perceive as the long term benefits of the forest management technique that you chose to illustrate?
4. Have students give an oral report to the class, using their illustration and their written report.
5. Discuss all of the finished projects with the class. Review all of the silviculture techniques, and discuss the benefits to the forest habitat.

Extensions:

1. Invite a local forester to class and have him/her listen to the oral reports.
2. Contact your local Soil and Water Conservation District office to have someone come to your class to discuss the soil of forest sites and how it relates to the silviculture technique that is chosen.
3. Contact a wildlife biologist or naturalist. Ask them to come to your classroom to discuss the wildlife that will benefit in each type of managed forest.
4. Display finished projects in the school library, town library, local forestry office, local soil conservation district office or any other location where the students' work would be visible to the community.

Subjects:
Science, Math, Social Studies

Objectives:

1. Students will be able to identify tree species using a key.
2. Students will be able to measure/calculate tree diameter and height.
3. Students will be able to record tree data using charts, graphs, and tables.
4. Students will better understand field skills necessary in forest resource management.
5. Students will understand the concepts behind forest resource management.
6. Students will be able to draw maps and understand mapping.

Skills: Interpreting, comparing and contrasting, generalizing, evaluating, classifying, categorizing, identifying attributes and components.

Materials

- Forestry CD
- Sample Inventory Sheet (Appendix B) street keys and identification guides
- Maps of inventory area (school grounds, village streets)
- Measurement equipment (tape measure, diameter tape, Biltmore Stick, etc.)
- Clipboards (optional)
- Paper
- Pencils

ACTIVITY 4
MANAGING THE URBAN AND COMMUNITY FOREST – TREE INVENTORY

Preparation:

1. Gather materials for class: measuring equipment, maps, Forestry CD, tree identification keys.
2. Secure permission from village/school/landowners as needed.
3. Review Forestry CD Summer Key use and data collection skills (tree measurement, pace, etc.) in Forestry CD Tools Section prior to field work.
4. This would be an ideal time to ask your state urban and community forestry program to provide a speaker to describe the process actually used in your region.
5. Contact your country or municipality and inquire about a section of the city, your neighborhood, or a park that needs a comprehensive or updated inventory. Ask them what information should be in the inventory (address, feet in from curb/highway, height, diameter or circumference, crown spread, etc.).
6. Discuss the benefits of the community forest. Why is it important?

Procedure:

1. Have students research types of trees native to their state and adapted to the area being inventoried. Identify trees that are best suited to the area the students are to survey.

2. Have students review information to be collected and have the class develop a data collection sheet. (See sample in Appendix B, but have students develop a format themselves.)
3. Organize class into data collection teams according to inventory area, supervision needs, and materials/equipment limitations.
4. Conduct inventory field work collecting all data necessary (address, distance from curb or street, distance from corner, species, diameter, height, etc.)
5. Create inventory maps and compile appropriate data using charts, tables, graphs or any combination thereof.
6. Optional:
    a. Have students research information on how to assess the general health/condition of trees.
    b. For trees found to be in serious trouble, have students use information gathered in Activity 1 and include in their report recommendations for replacement trees.

ASSESSMENT ACTIVITY
FOREST MANAGEMENT PRACTICES SECTION

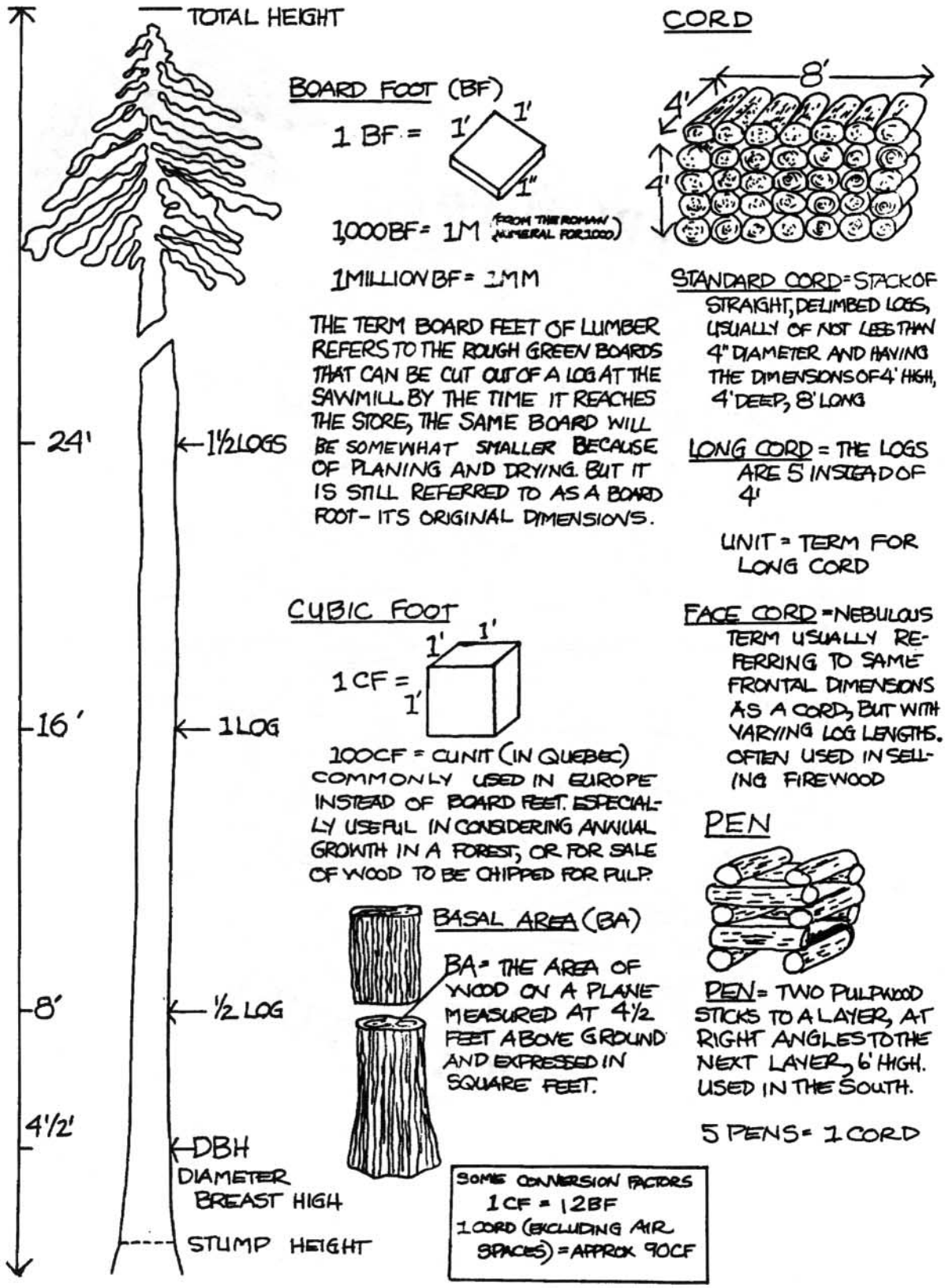
Have students construct a report containing findings, evaluations, and recommendations gathered in **Steps 1,2,3, and 4** of **Activity 4** above. Have students submit this report to the appropriate school, civic, or government authority.

Our Daily Wood

Every day,
each of Earth's
5.4 billion inhabitants
uses this much wood- about
one-half gallon on the average
But the average American uses 3.5
times this much wood. Should Americans
be using less wood? Steel, aluminum,
plastics, and concrete are often mentioned as
substitutes for wood, but these resources are not
renewable. Wood is the only natural resource on
Earth that is renewable, recyclable and biodegradable.
The only energy required to grow a tree is the sun. As
trees grow, they remove carbon dioxide from the air, and
give off oxygen. By weight, total U.S.wood consumption
exceeds combined consumption of steel and concrete. Wood
manufacturing processes consume only 4% of the energy used
by all primary industrial raw material manufacturers. Steel and concrete
manufacturers consume 56% of the energy used by all primary industrial
raw material manufacturers. If the energy required to manufacture this four-
pound block of wood had been used to make aluminum, the resulting piece
would weigh one ounce. Global demand for wood will increase by 50% by the
year 2020, but governments around the world are establishing more new forest
preserves where harvesting is prohibited. Left unanswered is this critical question:
Where will we get our daily wood? We believe the world should be using more wood,
not less, because no other natural resource on Earth can match its environmental advan-
tages. But first nations must make major global commitment to growing our daily wood
just as we do our daily bread. For more information about our daily wood contact:
The Evergreen Foundation, 4025 Crater Lake Hwy, Medford, OR 97504.

Source: Evergreen Magazine Forest Facts Book: p. 22–23

THE UNITS OF WOOD



Source: The Woodland Steward, p. 25.

FROM TREES TO LUMBER AND FUEL

We are all consumers of the commodity, **wood**, which comes from trees. Wood is consumed in many ways, e.g., fuel for heat and cooking, framing for houses, furniture, pulp for paper, etc. *More than 3.4 billion cubic meters of wood are extracted from the world's forests and woodlands each year, roughly half for fuel and half for lumber, plywood, paper and other industrial products*.[1] Good forest management practices have ensured that there are more trees available in the United States today than there were in 1850. The September 1992 Journal of Forestry stated: … *one reason we cut trees is that each American uses the equivalent of a 100-foot tree each year. To get some idea of how many trees we have grown and used since 1900, start with 76 million people living in the United States in 1900. By 1990, we had grown to more than 250 million people. So, from 1900 to 1990, we grew and used the equivalent of 14 billion 100-foot trees. And, because of good forest practices, America's beautiful green forests are the envy of the world. We still have more than two-thirds of the forestland we had when Columbus discovered the New World*.[2] Consumers have a responsibility to continue to use wisely the natural resources available to them and thereby help ensure the continued abundance of trees and all of the goods and environmental benefits (wildlife habitat, clean water, clean air, and aesthetics) derived from forests.

Lumber, plywood, paper and other industrial products:
The *Trees to Lumber* section on the Forestry CD explains the steps in the process of producing lumber, beginning with removal from the forest to production at the sawmill. Students will have an opportunity to become knowledgeable about the natural, capital, and human resources necessary to produce lumber and other industrial products. Lumber and other industrial products are goods (wares, merchandise) produced by many industries for human use.

Businesses (producers) use natural, capital, and human resources to make goods or perform services that society values. Natural resources are the raw materials used in production like plants, animals, soil, water and minerals. Some are renewable and some are non-renewable. Human resources include both the labor that makes the product or performs the service, and the entrepreneur who organizes the production process. Capital resources are the tools that are used to make the goods (factories and machines) or transport them (trucks and ships). Capital resources have changed significantly through time. We are all producers and consumers in society. Every producer depends upon other workers to be able to make a living. Consumers are the users of goods and services, and we are all consumers.

Fuel and heat:
In 1875, wood supplied 75% of the energy needs in the United States. Wood was replaced by coal in the early 1900's. By 1946, oil and gas provided the bulk (70%) of the nation's energy requirement. In the United States, the use of wood as a fuel has enjoyed a rebirth in popularity ever since the oil shortages of the 1970's. The use of wood as a fuel increased 45% during the period of 1975 to 1980. In some countries around the world, wood still is, and probably will remain, the main source of fuel for cooking and heating.

In the United States, people have returned to using wood as a fuel for many of the same reasons people in other countries have always used wood, namely, other fuel sources are unavailable, nonrenewable, or are too expensive. In this unit, your students will explore the use of wood as a fuel. They will specifically discover the characteristics, advantages, and disadvantages of fuel wood.

Pound for pound all wood produces about the same amount of heat energy. A pound of dry hardwood will produce about 8600 B.T.U.s of heat energy when burned. Because of high resin content some conifer wood may produce slightly over 9000 B.TU.s. Most hardwoods and some tropical woods are denser than conifers, and on a volume basis contain more heat value.[3]

Although the Forestry CD does not directly address the use of timber as a fuel, an activity involving this aspect has been included to facilitate student understanding of processing and usage of **wood as a renewable source of energy**.

1. *Postel, Sandra and Ryan, John C., "Reforming Forestry" in State of the World 1991 A Worldwatch Institute Report on Progress Toward a Sustainable Society, pp. 75–76.*
2. *"Trees the Renewable Resource That Benefits Both People and the Environment," in Journal of Forestry, September 1992, p. 12.*
3. *Wood Used for Fuel And Heat Curriculum for Middle School Social Science, Florida Ag in the Classroom, Inc.*

Subjects:
Economics, Sociology, Social Studies, Science, Language Arts

Objectives:
1. Students will define natural, capital, and human resources.
2. Students will distinguish between renewable and non-renewable resources.
3. Students will trace the process of the transformation of a tree to lumber.
4. Students will identify the resources in the transformation of a tree to lumber.

Skills:
Defining, processing, analyzing, evaluating, predicting, classifying, identifying attributes, researching, writing

Materials:
- Forestry CD
- Pencil and paper

ACTIVITY 1
LOOKING AT RESOURCES
A CAPITAL IDEA

Procedure

1. Discuss natural, capital, and human resources with the students. Help them realize the difference between renewable and non-renewable.
2. Have students play the Trees to Lumber Section on the Forestry CD.
3. Have the student imagine he/she is going to the lumber yard to purchase lumber to frame a house.
4. Have the student list the steps in the process from tree to lumber and identify the resources used in each of the following steps:

   Step one: In the forest
   Step two: From the forest to the sawmill
   Step three: At the sawmill
   Step four: At the lumber yard

5. For each step, have the students identify the following resources used:

   Natural Resources: Renewable, Non-renewable
   Capital Resources
   Human Resources

6. Have students individually or in groups research and write a report on one of the following:
   a. The student imagines he/she is going to the lumber yard to purchase lumber to frame a house in the year 1850 in their home state or territory.
   b. The student is a lone woodsman who builds a home on the Colonial frontier in the year 1750.
   c. Have students check on the price of wood vs. steel 2 by 4's at their local lumberyard. Discuss the properties of wood and steel in terms of renewability, recycling, the tools needed, and energy costs of extraction and manufacturing.
7. Have the students list the steps from tree to lumber and identify the resources used in each step.
8. Ask them the following questions:
   a. Have the natural resources changed over time? Explain.
   b. Have the capital resources changed over time? Explain.
   c. What other changes did they discover? Explain.

Subjects:
Language Arts, Social Studies, Economics

Objectives:
1. Students will observe the process of transforming trees into lumber.
2. Students will identify the human, capital, and natural resources used in this process.
3. Students will observe the collection and proposed use of the by-products of the sawmill process.

Skills: Observing, categorizing, interpreting data, evaluating

Materials:
- Sawmill
- Permission slips

ACTIVITY 2
FIELD TRIP TO A SAWMILL

Procedure
1. Before the trip have the students review the Trees to Lumber Section of the Forestry CD and become familiar with the names and uses of the machinery and tools used in the sawmill.
2. At the sawmill, and later in class, have students chart–either in words and pictures or a combination of the two—the process that begins with the felling of a tree and ends with the purchase of a board by a consumer:
   Sale of trees
   Methods/result of harvesting
   Procedures used in the mill
   Use of by-products (bark, sawdust, etc.)
   Sale of product to wholesalers/retailers

Subjects:
Language Arts, Social Studies, Economics, Geography

Objectives:
1. Students will research the raw materials, methods, products, and resources employed in their local sawmill.
2. Students will compare and contrast the raw materials, methods, products, etc. of a sawmill in another USDA Forest Service region.

Skills: Writing, evaluating, comparing, categorizing

Materials:
- Forestry CD
- Paper, pens, envelopes, stamps
- Addresses of local sawmill owners
- USDA Forest Service regional information (Appendix B)

ACTIVITY 3
MILLS APART

Procedure:
1. Give students a list of the names and addresses of local sawmills.
2. Have students locate each sawmill on the state map.
3. Have students write (individually, or as groups) to one sawmill owner and ask the following:
   a. How long the sawmill has been in existence?
   b. How long the present owner has been involved with the sawmill?
   c. The primary species processed in the sawmill?
   d. The primary source of the sawmill's trees—geographic area, company land, or from Federal, state or private land?
   e. The primary purchasers of the sawmill's primary product (lumber) and secondary products (bark, sawdust).
   f. Changes from past years in consumers, uses of sawmill products, sources of trees, and machinery/methods of the sawmill.

4. Give students the following information:
   - ***USDA Forest Service regional information*** (Appendix B)
5. Have students write (individually, or as groups) to sawmill owners in other USDA Forest Service regions and ask the same questions as in Procedure 3, above. **Note:** The teacher may want to assign regions to individuals or groups to be sure that a good cross section of information will be gathered.
6. Have individual students or groups compare information gathered in steps 3 and 5 above.
7. As a section assessment activity, have students (individually or in groups) present findings to the class.

Subjects:
Science, Language Arts

Objectives:
1. Students will reinforce tree identification skills.
2. Students will understand the differing uses of trees.
3. Students will utilize research procedures.
4. Students will define the term native species.

Skills:
Comparing, contrasting, analyzing, researching

Materials:
- Forestry CD
- Tree identification guides and keys

ACTIVITY 4
NATIVE WOOD

Procedure:
1. Define the term native wood.
2. Have students research trees on the Forestry CD summer key and list those that are native to their area.
3. Research differences in the wood produced by five native trees and the products commonly manufactured from those trees.

Subjects:
Language Arts, Economics, Geography, Social Studies

Objectives:
1. Students will follow the economic impact of the timber industry.
2. Students will examine the global involvement of trade.
3. Students will research economic and social factors affecting goods.

Skills: evaluation, analyzing, researching, writing, comparing, contrasting

Materials:
Tree identification guides and keys

ACTIVITY 5
NON-NATIVE WOOD
The Princess Tree (*Paulownia tomentosa*)

Procedure:
1. Have the students research this fascinating tree.
2. Ask them to determine when it was introduced into this country and its country or region of origin.
3. Have the students write a report on what economic, social, and cultural values are placed on this tree in the United States and in the country(ies) of origin?
4. Ask them to determine where the major eastern shipping port for this product located? (*Hockessin, Delaware*)

Subjects:
Science, Social Studies, Math, Economics

Objectives:
1. Students will understand the meaning of density.
2. Students will contrast present and changed life styles.
3. Students will realize the effect of technology on their lives.
4. Students will examine the extent of various sources of pollution.

Skills:
Comparing, contrasting, debating, evaluating, research, writing

Materials:
- Wood samples

ACTIVITY 6
USING WOOD AS A FUEL

Procedure:
1. Lead the class into a discussion about using wood as a fuel by having the students list all current energy sources. **Remember** – electric energy originates with nuclear, coal, oil, wind, solar, water, or gas power.
2. Ask if any of the students use wood in their homes.
3. Ask the students to assume they have only wood to use as a fuel. In small groups have students discuss how this would affect their lives. Sample discussion follows:

I. Why do we need energy?
   a. To cook with
   b. To heat our homes
   c. To make our cars go
   d. To cool our homes
   e. To operate machinery and factories
   f. To light our homes, schools, etc.

II. What sources of energy do we use?
   a. *Oil*
   b. *Coal*
   c. *Natural gas*
   d. *Solar*
   e. *Wood*
   f. *Nuclear*
   g. *Wind*
   h. *Water*

III. Do any of you use wood as a fuel in your home: What does it do?
   a. *heats our home*
   b. *cooks food, boil water*

IV. Why do you use wood?
   a. *May have a plentiful supply*
   b. *Is pleasant to smell, (see aesthetic)*

V. If wood were the only source of energy, imagine differences in your home. Think about your house, and take out all the gas and electric appliances, replacing them with a fireplace, woodstove, and wood furnace. How would this change your life?
   a. *You would spend time finding and cutting wood.*
   b. *Time would be needed for chopping and splitting wood.*
   c. *To cook with, you would need to build a fire beforehand. You cannot instantly "turn on" a fire.*
   d. *"c" also applies to heating.*
   e. *Fires must be tended – wood added and fire stoked.*

   These are the tasks that pioneers in this country had to perform. It took a lot of time, every day, all year, to maintain their wood supply. People still use wood as a fuel in many countries today. And it is as important to them today as it was to the pioneers of our nation.

VI. What are advantages of using wood as a fuel?
   a. *We use less oil, coal, (fossil fuels) which are non-renewable resources.*
   b. *We use a renewable resource which is less polluting. We can always plant trees.*
   c. *There is wood available for use as fuel, which otherwise would be wasted (by-product of the timber industry and land development.)*

4. Have students bring in pieces of wood that can be used as fuel. Discuss the merits of each.
5. Have students locate sources of wood in the community both free and for sale.
6. Have students write an essay on wood as a fuel and how and where it could be used in our society to reduce the amount of fossil fuels we consume.

7. **Wood density:**
   a. Have students research (library or Internet) the wood density of the following trees: Ash, Black Tupelo, Black Willow, Eastern Cottonwood, Northern Red Oak, Quaking Aspen, Red Maple, Shagbark Hickory, Southern Red Oak, Sassafras, Sugar Maple, Sycamore, White Birch, White Oak, Yellow (Tulip) Poplar, and rank the trees as to their energy value for fuel and heat.

   Note: Density is defined as *the quantity of something per unit volume, unit area, or unit length*. *A Density of Trees and Heat Produced* chart listing the density of the above trees is included in Appendix B for the teacher.

8. Using the wood samples brought into class, or lumber samples from saw mills or lumber yards, have the students develop a laboratory activity which demonstrates the differences in density of various woods.

9. Following laboratory safety precautions, have students use a calorimeter in science laboratory to measure the differences in heat potential of the different wood samples.

10. Have students discuss the generation of "greenhouse gases" from wood burning, as opposed to fossil fuel burning.

ASSESSMENT ACTIVITY
TREES TO LUMBER AND FUEL SECTION

The combination of field trips and evaluations, correspondence with mill owners, research and reports will serve as a cumulative evaluation instrument for this section.

Student Worksheet 1 Early Measurements Group No. _____

	Hand span	Arm span	Nose to thumb	Cubit
Student 1				
Student 2				
Student 3				
Student 4				
Student 5				
Average				

	Length of classroom	Side of desk	Door height	Ceiling height
Student 1				
Student 2				
Student 3				
Student 4				
Student 5				
Average				

Using Yardstick:

	Length of classroom	Side of desk	Door height	Ceiling height
Student 1				
Student 2				
Student 3				
Student 4				
Student 5				
Average				

	Circumference of trunk	Height of tree
Student 1		
Student 2		
Student 3		
Student 4		
Student 5		
Average		

Student Worksheet 2 **Group No. _____**

Native American Method of Measuring Tree Height

	Number of steps to tree	Estimated height of tree
Student 1	_____	_____
Student 2	_____	_____
Student 3	_____	_____
Student 4	_____	_____
Student 5	_____	_____
Average	_____	_____

Using a person of known height to determine the height of a tree

Height of person standing at tree _____

Number of pencil lengths to top:

Student 1	_____
Student 2	_____
Student 3	_____
Student 4	_____
Student 5	_____
Average	_____

Estimated height of tree _____

Student Worksheet 3 **NAME** _____

DETERMINE LENGTH OF STEP

Procedure:

Walk 2 times (in a normal step) the distance marked off. Record number of steps you took each time.

Number of steps 1st time _____

Number of steps 2nd time _____

Total steps (A). _____

Total number of feet in distance walked (B) _____

_____	÷	_____	=	_____
(B) (total distance walked)		(A) (total steps taken)		(C) (number of feet in each step)

Student Worksheet 4 **NAME** _____

DETERMINE LENGTH OF PACE

A pace is two steps. To calculate the length of your pace, **measure out a distance of 200 feet on the ground. At your normal walking speed, walk the distance several times**. As you walk, **count the number of paces you take to go 200 feet. Walk the distance four times, and take an average of the last two or three attempts**. If **you start out walking on your right foot, count the number of times that you step with your left foot**. Most adults have a pace of about 5 feet.

Procedure:

Walk 4 times (in a normal step) the distance marked off. Record number of paces you took each time.

Number of paces 1st time

Number of paces 2nd time

Total steps (A)

Total number of feet in distance walked (B)

_____	÷	_____	=	_____
(B) (total distance walked)		(A) (total paces taken)		(C) (number of feet in each step)

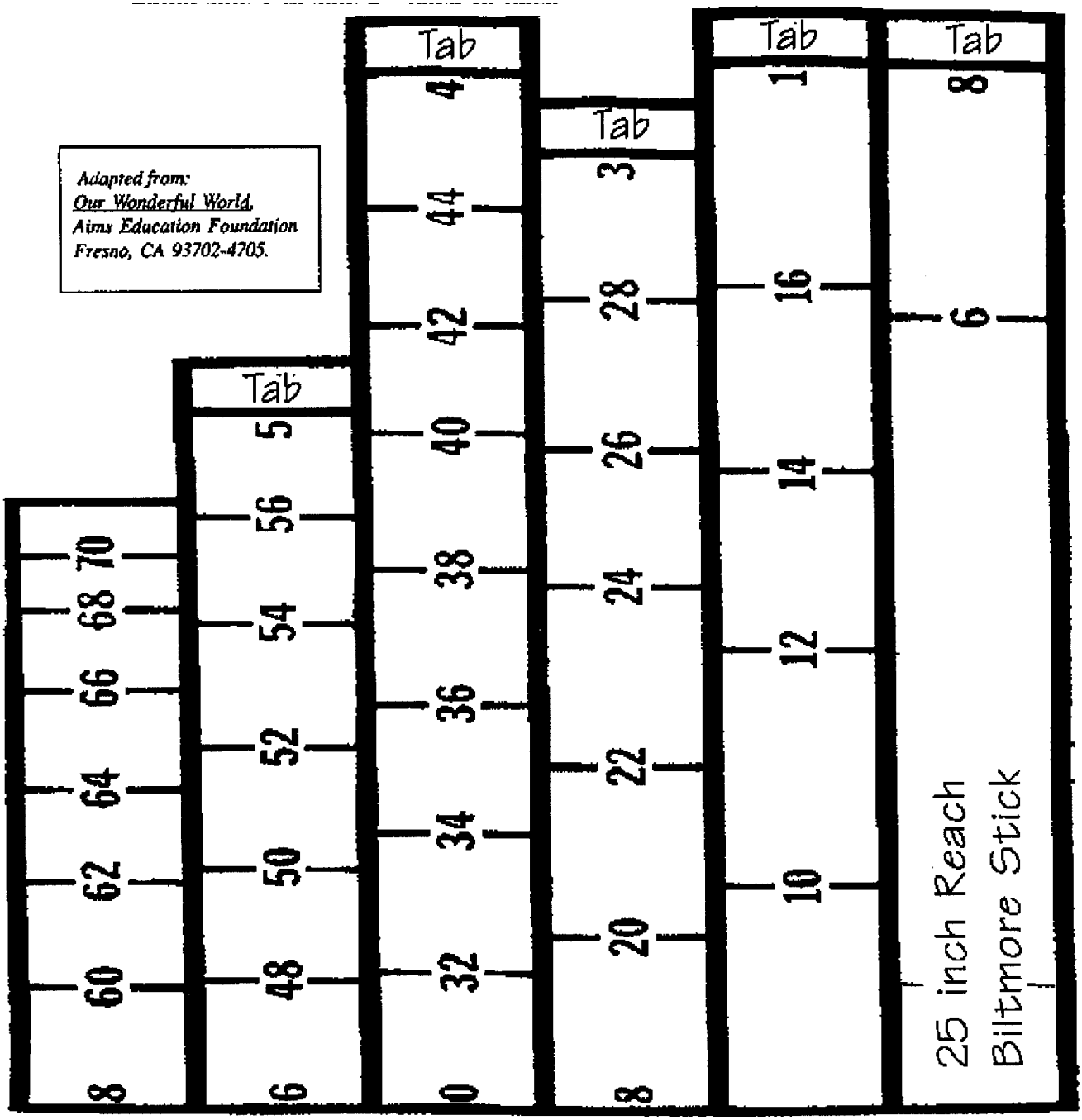
NOTE: Round the length of your pace to the nearest half foot: 4′, 4½′, 5′, 5½′

STUDENT WORKSHEET 5a

MAKE A BILTMORE STICK

Side 1 of Biltmore Stick *copy side 1 and side 2 separately

- **Cut on heavy black lines**
- **Join each section at tabs**
- **Join side 1 to side 2 - back to back**



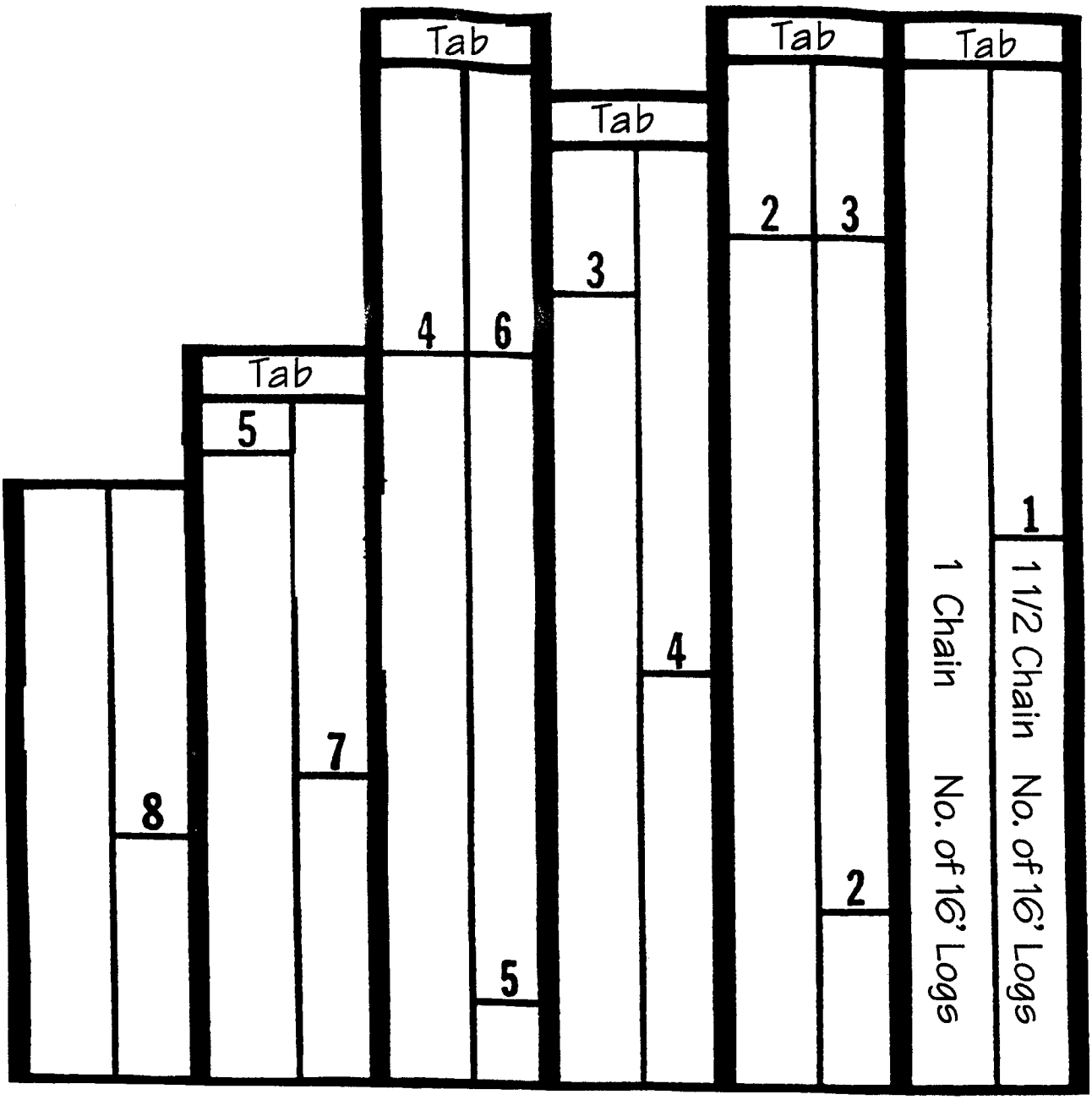
Adapted from:
Our Wonderful World,
Aims Education Foundation
Fresno, CA 93702-4705.

STUDENT WORKSHEET 5b

MAKE A BILTMORE STICK

Side 2 of Biltmore Stick (Hypsometer)

- **Cut on heavy black lines**
- **Join each section at tabs**
- **Join side 1 to side 2 - back to back *attach to sheet of cardboard/yardstick**



Student Worksheet 6 **Group No. _____**

Tolling on through the CD

a. Diameter of the tree:

	Measurement 1	Measurement 2	Average
Student 1	_____	_____	_____
Student 2	_____	_____	_____
Student 3	_____	_____	_____
Student 4	_____	_____	_____
Student 5	_____	_____	_____
Group Average	_____	_____	_____

b. Height of the tree:

	Number of 16 foot logs in tree	Height of tree
Student 1	_____	_____
Student 2	_____	_____
Student 3	_____	_____
Student 4	_____	_____
Student 5	_____	_____
Group Average	_____	_____

c. Merchantable height of the tree:

	Number of 16 foot logs in tree	Merchantable height of tree
Student 1	_____	_____
Student 2	_____	_____
Student 3	_____	_____
Student 4	_____	_____
Student 5	_____	_____
Group Average	_____	_____
Number of board feet in the tree	_____	_____

Solve the problem:
How many trees like the one measured in **step c** would it take to build three average U.S. homes?
Note: *An average U. S. home contains approximately 16,900 board feet of lumber for the structural portions of the house.*

Answer: _____

Student Worksheet 7 **Name(s) _____**

USING A CLINOMETER

Tree number 1:

Angle of elevation _____

Tangent of angle of elevation _____

Number of paces from tree to clinometer _____

Number of feet from tree to clinometer _____

Height of tree _____

Tree number 2:

Angle of elevation _____

Tangent of angle of elevation _____

Number of paces from tree to clinometer _____

Number of feet from tree to clinometer _____

Height of tree _____

Tree number 3:

Angle of elevation _____

Tangent of angle of elevation _____

Number of paces from tree to clinometer _____

Number of feet from tree to clinometer _____

Height of tree _____

STUDENT WORKSHEET 8

Big Tree Worksheet

Date: _____

Your Name: _____ Home Phone: _____

Address: _____

City: _____ State: _____ Zip: _____

School District: _____

School: _____

Teacher's Name: _____ Grade: _____

Tree's common name: _____

Tree's scientific name: _____

Tree's location: _____

Land owner's name and address: _____
_____

A. Circumference (inches): _____

B. Estimated height (feet): _____

C. Crown spread (feet): _____

D. Divide answer to C by 4: _____

♦Fill in the blanks with the answers to the lettered questions.

_____ + _____ + _____ = _____

(A) (B) (D) (point total)

This answer is the point total for your tree.

♦♦If the point total of your Big Tree is equal to or greater than the point total of the same species (type) listed in your state's big tree registry or the National Registry of Big Trees, send a copy of this completed worksheet to the NRCE Coordinator at your State Forestry Office.

Student Worksheet 9 **Name _____ Group number _____**

Using a summer key

Leaf number _____ **Common Name _____** **Scientific Name _____**	**Leaf number _____** **Common Name _____** **Scientific Name _____**
Leaf number _____ **Common Name _____**	**Leaf number _____** **Common Name _____**

Student Worksheet 10 **Name** _____ **Group number** _____

Using a Summer Key

Station 1 _____

Common Name _____

Scientific Name _____

Station 2 _____

Common Name _____

Scientific Name _____

Station 3 _____

Common Name _____

Scientific Name _____

Station 4 _____

Common Name _____

Scientific Name _____

Station 5 _____

Common Name _____

Scientific Name _____

Station 6 _____

Common Name _____

Scientific Name _____

Station 7 _____

Common Name _____

Scientific Name _____

Station 8 _____

Common Name _____

Scientific Name _____

Station 9 _____

Common Name _____

Scientific Name _____

Station 10 _____

Common Name _____

Scientific Name _____

Station 11 _____

Common Name _____

Scientific Name _____

Station 12 _____

Common Name _____

Scientific Name _____

Station 13 _____

Common Name _____

Scientific Name _____

Station 14 _____

Common Name _____

Scientific Name _____

Station 15 _____

Common Name _____

Scientific Name _____

Station 16 _____

Common Name _____

Scientific Name _____

Station 17 _____

Common Name _____

Scientific Name _____

Station 18 _____

Common Name _____

Scientific Name _____

Station 19

Common Name _____

Scientific Name _____

Station 20 _____

Common Name _____

Scientific Name _____

Station 21 _____

Common Name _____

Scientific Name _____

Station 22 _____

Common Name _____

Scientific Name _____

Station 23 _____

Common Name _____

Scientific Name _____

Station 24 _____

Common Name _____

Scientific Name _____

Station 25 _____

Common Name _____

Scientific Name _____

Station 26 _____

Common Name _____

Scientific Name _____

Station 27 _____

Common Name _____

Scientific Name _____

Station 28 _____

Common Name _____

Scientific Name _____

Student Worksheet 11 **Name** _____

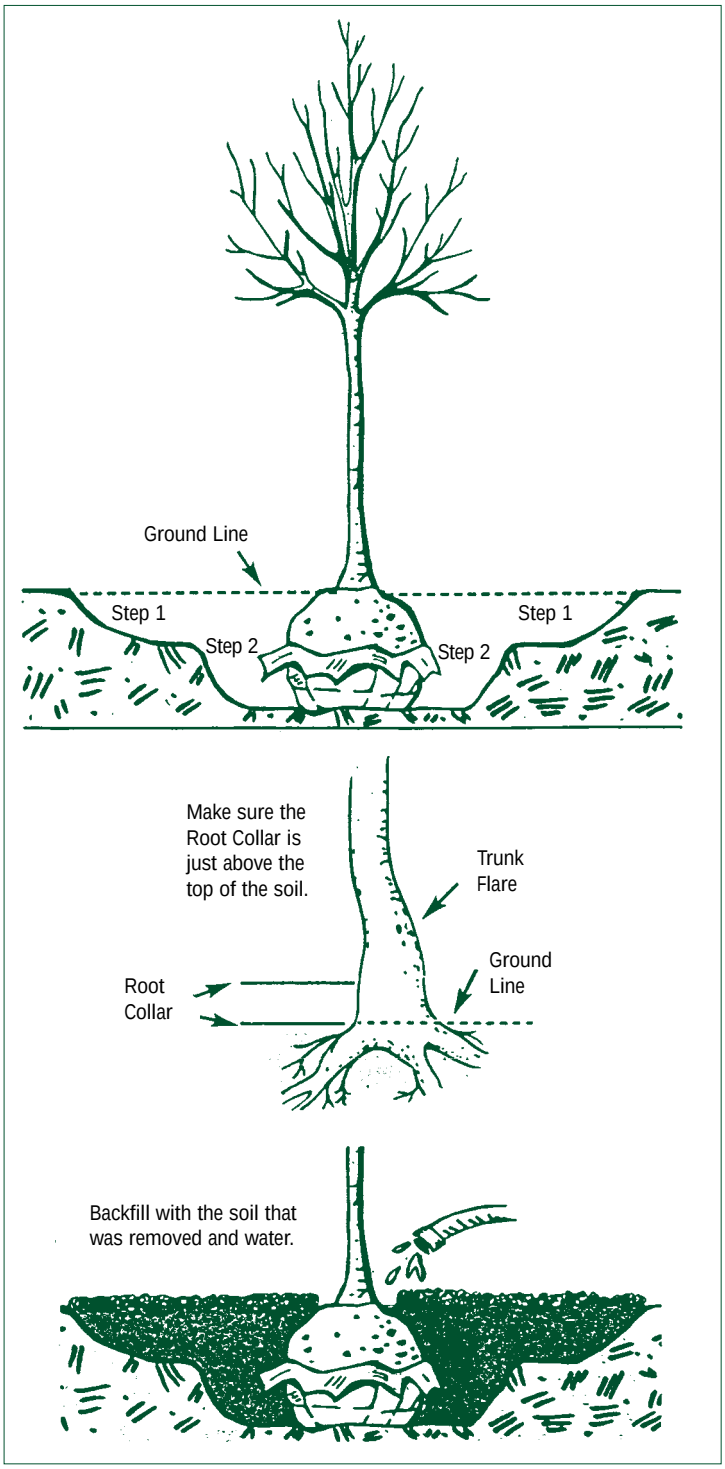
Map the Route

Plant A Tree The Right Way!

Containerized and Balled & Burlapped Trees and Shrubs

Select the right tree for the right site and …

- Measure how deep to plant the tree. The tree's root collar (right above the root system) should be just above the surface of the soil.
- Prepare the site by digging a wide saucer shaped hole 2 to 3 times larger than the root ball. *(Step 1)*
- Dig a second hole in the center of the large circle that is 1 foot larger in diameter than the root ball and as deep as the root collar maintaining undisturbed soil beneath the root ball. Don't dig the hole too deep. It is better to have the root ball 1-2 inches higher than ground level because of possible settling. *(Step 2)*
- Place the tree carefully in the center of the hole. Use care not to break the root ball. Position the tree as straight as possible and to the proper depth before back filling.
- Back fill the hole with the soil that was removed. As the back fill is added, lightly push the soil around the roots or water the soil to eliminate air pockets (do not pack the soil after you water). Continue to back fill to the height just below the root collar. Don't back fill the tree too deeply.
- Mulch with composted woodchips to a depth of 2" to 4" on top of the planting circle. Keep the mulch 6" away from the trunk to prevent fungus from growing on the tree trunk. The mulch helps to retain moisture, controls weed growth and protects the tree from mowers and trimmers.
- Water is very important to a newly planted tree. A slow, root saturating one-hour trickle once a week provides the new roots with sufficient moisture without drowning them. If it rains or is very dry, the watering schedule should be adjusted accordingly.

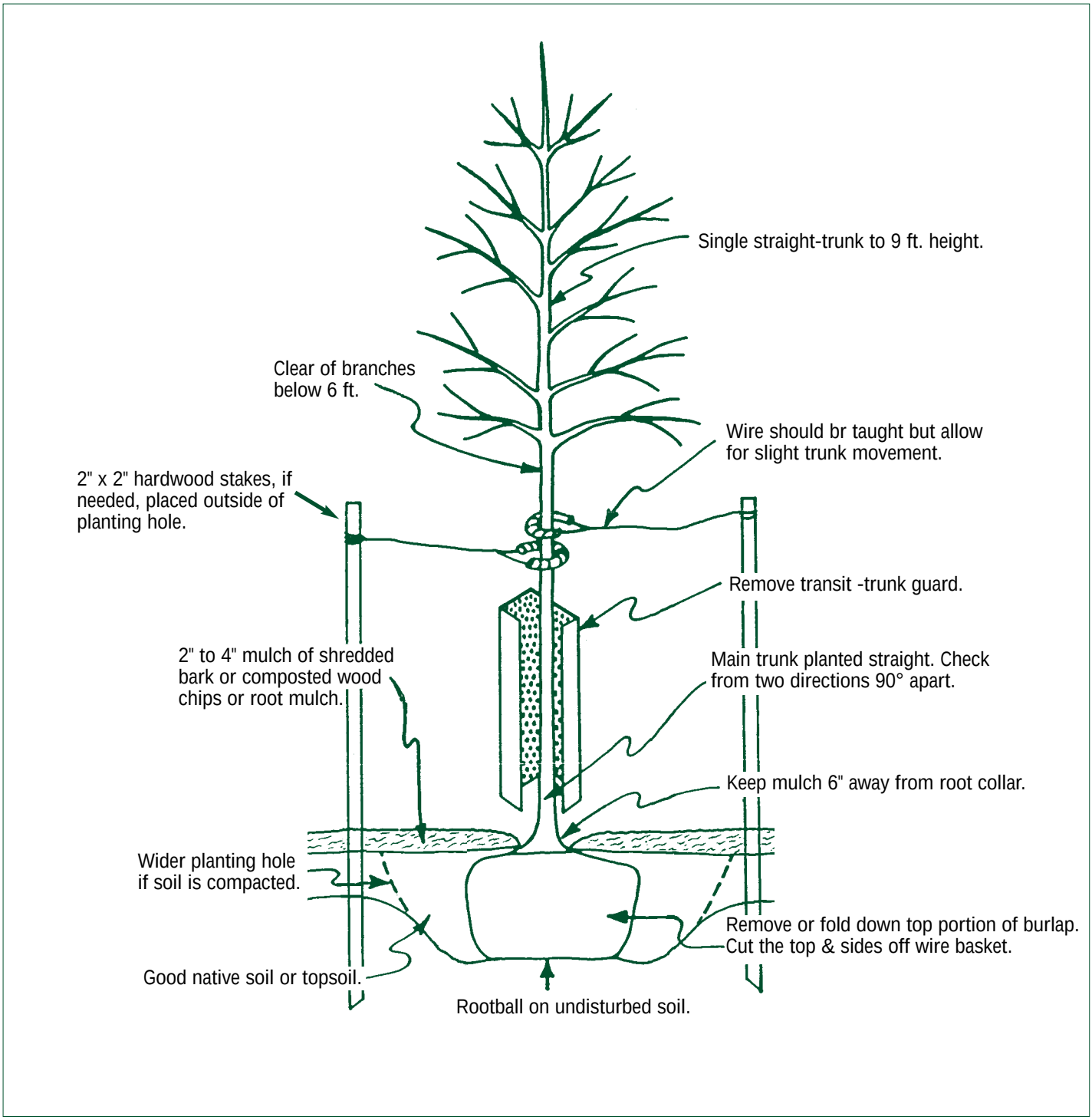


NJ Department of Environmental Protection
Division of Parks and Forestry • NJ Forest Service
370 East Veterans Highway • Jackson, NJ 08527

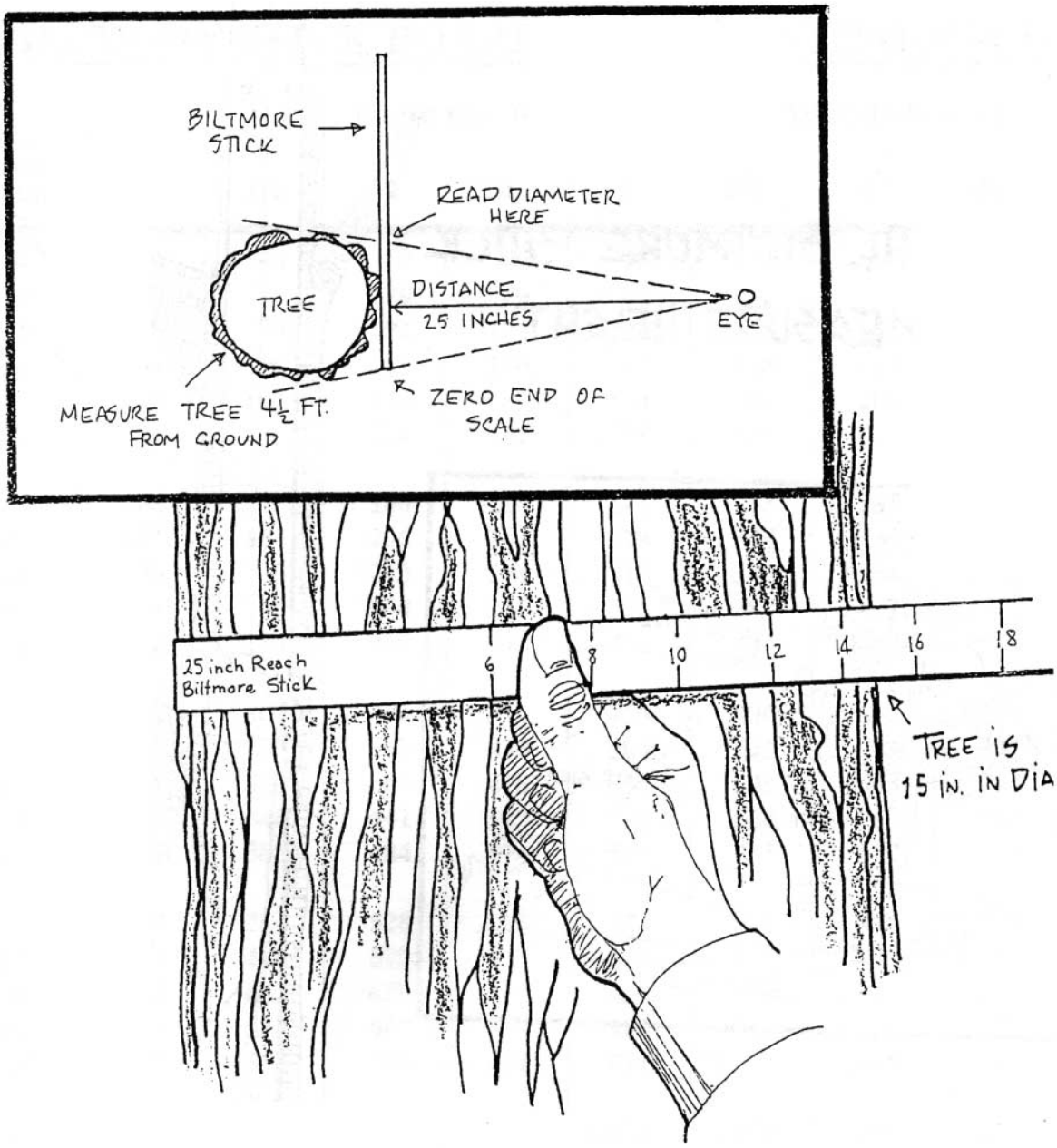
732-928-0029 • Fax 732-928-4925 • Email njfsfrec@bellatlantic.net • www.state.nj.us/dep/forestry/service

Tree Planting Detail

Use this simple guide to help you plant your next tree.



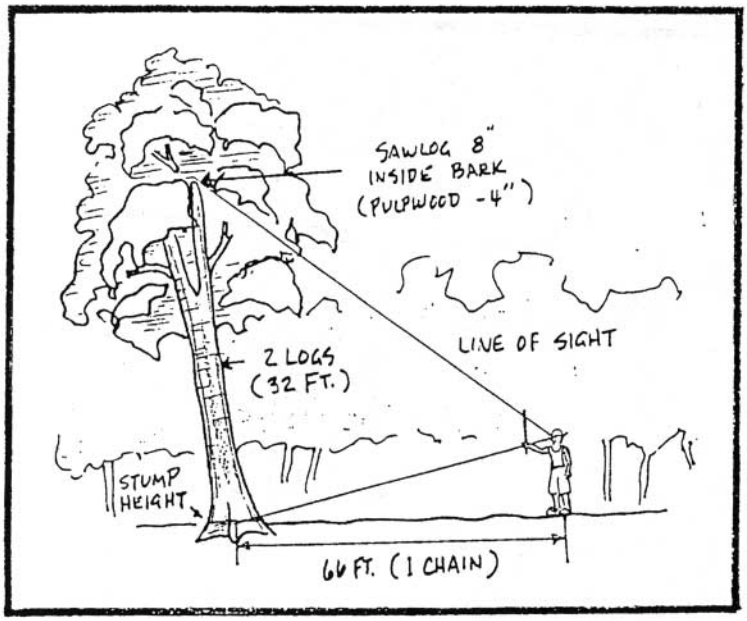
Plant Trees!
Bring Life to Your Community!



USING THE BILTMORE STICK TO MEASURE DIAMETER

Illustration courtesy of John Riley

USING THE BILTMORE STICK TO MEASURE HEIGHT



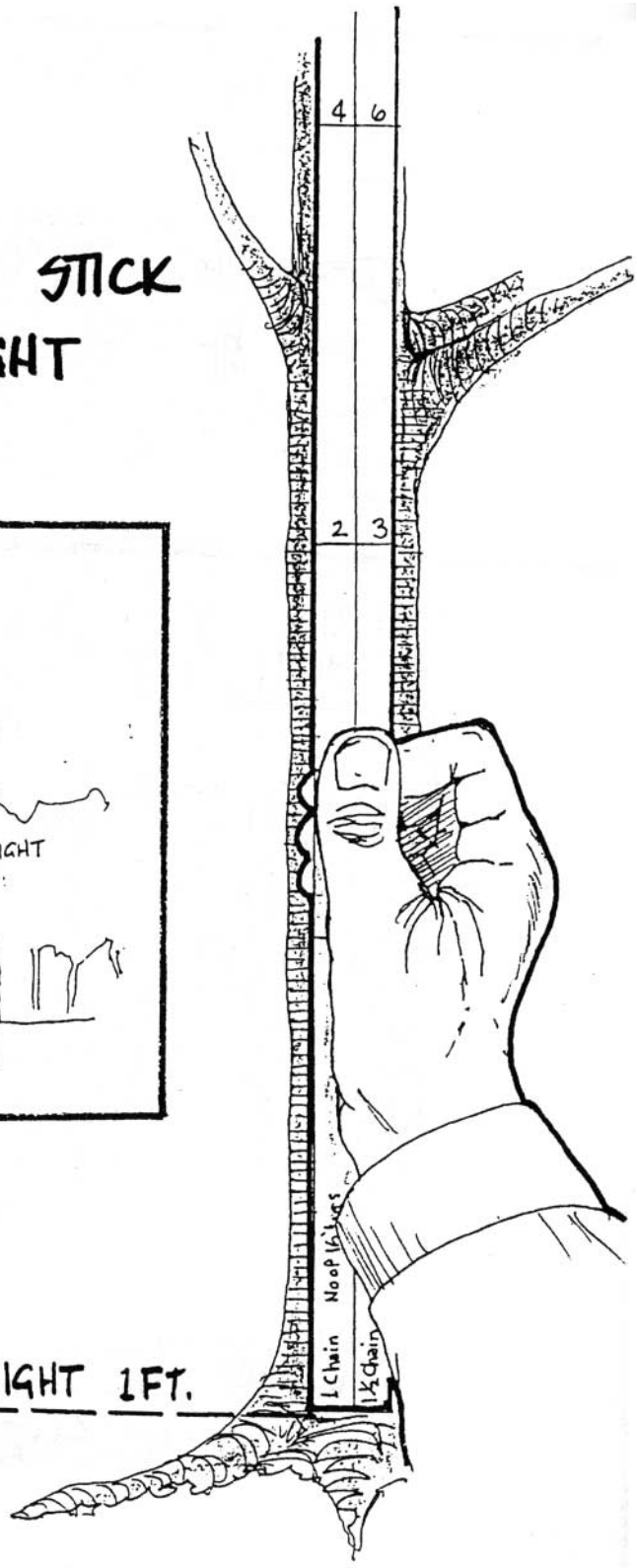


Illustration courtesy of John Riley

BILTMORE STICK BOARD FEET CONVERSION CHART

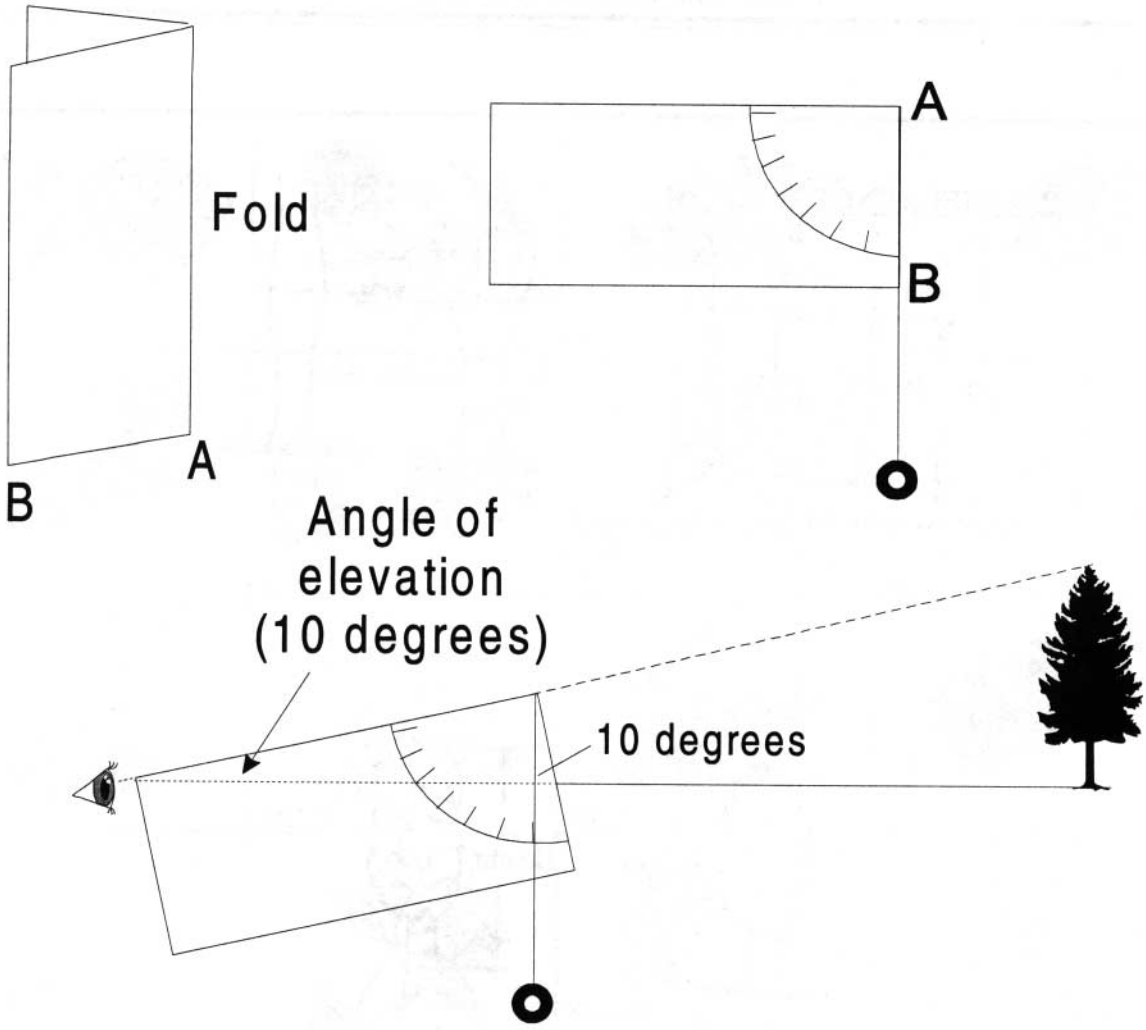
TREE DIAMETER IN INCHES	VOLUME (board feet) BY NUMBER OF USABLE 16-FOOT LOGS								
	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5
10″	36	48	59	66	73				
11″	46	61	76	86	96				
12″	56	74	92	106	120	128	137		
13″	67	90	112	130	147	158	164		
14″	78	105	132	153	174	187	200		
15″	92	124	156	182	208	225	242		
16″	106	143	180	210	241	263	285		
17″	121	164	206	242	278	304	330		
18″	136	184	233	274	314	344	374		
19″	154	209	264	311	358	392	427		
20″	171	234	296	348	401	440	480	511	542
21″	191	262	332	391	450	496	542	579	616
22″	211	290	368	434	500	552	603	647	691
23″	231	318	404	478	552	608	663	714	766
24″	251	346	441	523	605	664	723	782	840
25″	275	380	484	574	665	732	800	865	930
26″	299	414	528	626	723	801	877	949	1,021
27″	323	448	572	680	788	870	952	1,032	1,111
28″	347	482	616	733	850	938	1,027	1,114	1,201
29″	375	521	667	794	920	1,016	1,112	1,210	1,308
30″	403	560	718	854	991	1,094	1,198	1,368	1,415
31″	432	602	772	921	1,070	1,184	1,299	1,412	1,526
32″	462	644	826	988	1,149	1,274	1,400	1,518	1,637
33″	492	686	880	1,053	1,236	1,360	1,495	1,622	1,750
34″	521	728	934	1,119	1,304	1,417	1,500	1,727	1,864
35″	555	776	998	1,196	1,394	1,548	1,702	1,851	2,000
36″	589	826	1,063	1,274	1,485	1,650	1,814	1,974	2,135
37″	622	873	1,121	1,351	1,578	1,752	1,936	2,099	2,272
38″	656	921	1,186	1,428	1,670	1,854	2,038	2,224	2,410
39″	694	976	1,258	1,514	1,769	1,968	2,166	2,359	2,552

Gross volume of tree, International 1/4 inch rule, form class 78.

TANGENT CHART
FOR DETERMINING THE ANGLE OF ELEVATION

Angle			Angle			Angle	
1°	.0175		31°	.6009		61°	1.8040
2°	.0349		32°	.6249		62°	1.8807
3°	.0524		33°	.6494		63°	1.9626
4°	.0699		34°	.6745		64°	2.0503
5°	.0875		35°	.7002		65°	2.1445
6°	.1051		36°	.7265		66°	2.2460
7°	.1228		37°	.7536		67°	2.3559
8°	.1405		38°	.7813		68°	2.4751
9°	.1584		39°	.8098		69°	2.6015
10°	.1763		40°	.8391		70°	2.7415
11°	.1944		41°	.8093		71°	2.9042
12°	.2126		42°	.9004		72°	3.0777
13°	.2309		43°	.9325		73°	3.2709
14°	.2493		44°	.9657		74°	3.4874
15°	.2679		45°	1		75°	3.7321
16°	.2867		46°	1.0355		76°	4.0108
17°	.3057		47°	1.0724		77°	4.3315
18°	.3249		48°	1.1106		78°	4.7046
19°	.3443		49°	1.1504		79°	5.1446
20°	.3640		50°	1.1918		80°	5.6123
21°	.3839		51°	1.2349		81°	6.3138
22°	.4040		52°	1.2799		82°	7.1154
23°	.4245		53°	1.3270		83°	8.1443
24°	.4452		54°	1.3764		84°	9.5144
25°	.4663		55°	1.4281		85°	11.4301
26°	.4877		56°	1.4826		86°	14.3007
27°	.5095		57°	1.5399		87°	19.0811
28°	.5317		58°	1.6003		88°	28.6363
29°	.5543		59°	1.6643		89°	57.2900
30°	.5714		60°	1.7321		90°	undetermined

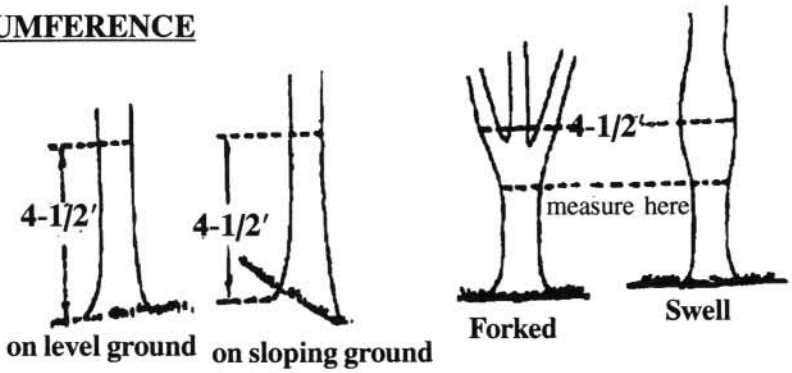
DIAGRAM FOR MAKING A CLINOMETER



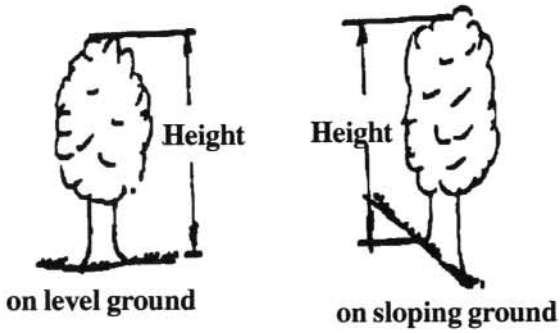
1. Fold a piece of heavy A4 (cardstock) paper in half lengthwise, as shown.
2. Draw a quadrant with radius of 10 cm and center at **A** as shown in diagram.
3. Mark every 5 degrees around the quadrant starting at **B**, and label the points.
4. Carefully attach a 20 cm length of cotton string at **A** so that it hangs freely.
5. Tie a small weight (washer) to the end of the string.

BIG TREE MEASUREMENTS

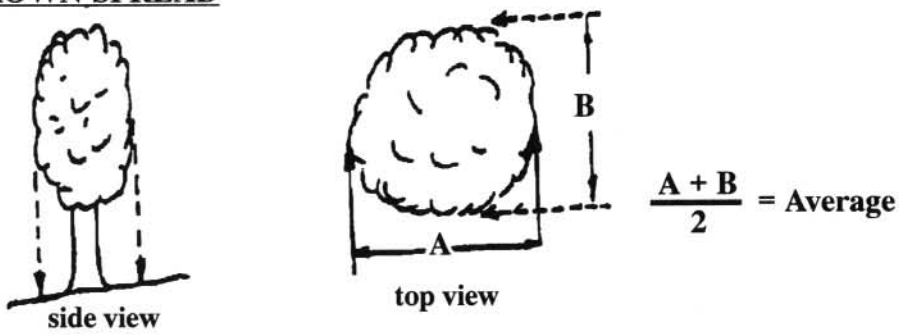
1. CIRCUMFERENCE



2. HEIGHT



3. AVERAGE CROWN SPREAD



TREE CONCENTRATION – LEAF Page 1

These are not to scale. Refer to a field guide to trees for measurements.

Primary graphics source: Iowa Project Learning Tree, Iowa DNR.
Other contributors: Barbara Newlon, Jennie M. Turner.

TREE CONCENTRATION — LEAF Page 2

These are not to scale. Refer to a field guide to trees for measurements.

Primary graphics source: Iowa Project Learning Tree, Iowa DNR.
Other contributors: Barbara Newlon, Jennie M. Turner.

TREE CONCENTRATION — COMMON NAME Page 1

American Basswood 49.	Atlantic White Cedar 50.	Butternut 51.	Osage Orange 52.
American Holly 53.	White Oak 54.	Eastern Cottonwood 55.	Pin Oak 56.
American Black Cherry 57.	White Ash 58.	White Pine 59.	Staghorn Sumac 60.
American Chestnut 61.	Ohio Buckeye 62.	Hawthorn 63.	Yellow Poplar (Tulip Tree) 64.
Black Oak 65.	Red Oak 66.	Black Birch 67.	Red Maple 68.
American Hornbeam 69.	Eastern Hemlock 70.	Mountain Laurel 71.	Sassafras 72.

TREE CONCENTRATION — COMMON NAME Page 2

Black Locust 73.	Sycamore 74.	Catalpa 75.	Paulownia 76.
Black Walnut 77.	Cucumber Magnolia 78.	Eucalyptus 79.	Eastern Redbud 80.
Virginia Pine 81.	Shagbark Hickory 82.	Hackberry 83.	American Beech 84.
Box Elder 85.	Eastern Red Cedar 86.	Honey Locust 87.	Weeping Willow 88.
Sugar Maple 89.	Slippery Elm 90.	Loblolly Pine 91.	Striped Maple 92.
Choke Cherry 93.	Dogwood 94.	Norway Spruce 95.	Blackgum 96.

TREE CONCENTRATION
IDENTIFYING CHRACTERISTICS Page 1

Leaves are 4–7 inches long, heart shaped; buds are red-brown 97.	Grows only in a narrow coastal belt 50–130 miles wide, from Maine to Florida, and westward to Mississippi. 98.	11–17 leaflets; one leaflet is usually at the end; inside the twig, pith is dark chocolate brown and is chambered. 99.	Leaves 3–5 inches long with smooth margins (edges); thorns are straight and 1/2 inch in length 100.
Leaves: Prickly, evergreen; 2–4 inches. **Fruit:** red berries. **Wood:** ivory white. 101.	Rounded lobes; 7–9 lobes; acorn is mostly round like a ball with a smooth cap 102.	Small branches are white or yellow; buds are sticky; leaf coarsely toothed. 103.	**Leaves:** 5–7 sharply pointed lobes; wide, deep sinuses (rounded at the bottom). **Wood:** requires special handling in drying; tends to split and check. 104.
Midrib often hairy; fringed beneath. Valuable for lumber (distinctive light to dark reddish brown color, often has beautiful grain patterns). 105.	**Leaves:** Smooth dark green upper surface; pale light green to whitish underside. **Wood:** Very popular for baseball bats. 106.	Needles in bundles of 5, 2–4 inches long; soft to the touch. 107.	Leaves with 5 or more lobes, coarse teeth; fruit is a v-shaped samara (helicopter); under side of leaf is light colored. 108.
Leaves: Variable in form, 7 toothed lobes (sometimes 5) taper from a broad base; rounded sinuses; glossy above, hairless beneath. 109.	5 leaflets arranged like fingers on a hand; fruit is a spiny, leathery seed covering with one seed 110.	Leaf margin (edge) is coarsely doubly toothed; thorns not branched. 111.	Tallest of broad leaved trees in the Eastern U. S. Leaves, 3–6 inches long, square-lobed; Flowers are yellow-green and orange, resembling tulips. 112.
Leaves have sandpaper feel; leaves 4–6 inches long, hairy below; buds are brown; twigs are reddish brown and tend to droop 113.	Pointed lobes; 7–11 loves; leaf is green below; acorn cap does not extend up the acorn. 114.	1–6 inch short pointed leaves; leaves double toothed; twigs have aromatic (wintergreen) odor. 115.	**Leaves:** 3–5 lobes; coarsely toothed margins; 2–6 inches long. **Fruit:** paired, v-shaped samaras on drooping stems. 116.
Bark is smooth, thin, and blue grey; nut is in spike-like clusters. 117.	**Leaves:** Evergreen; flat, round-tipped needles 1/3–2/3 inches long; two pale lines on lower surface. **Cones:** Roughly oval, 1/2–3/4 inches long. 118.	Small tree or shrub. **Leaves:** 2–5 inches. Found mainly on mountain and hill slopes. 119.	**Leaves:** No lobes; 1 lobe (like a mitten); or 3 lobes 120.

Information sources: *Newlon, Charles J., Dendrology Lectures, Delaware State University*
Important Forest Trees of the Eastern United States, USDA Forest Service
Petrides, George A., Peterson Field Guides Eastern Trees

TREE CONCENTRATION
IDENTIFYING CHARACTERISTICS Page 2

1/2 inch long spines at the leaf base 121.	Leaves have 3–5 lobes, margins (edges) coarsely toothed/fruit is a hairy ball of seeds; bark is scaly, leaves are very large. 122.	Large leaves 8–12 inches, heart-shaped; fruit is long, skinny 8–20 inch pod 123.	Very large, paired, heart shaped leaves. Non-native tree imported from the Orient where the wood is highly valued. 124.
15–23 leaflets; leaflet at end is small or missing; inside twig is chambered and tan in color. 125.	**Leaves:** large 5–10 inches long; thin; smooth edged; often wavy edged; egg shaped; shiny, yellowish green on upper surface, paler below. 126.	Native to Australia. Widely planted in California. Very susceptible to fire because of highly aromatic leaves and shedding bark. 127.	Heart-shaped leaves 2–6 inches long; hairless or slightly hairy beneath. 128.
2–3 inch needles in clusters of two; 129.	5 leaflets; entire leaf 7–14 inches long; bark smooth when young and shaggy when older. 130.	**Leaves:** Symmetrically oval, 2 1/2–3 1/2 inches long, sharply toothed margins. **Bark** has warty growths or ridges. 131.	Elliptic (egg shaped), coarsely toothed leaves; smooth grey bark. 132.
3 leaflets; twigs have whitish powdery coating; fruit is a double samara (helicopter). 133.	Leaves are dark green; leaves are both awl-and scale-like; cone is dark blue and berry-like. 134.	**Leaves:** 7–8 inches, pinnately and bipinnately compound. **Thorns:** 2–3 inches long, branched, attached to stem and twigs. 135.	Believed to have grown in the urban forest of ancient Babylon. 136.
Leaves with 5 lobes, margin (edge) is smooth; fruit is a u-shaped samara (helicopter) 137.	Leaves have sandpaper feel; leaves 5–7 inches long, very rough above and hairy below; twigs are grey and grow upwards. 138.	Needles in clusters of 3; needles 6–9 inches long; needles dull and light green. 139.	Leaves opposite, 3 long pointed lobes, doubly toothed, hairless, paler green beneath. 140.
Leaf is finely toothed with outward curved teeth; leaves are thin; fruit is in red clusters; bark is brownish and smooth. 141.	Leaves 3–6 inches long; veins run parallel to leaf margin (edge); middle vein contains fine strands when pulled apart. 142.	Sharp needles are 1/2–1 inch long; needles are dark green; branches appear to droop; cone is 4–7 inches long. 143.	**Leaves:** Shiny, egg shaped, leathery. **Bark:** blocky like alligator hide. 144.

Information sources: Newlon, Charles J., Dendrology Lectures, Delaware State University
Important Forest Trees of the Eastern United States, USDA Forest Service
Petrides, George A., Peterson Field Guides Eastern Trees

TREE CONCENTRATION — SCIENTIFIC NAME Page 1

Tilia americana 145.	Chamaecyparis thyoides 146.	Juglans cinerea 147.	Maclura pomifera 148.
Ilex opaca 149.	Quercus alba 150.	Populus deltoides 151.	Quercus palustris 152.
Prunus serotina 153.	Fraxinus americana 154.	Pinus strobus 155.	Rhus typhina 156.
Castanea dentata 157.	Aesculus glabra 158.	Crataegus 159.	Liriodendron tulipifera 160.
Quercus velutina 161.	Quercus rubra 162.	Betula lenta 163.	Acer rubrum 154.
Carpinus caroliniana 165.	Tsuga canadensis 166.	Kalmia latifolia 167.	Sassafras albidum 168.

TREE CONCENTRATION — SCIENTIFIC NAME Page 2

Robinia pseudoacacia 169.	Platanus occidentalis 170.	Catalpa speciosa 171.	Paulownia tomentosa 172.
Juglans nigra 173.	Magnolia acuminata 174.	Eucalyptus globulus 175.	Cercis canadensis 176.
Pinus virginiana 177.	Carya ovata 178.	Celtis occidentalis 179.	Fagus grandifolia 180.
Acer negundo 181.	Juniperus virginiana 182.	Gleditsia triacanthos 183.	Salix babylonica 184.
Acer saccharum 185.	Ulmus rubra 186.	Pinus taeda 187.	Acer pennsylvanicum 188.
Prunus virginiana 189.	Cornus florida 190.	Picea abies 191.	Nyssa sylvatica 192.

LEAF COLLECTION WORKSHEET

Common name

Scientific name

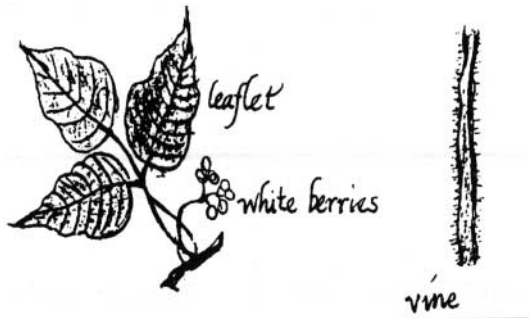
Family County, State

Site information

Collector Coll.# month/day/year

Botanical Collection Procedures

First a cautionary note:
Poison Ivy – *Rhus toxicodendron*



Grows in the form of a shrub or a vine.

A. Leaflets Three – Let It Be!
B. Berries white-get outta' sight!
C. Vine with hairy roots in air – best beware!

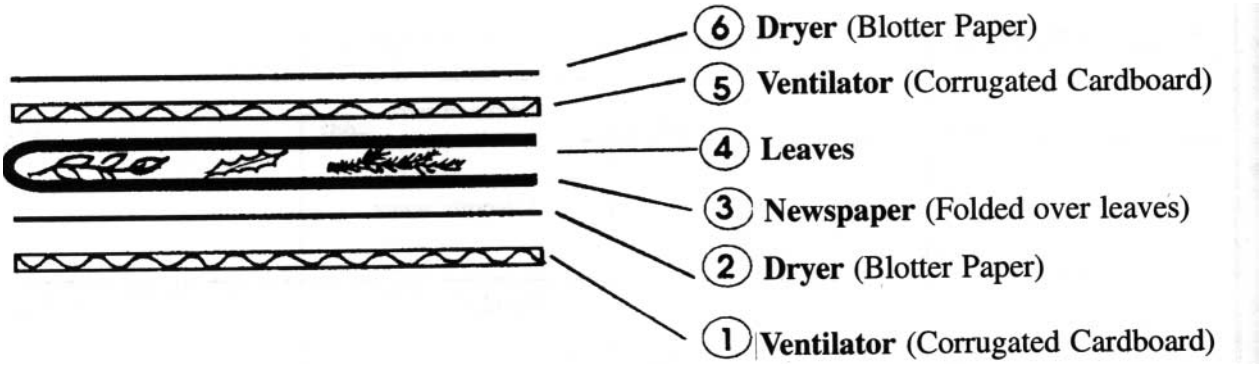
Don't give trees a haircut:
Be thoughtful as you collect. Don't leave an unsightly stub. Be sure it's OK to collect from that tree.

Size of sample:
Collect a section of a branch or twig with at least 5 or 6 leaves (unless one leaf fills the page) and about 6 to 9 inches long for the 8 $^{1}/_{2}$ by 11 inch collection sheet.

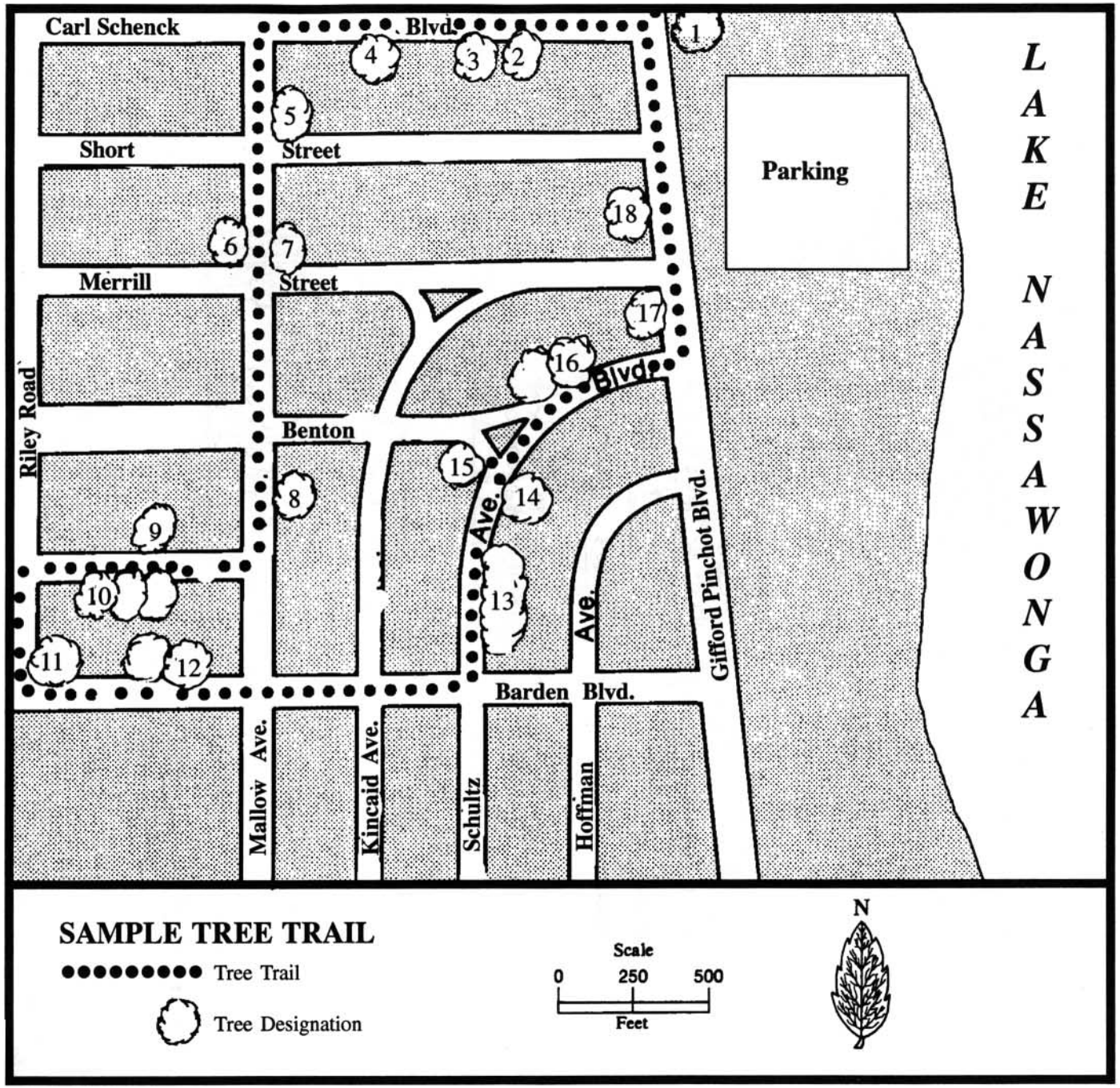
Collection list:
Always assign a new consecutive collection number to each specimen you collect and record in your collection journal or notebook.

Pressing your leaf samples:
Spread each sample out neatly on a single, full sheet of newspaper, turning one leaf opposite side up. Write your name, date, and collection number on each newspaper. Use the collection number you have recorded in your collection journal. Don't write on the blotters or wood press.

Pressing sequence:
Make a "Dagwood sandwich" of a ventilator (corrugated cardboard), a dryer (blotter), one to three sheets of newspaper folded over your specimen, and a ventilator, blotter and so on until you have prepared your stack of specimens for drying. Place an oak lattice top and bottom, strap the press together tightly with two straps. Let dry 3 to 4 days. Place the "press stack" on edge so that the warm air will circulate through it. Two or three days will do.



Information Source: Newlon, Charles J., Dendrology Instructional Material, Delaware State University



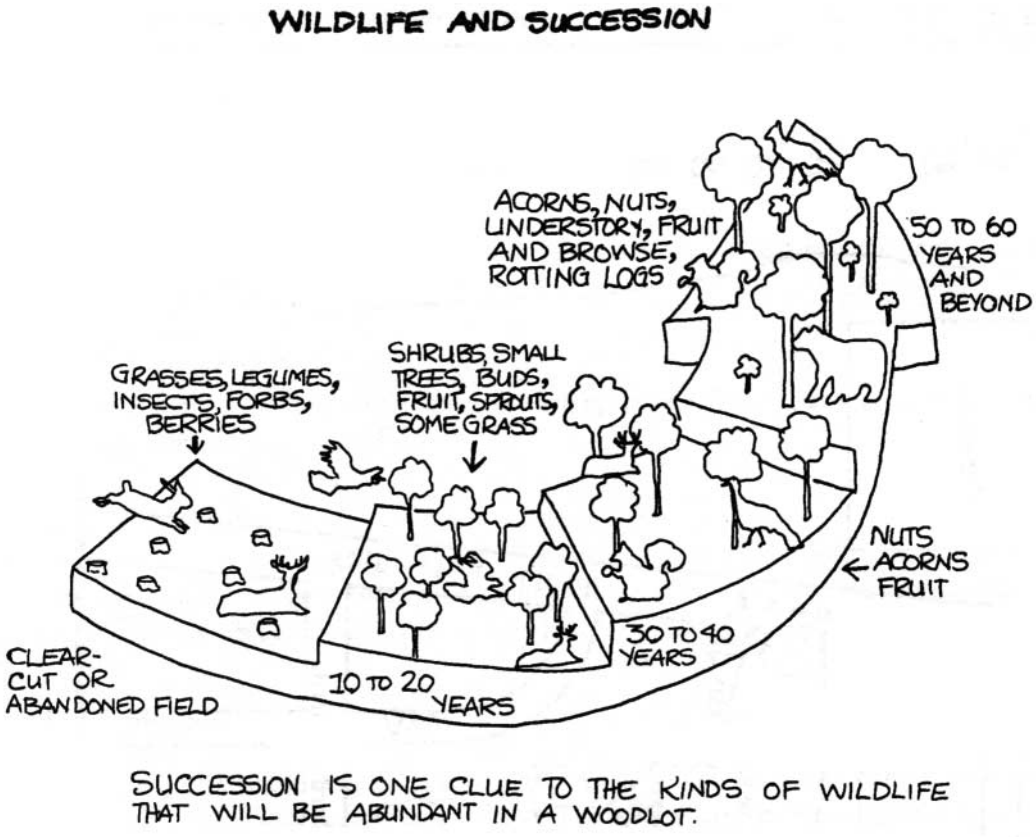
SAMPLE TREE TRAIL

Park your car in the municipal parking lot near the East Pavilion on Lake Nassawongo. There are many different species of trees of varying ages which comprise the nearby community forest. This trail highlights 18 different species.

1. **Northern Red Oak, *Quercus rubra.*** A large tree is located on the lake side of Gifford Pinchot Blvd. at the intersection of Carl Schenck Blvd. It is the state tree of New Jersey and one of the most common trees in the eastern forest. It provides food and habitat for wildlife (urban and non-urban); and is a good shade tree.

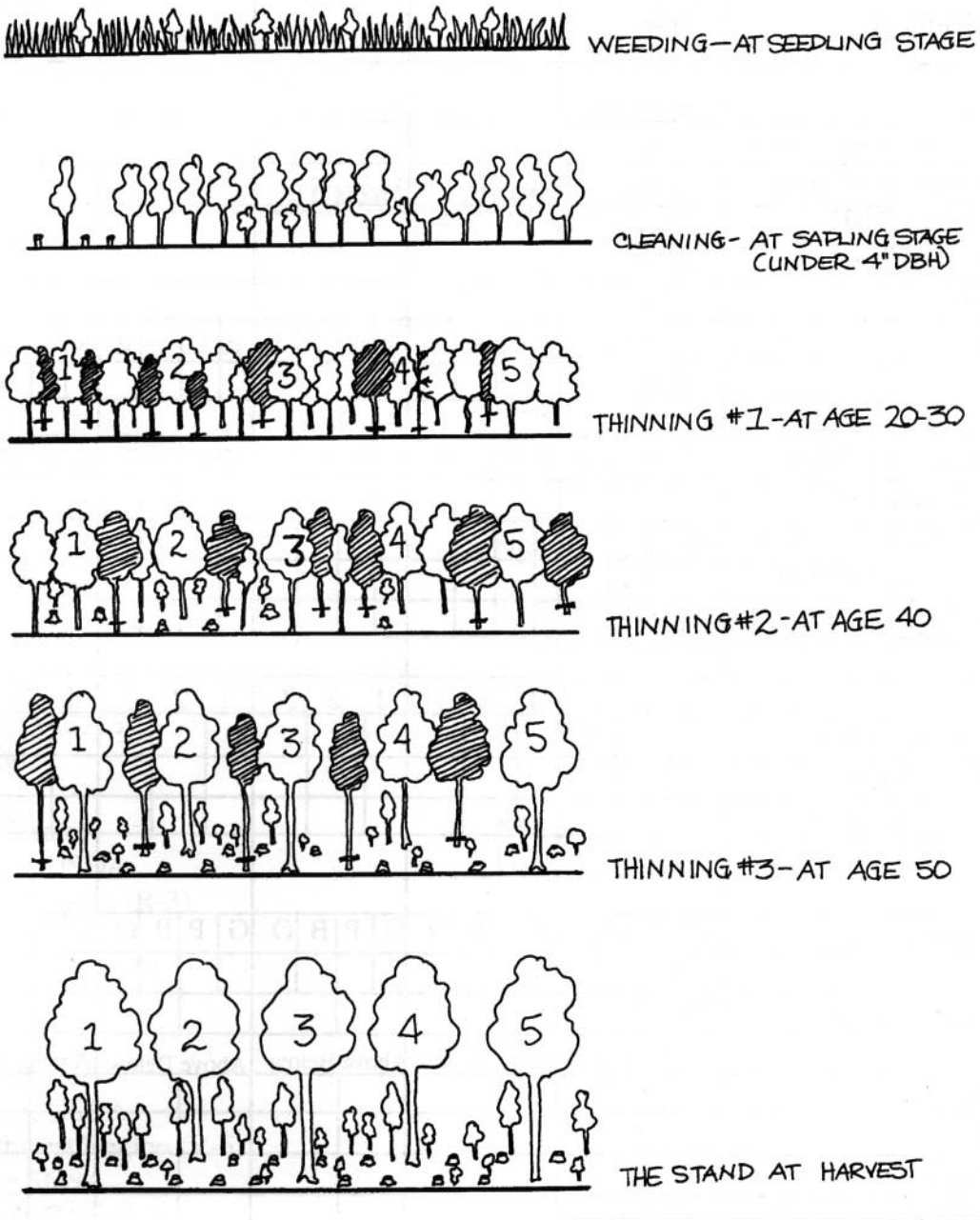
2. **Sugar Maple, *Acer saccharum.*** Walk approximately 500 ft. east along Carl Schenck Blvd.. look to your left (south). In the east side yard of the house at 503 Carl Schenck is a large, old Sugar Maple tree. Sugar Maples are renowned for their syrup and are good shade trees. Their wood is used in furniture; the leaf shape is on the flag of Canada.

3. **Yellow-poplar or Tulip Poplar, *Liriodendron tulipifera*.** Walk to the next home. Look in the west side yard of 505 Carl Schenck and find a Yellow-poplar. A very valuable tree; tallest of all broad leaved trees in the Eastern United States. Leaves are large, 3 - 6 inches long , square-lobed; flowers are yellow-green and orange, resembling tulips.



Source: The Woodland Steward, p. 164

PROVIDING GROWING ROOM



After harvest, this cycle would begin again.

Source: The Woodland Steward, p. 66

SAMPLE COMMUNITY FORESTRY INVENTORY SHEET

Organization requesting survey: Dept. of Parks, Metropolis, VA **DATE** Mar. 21, 1996

Codes:				
Ownership R = Residential C = Commercial P = Public I = Industrial	**Motorist Visibility** G = Good F = Fair P = Poor U = Unaccept.	**Trimming Need** **Wound Repair** **Disease & Insects** 1 = need 2 = minor 3 = none	**Ground Cover** G = Grass P = Pavement B = Bare O = Other	**Vigor of Tree** G = Good F = Fair P = Poor D/D = Dead and Dying

Survey Team: 4
John Jones
Charlie Smith
Cindy Ellis

Street Name and Number	E. 7th 2150					
Species	Acer rubrum					
Distance from corner	12 ft.					
Distance from curb	8 ft.					
Diameter DBH	12 in.					
Height of Tree	30 ft.					
Crown	37 ft.					
Ownership	R C P I	R C P I	R C P I	R C P I	R C P I	R C P I
	X					
Motorist Visibility	G F P U	G F P U	G F P U	G F P U	G F P U	G F P U
Stoplights-signs	X					
Pedestrian clearance	X					
Sidewalk condition	X					
Streetlight visibility	X					
	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Trimming needs	X					
Wound Repair	X					
Disease & Insect	X					
Ground cover	G P B O	G P B O	G P B O	G P B O	G P B O	G P B O
	X					
Historical tree	No					
	Above Below	Above Below	Above Below	Above Below	Above Below	Above Below
Water/sewer	X					
Gas						
Electric	X					
Telephone	X					
Cable TV	X					
Vigor of Tree	G F P D/D	G F P D/D	G F P D/D	G F P D/D	G F P D/D	G F P D/D
	X					

Note: *This sheet is intended to be the model for the inventory sheet which the students will create based on their project. Categories and factors selected would be based on the students' project goals.*

USDA Forest Service
Regional Information

USDA Forest Service
Natural Resource Conservation Education (NRCE) Coordinator
P.O. Box 96090
Washington, DC 20090–6090

USDA General Information 202–720–USDA

Regional Field Offices

NRCE Coordinator
Forest Service, USDA
Northern Region (R-1)
Federal Building
P.O. Box 7669
Missoula, MT 59807–7669
406–329–3511

NRCE Coordinator
Forest Service, USDA
Rocky Mountain Region (R-2)
740 Simms Street
P.O. Box 25127
Lakewood, CO 80225
302–275–5350

NRCE Coordinator
Forest Service, USDA
Southwestern Region (R-3)
Federal Building
Albuquerque, NM 87102
505–842–3292

NRCE Coordinator
Forest Service, USDA
Pacific Southwest Region (R-5)
630 Sansome Street
San Francisco, CA 94111
415–705–2874

NRCE Coordinator
Forest Service, USDA
Pacific Northwest Region (R-6)
333 S. W. 1st Avenue
P. O. Box 3623
Portland, OR 97208
503–326–3651

NRCE Coordinator
Forest Service, USDA
Southern Region (R-8)
1720 Peachtree Road, NW
Atlanta, GA 30367
404–347–2384

NRCE Coordinator
Forest Service, USDA
Eastern Region (R-9)
310 West Wisconsin Avenue, Rm. 500
Milwaukee, WI 53203
414–297–3693

NRCE Coordinator
Forest Service, USDA
Alaska Region (R-10)
P. O. Box 21628
Juneau, AK 99802–1628
907–586–8863

DENSITY OF TREES AND HEAT PRODUCED

An air-dried cord of these woods produces the equivalent in heat of anywhere from 121 gallons of fuel oil for fir, up to 219 gallons for hickory.

Species	Relative Density	BTU/Cord
HARDWOODS		
Shagbark Hickory	.72	32,800,000
Black Locust	.69	31,400,000
White Oak	.68	31,000,000
Bitternut Hickory	.66	30,000,000
Chestnut Oak	.66	30,000,000
American Beech	.64	29,100,000
Laurel Oak	.63	28,700,000
Northern Red Oak	.63	28,700,000
Rock Elm	.63	28,700,000
Sugar Maple	.63	28,700,000
Yellow Birch	.62	28,200,000
White Ash	.60	27,300,000
Southern Red Oak	.59	26,900,000
Black Walnut	.55	25,000,000
Oregon Ash	.55	25,000,000
White Birch	.55	25,000,000
Black Tupelo	.50	22,800,000
American Sycamore	.49	22,300,000
Silver Maple	.47	21,400,000
Sassafras	.46	21,000,000
Yellow Poplar	.42	19,000,000
Red Alder	.41	18,600,000
Eastern Cottonwood	.40	18,200,000
Black Willow	.39	17,800,000
Quaking Aspen	.38	17,300,000
SOFTWOODS		
Tamarack	.53	24,100,000
Western Larch	.52	23,700,000
Douglas-Fir	.48	21,900,000
Bald Cypress	.46	21,000,000
Red Pine	.46	21,000,000
Hemlock	.45	20,500,000
Cedar	.44	20,000,000
Fir	.43	19,600,000
Pine	.41	18,600,000
Spruce	.40	18,200,000

Source: "Firewood: How and What to Buy," in Back Home, Fall 1992, p. 62

National Science Education Standards

TOOLS USED IN FORESTRY

Content Standards

Unifying concepts and processes in science.

*Systems, order, and organization.
*Evidence, models, and explanation.
*Change, constancy and measurement.

Science as Inquiry.

*Abilities necessary to do scientific inquiry.
*Understanding about scientific inquiry.

Physical Science.

*Properties and changes of properties in matter.
*Motions and forces.

Life Science.

*Structure and function in living systems.

Science and Technology.

*Abilities of technological design.
*Understanding about science and technology.

Science in Personal and Social Perspectives.

*Science and technology in society.
*Science and technology in local, national, and global challenges.

History and Nature of Science Standards.

*Science as a human endeavor.
*Nature of scientific knowledge.
*Historical perspectives.

Assessment Standards

Assessment Standard A

Assessments must be consistent with the decisions they are designed to inform.

*Assessments are deliberately designed.
*Assessments have explicitly stated purposes.
*The relationship between the decisions and the data is clear.
*Assessment procedures are internally consistent.

Assessment Standard B

Achievement and opportunity to learn science must be assessed.

*Achievement data collected focus on the science content that is most important for students to learn.
*Opportunity-to-learn data collected focus on the most powerful indicators.
*Equal attention must be given to the assessment of opportunity to learn and the assessment of student achievement.

Assessment Standard C

The technical quality of the data collected is well matched to the decisions and actions taken on the basis of their interpretation.

*The feature that is claimed to be measured is actually measured.
*Assessment tasks are authentic.
*An individual student's performance is similar on two or more tasks that claim to measure the same aspect of student achievement.
*Students have adequate opportunity to demonstrate their achievements.
*Assessment tasks and methods of presenting them provide data that are sufficiently stable to lead to the same decisions if used at different times.

Assessment Standard D

Assessment practices must be fair.

*Assessment tasks must be set in a variety of contexts, be engaging to students with different interests and experiences, and must not assume the perspective or experience of a particular gender, racial, or ethnic group.

Assessment Standard E

The inferences made from assessments about student achievement and opportunity to learn must be sound.

*When making inferences from assessment data about student achievement and opportunity to learn science, explicit reference needs to be made to the assumptions on which the inferences are based.

TREE IDENTIFICATION

Content Standards

Unifying concepts and processes in science.

*Systems, order, and organization.
*Evidence, models, and explanation.
*Change, constancy and measurement.

Science as Inquiry.

*Abilities necessary to do scientific inquiry.
*Understanding about scientific inquiry.

Physical Science Standards.

*Properties and changes of properties in matter.

Life Science Standards.

*Structure and function in living systems.
*Populations and ecosystems
*Diversity and adaptations of organisms
*Interdependence of organisms
*Matter, energy, and organization in living systems

Science in Personal and Social Perspectives.

*Science and technology in society.
*Science and technology in local, national, and global challenges.

History and Nature of Science Standards.

*Science as a human endeavor.
*Nature of scientific knowledge.
*Historical perspectives.

Assessment Standards

Assessment Standard A

Assessments must be consistent with the decisions they are designed to inform.

*Assessments are deliberately designed.
*Assessments have explicitly stated purposes.
*The relationship between the decisions and the data is clear.
*Assessment procedures are internally consistent.

Assessment Standard B

Achievement and opportunity to learn science must be assessed.

*Achievement data collected focus on the science content that is most important for students to learn.
*Opportunity-to-learn data collected focus on the most powerful indicators.
*Equal attention must be given to the assessment of opportunity to learn and the assessment of student achievement.

Assessment Standard C

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*An individual student's performance is similar on two or more tasks that claim to measure the same aspect of student achievement.
*Students have adequate opportunity to demonstrate their achievements.
*Assessment tasks and methods of presenting them provide data that are sufficiently stable to lead to the same decisions if used at different times.

Assessment Standard D

Assessment practices must be fair.

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Assessment Standard E

The inferences made from assessments about student achievement and opportunity to learn must be sound.

*When making inferences from assessment data about student achievement and the opportunity to learn science, explicit reference needs to be made to the assumptions on which the inferences are based.

FOREST MANAGEMENT

Content Standards

Unifying concepts and processes in science.

*Systems, order, and organization.
*Evidence, models, and explanation.
*Change, constancy and measurement.
*Evolution and equilibrium.

Science as Inquiry.

*Abilities necessary to do scientific inquiry.
*Understanding about scientific inquiry.

Physical Science Standards.

*Properties and changes of properties in matter.

Life Science Standards.

*Structure and function in living systems.
*Populations and ecosystems.
*Diversity and adaptations of organisms.
*Interdependence of organisms.
*Matter, energy, and organization in living systems.

Science in Personal and Social Perspectives.

*Science and technology in society.
*Science and technology in local, national, and global challenges.

History and Nature of Science Standards.

*Science as a human endeavor.
*Nature of scientific knowledge.
*Historical perspectives.

Assessment Standards

Assessment Standard A

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*Opportunity-to-learn data collected focus on the most powerful indicators.
*Equal attention must be given to the assessment of opportunity to learn and the assessment of student achievement.

Assessment Standard C

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FROM TREES TO LUMBER AND FUEL

Content Standards

Unifying concepts and processes in science.

*Systems, order, and organization.
*Evidence, models, and explanation.
*Change, constancy and measurement.
*Form and Function.

Science as Inquiry.

*Abilities necessary to do scientific inquiry.
*Understanding about scientific inquiry.

Physical Science Standards.

*Properties and changes of properties in matter.
*Motions and forces.

Life Science Standards.

*Structure and function in living systems.

Science and Technology Standards.

*Abilities of technological design.
*Understanding about science and technology.

Science in Personal and Social Perspectives.

*Science and technology in society.
*Science and technology in local, national, and global challenges.
*Natural hazards.
*Risks and benefits.
*Environmental quality.
*Natural and human-induced hazards.

History and Nature of Science Standards.

*Science as a human endeavor.
*Nature of scientific knowledge.
*Historical perspectives.

Assessment Standards

Assessment Standard A

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*Opportunity-to-learn data collected focus on the most powerful indicators.
*Equal attention must be given to the assessment of opportunity to learn and the assessment of student achievement.

Assessment Standard C

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*Assessment tasks are authentic.
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*Students have adequate opportunity to demonstrate their achievements.
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National Science Research Council, National Science Education Standards, National Academy Press, Washington, DC. 1996.