ACTIVITY

Tree Detectives!

Summary:

Participants practice observation skills and apply them to identifying trees in their neighborhood.

Grade Level:

3-6

Time:

45 minutes

Learning Objectives:

Participants will be able to:

- Demonstrate basic observation and identification skills.
- Describe different characteristics of two (or more) different tree species.
- Associate particular characteristics with different tree species.

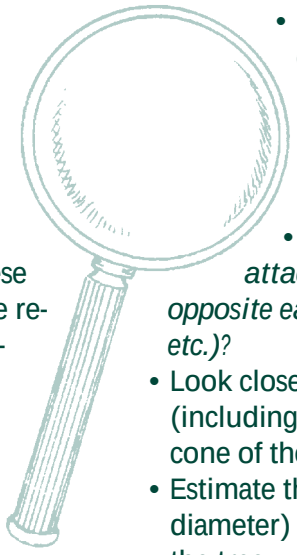
Materials Needed:

- Age-appropriate field guides, including: The Audubon Society's Nature Guides, Golden Guides, The Peterson's Field Guide Series (Peterson First Guide to Trees for younger participants), Nature Study Guild's Tree Finder, etc.
- For younger participants, large pictures of leaves and bark of trees examined
- Small notebooks and pencils

Background:

Learning how to identify trees by studying their different parts and examining their habitats can help participants become familiar with local plant life. In addition, once participants learn good observation and identification techniques, it is easier for them to transfer these skills to the study of other organisms that live in the area, such as songbirds or native flowering plants.

A good rule of thumb when working to identify trees, or most other life forms, is to observe three or more characteristics about the organism before heading for a field guide or making a final decision. At least two of these characteristics should not be related to the size of the specimen. Relying too heavily on one type of clue can lead to incorrect identification.



For example, imagine that a participant knows that the leaves of a quaking aspen tree flutter in the wind and that the tree generally grows somewhere between 40 and 70 feet tall. With nothing else to go by, he or she might spot a young 40 foot tall eastern cottonwood, (they grow to about 100 feet!) its leaves fluttering much the same way an aspen's would, and incorrectly call the tree an aspen. Examining other details, such as the bark of the tree, the leaf shape, and its habitat would make correct identification much more likely.

The following are things to consider when identifying trees:

- *Does it have needles or leaves?*
- *Does it lose its leaves in the winter (deciduous), or not (evergreen)?*
- *What is the size, shape, color and general appearance of the leaves or needles?*
- Look closely at the color, texture (scaly, smooth, ridged, fissured, etc.), thickness, and anything unusual about the bark.
- *How are the leaves attached to the stem (facing opposite each other, alternating, etc.)?*
- Look closely at the flower, fruit (including nuts and acorns), or cone of the tree.
- Estimate the size (in height and diameter) and general shape of the tree.
- *What does the crown, or top area of the tree, look like?*
- Look closely at its habitat. *What is growing around the tree? What is the area like (swampy, mountainous, near a lake, desert-like, in the tundra, etc.)?*
- Consider its geographic region. Some trees, like the live oak (found almost exclusively along

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Southeastern U.S. coastlines), are confined to certain regions.
- Consider any unusual characteristics, such as the great height and width of the California Redwoods.

What to Do:

1. Find a wooded area that has at least five different types of trees, preferably native trees, to conduct the activity. If no such stand exists near the place your group meets, consider planning a field trip to a nearby park. Have volunteers help as needed.

Note: *A local arborist, either from a private tree care company or a county/municipal government office, can serve as an excellent resource for information on local tree species and identification. Consider contacting an arborist from the community to help with this activity.*

2. Ask participants, *Do you know how to tell one kind of tree from another?* Have them name different characteristics that can help them to identify trees. Brainstorm a list. With visual aids such as posters, or the accompanying handout (Leaf and Bark Clues, below), explain the different parts of a tree and how needles, leaves, and bark can all vary from one tree to the next. *What do trees need to survive? What kinds of things do they need in their habitat?* Discuss with participants the idea that, like animals, trees have different habitats and need varying levels and/or types of sunlight, water, soil, and space.

3. Tell participants that they are all going to become "tree detectives" and will have the opportunity to study different trees in detail. Each participant should have at least one partner with whom he or she will work. Make sure that at least one of the partners has a clipboard or other hard surface, copies of both the Leaf and The Whole Tree Clue sheets, and a pencil. Tell participants that these worksheets are a part of their field notebook, in which they will carefully describe different tree characteristics.

4. Begin by exploring leaves. Ask the teams or small groups to find at least three leaves on the ground, and on the leaf worksheets, to write their best description of the color(s), shape, texture, and size of each of the leaves. If participants can see how the leaves are arranged on a twig (i.e., alternating, opposing, etc.; see Leaf and Bark Clues, below), have them note that as well. They can also draw the leaves in a notebook. Once they have done this, ask all the participants to throw their leaves in a large pile and mix them up. Then, ask them to look at their notes and try to locate their own leaves. Often, participants will have studied their leaves well enough that they will be able to find the leaf without their notes; encourage them to cite evidence in their notes, too.

5. Once all participants have located their leaves, have them use field guides to try to find out what kind of tree the leaves came from. Encourage them to use several characteristics of the leaves to find their tree. Assist where necessary.

6. After they have completed their leaf hunt, have partner groups find a single tree to study. Using the Whole Tree Clue worksheet, have them take notes on every detail of the tree they can find, including the appearance of the leaves, flowers, fruits (including nuts and acorns), or needles and cones. They should also consider the color, texture, and patterns in the bark, and the general size and shape of the tree. Also ask them to consider the area in which the tree is growing. Participants can also draw a picture of their trees in their field notebook.

7. When they have finished taking notes on their tree, have them investigate what kind of tree they have found using field guides. Ask each pair or small group to make a short presentation to the whole group about their tree and any interesting information the field guides may have told them about this species.

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In particular, encourage small groups to discuss what wildlife might depend on the tree they have studied, and what kinds of native plants might grow nearby. Ask participants if they can find other trees of the same kind at their study site.

8. Ask participants, *Why do you think tree identification can be useful? (*Helps to evaluate the health of the forest, the kind of habitat available, the amount of biodiversity present, the kinds of trees certain animals use, etc.) Ask them what interesting things they learned about the process.

Note: *The leaf hunt portion can also be done with nuts, seed pods, other fruits, or pine cones. Consider doing a nut/fruit/cone hunt in addition to the leaf hunt if the items are available.*

For Younger Participants (Grades 1-2):

Prior to the activity, select a number of different tree leaves and paste one of each on a sheet of paper. Make several sets of these guides, enough for one for each small group. On the tree hunt, have participants try to find a leaf that matches each of those in their guide. If the leaves can be found on the ground, have them take one that matches each sample. Ask participants to explain what is similar about the leaves they found and to describe some differences. *How can they tell which ones match?* Have participants draw pictures of the leaves they found.

For Older Participants (Grades 7 and Up):

Instead of using the Leaf and The Whole Tree Clue Sheets below, have participants create their own field notebook. Have them answer the same questions, but do so by organizing their own notes. Older participants may come up with their own method for identifying trees.

Questions:

- How can you tell one kind of tree from another?
- What characteristics can you use?
- What does this information tell you about a forest?

Adaptations:

Refer to general adaptations on pages 11-16.

Hearing Disabilities:

- Have tree part samples such as leaves, bark, and acorns for participants to explore to help illustrate your discussion and reinforce learning.
- Have a set time and place for participants to meet in case they get separated while outside. Consider marking boundary areas with flags or rope for the tree expedition.
- Position yourself and the interpreter so the participants can see you for further directions or warnings while on the trail.

Learning/Cognitive Disabilities:

- Have tree part samples such as leaves, bark, and acorns for participants to touch to help illustrate your discussion and reinforce learning.
- Create a separate sheet for each of the graphics on the handout to use as a demonstration. Create leaf shapes, etc., out of felt or other fabric so participants can feel the differences. If possible,

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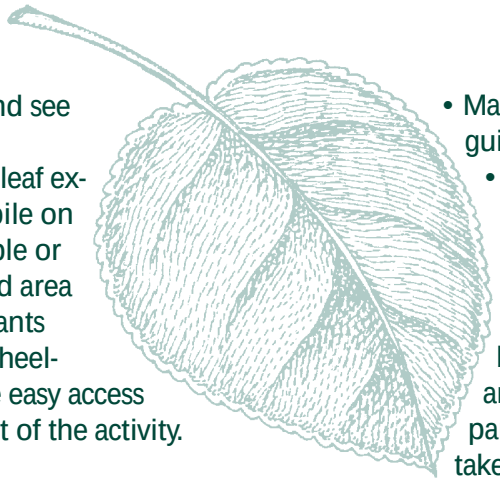


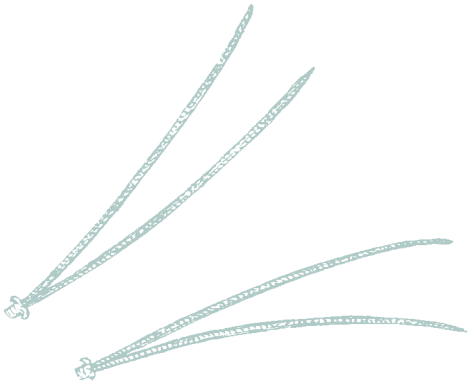
have real examples of each of the types represented on the sheet for participants to explore.
- Have a set time and place for participants to meet in case they get separated while outside. Consider marking boundary areas with flags or rope for the tree expedition.
- Give each participant a magnifying glass so they can closely examine the bark and other tree features. Encourage participants to look for fine details.
- Use simplified resource materials as needed. Consider making your own site specific field guides as suggested in the younger participant version of this activity.
- Have participants who have difficulty writing draw pictures of their tree and its parts, or have them circle the correct leaf, bark, etc., on the worksheets. Participants can color these items to help further illustrate their particular tree. Have partners assist as needed.

Motor Disabilities:

Overall:
- Choose a largely accessible site (i.e., mostly level, no standing water, etc.) for the tree expedition.
- Encourage the use of adaptive equipment such as reachers for participants to engage fully in the collection process.
- Encourage partners to engage the participants in the exploration as much as possible. This might mean having partners pick up leaves, acorns, etc., for participants to touch and see up close.
- Create the leaf exploration pile on a picnic table or other raised area so participants who use wheelchairs have easy access for this part of the activity.

For participants with limited muscle strength, coordination, or dexterity of the hands:
- If possible, provide small tape recorders for participants who have difficulty writing to record notes on their trees. Participants can also place a mark next to the correct leaf or bark on the handout.

Visual Disabilities:
- Have tree part samples such as leaves, bark, and acorns for participants to touch to help illustrate your discussion and reinforce learning.
- Create separate sheets for each of the graphics on the handout using fabric to create the different leaf shapes. An alternative is to enlarge the graphics and outline them in heavy black lines and raised lines of glue for participants to feel. Label the sheets in large print and Braille.
- If possible, have resources available in alternative formats including Braille, large print, and audio cassette.
- Mark off the area with a guide rope.
- Provide magnifiers for participants with low vision to use to examine their trees.
- Provide large note books or clipboards and paper for participants with low vision to take notes on their trees. Provide thick black markers.
- Encourage partners to vividly describe the textures, shapes, and surroundings of the trees. Encourage the partners to guide the participants in feeling and exploring their trees and its many parts.
- If possible, provide small tape recorders for participants who are blind to record notes on their trees.
- Provide clay and pieces of cardboard for participants who are blind to make models of their leaf shape instead of drawings. If possible, have a Braille labeler for them to use.

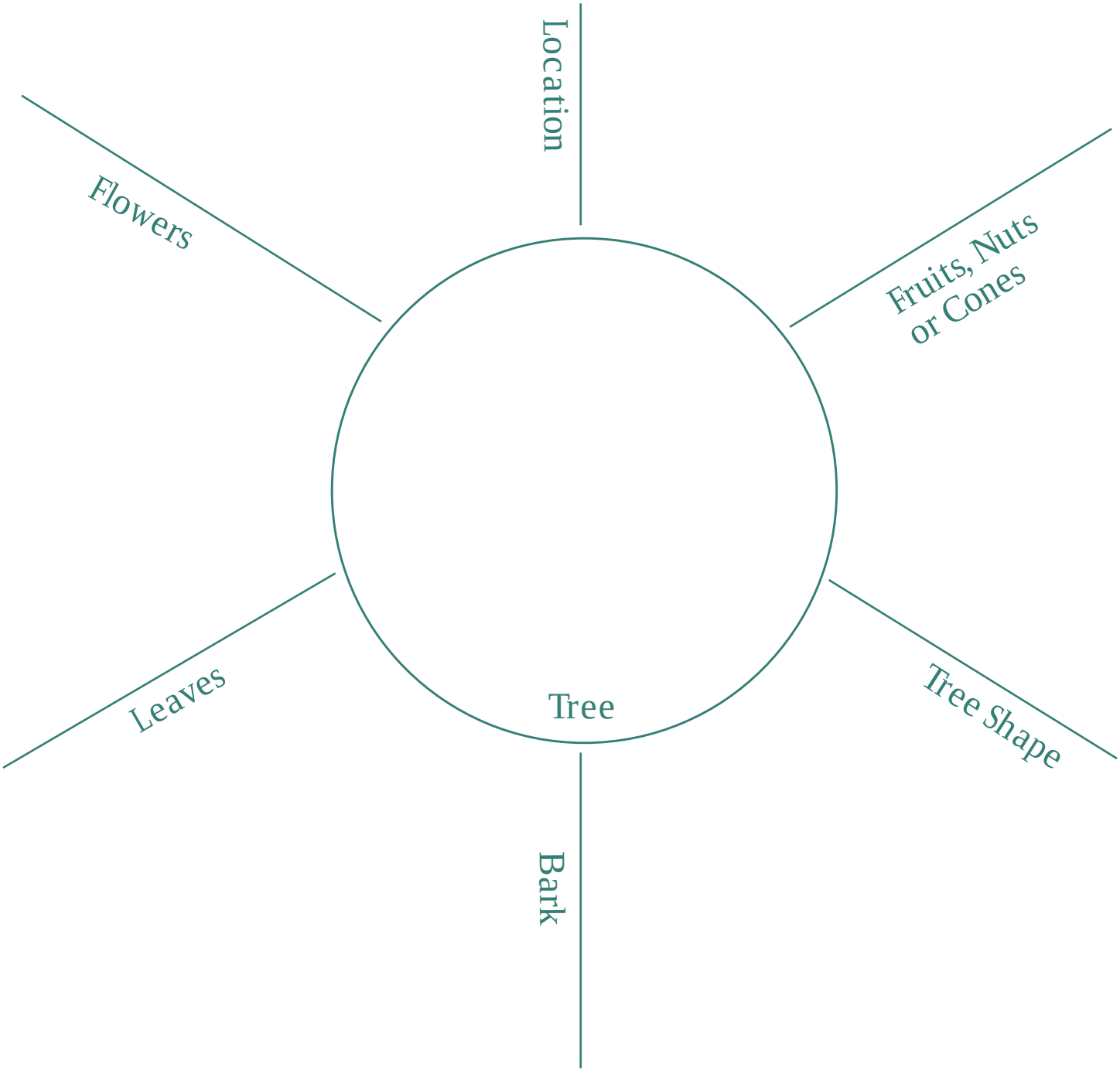


WORKSHEET

Tree Detectives!

THE WHOLE TREE CLUE SHEET

DIRECTIONS: Draw a picture of your tree in the middle, where it says "Tree," and briefly describe or draw each characteristic of the tree (e.g., location, flowers, bark, etc.) in the space provided.

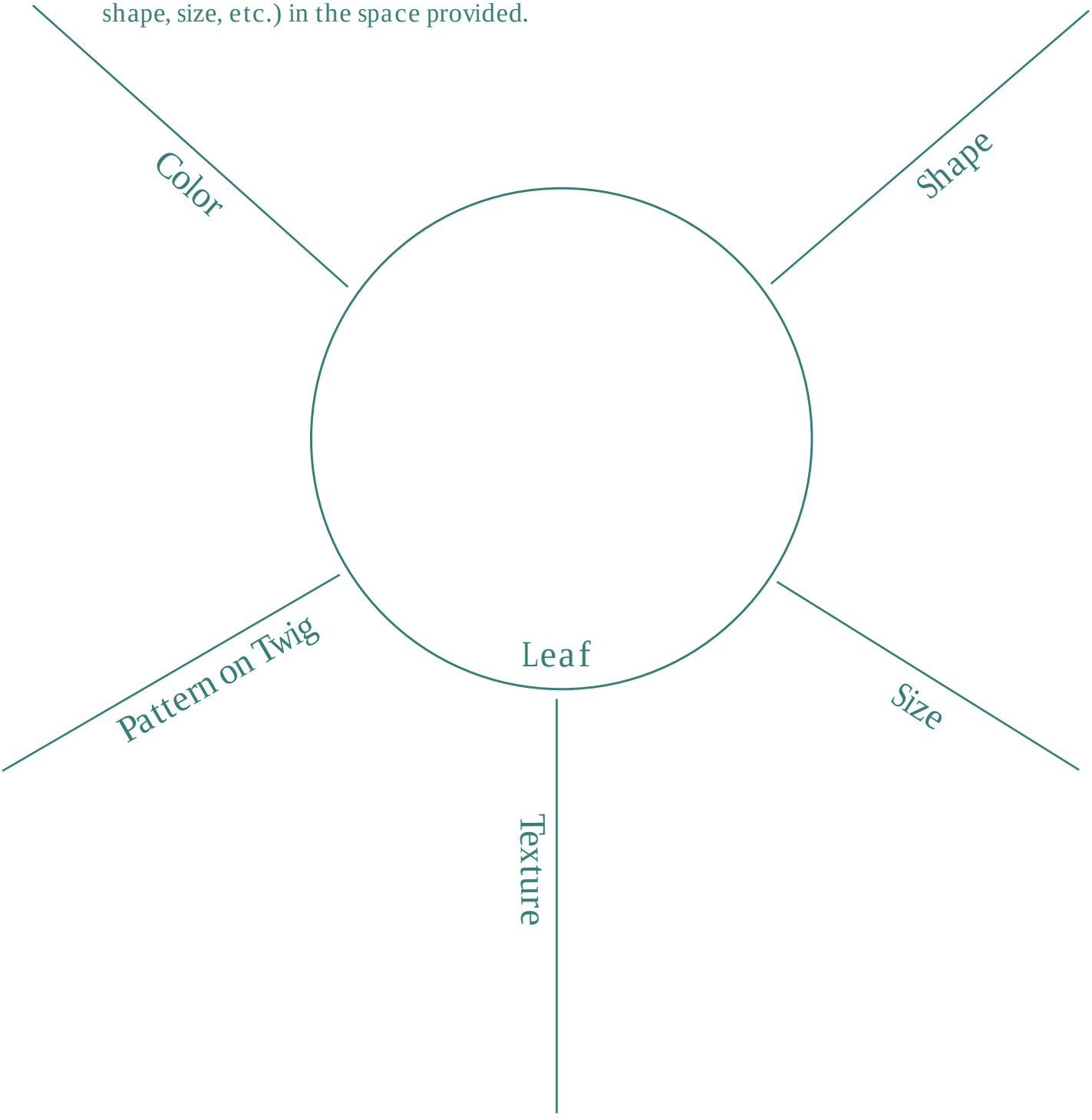


Tree Detectives!

WORKSHEET

LEAF CLUE SHEET

DIRECTIONS: Draw a picture of your leaf in the middle, where it says "Leaf," and briefly describe or draw each characteristic of the leaf (e.g., color, shape, size, etc.) in the space provided.



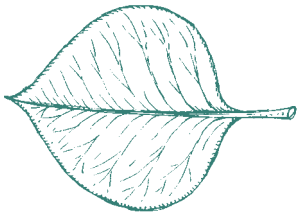
WORKSHEET

Tree Detectives!

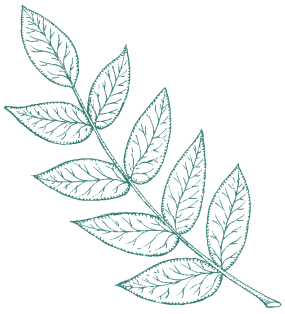
LEAF AND BARK CLUES

Leaves:

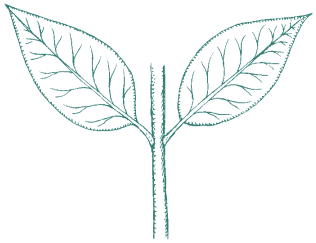
Needles



Simple leaves

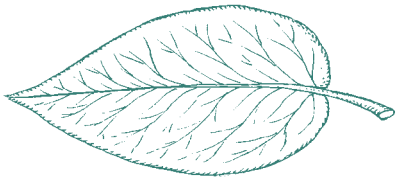


Compound leaves

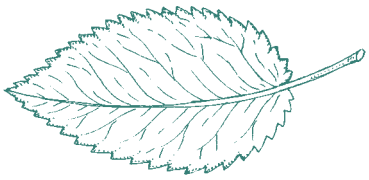


Attached opposite

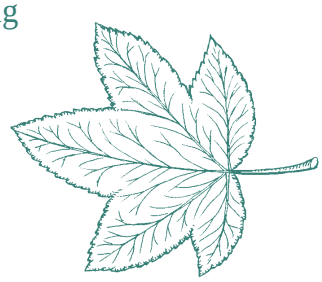
Attached alternating



Smooth edged leaves

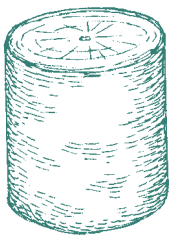


Toothed edged leaves

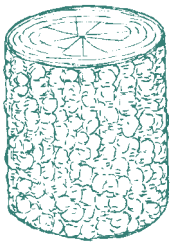


Lobed leaves

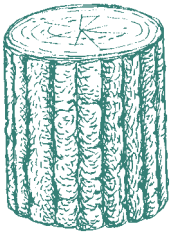
Bark:



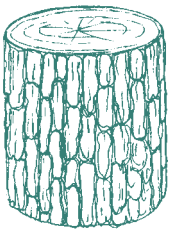
Smooth



Bumpy



Ridged



Scaly

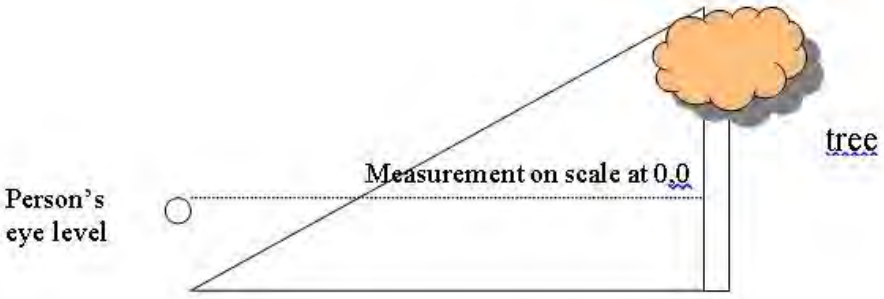
How to use a clinometer

Minnesota Project Learning Tree
www.mndnr.gov/plt

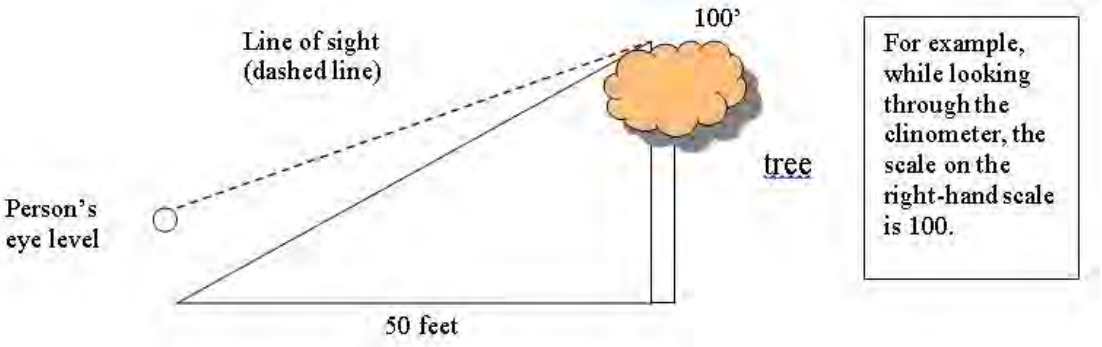
What they're used for:
Foresters use clinometers to quickly determine a tree's height or percent grade on a slope.

To determine a tree's height:

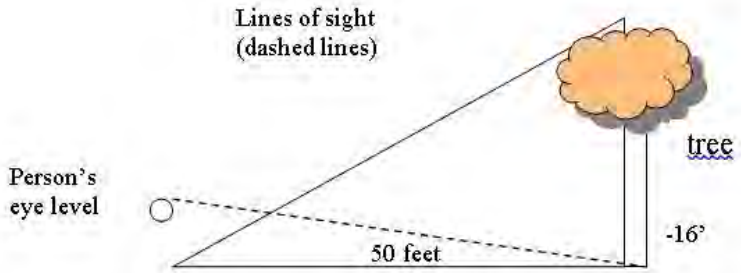
1. Hold the clinometer with the red dot pointing away from you. The red dot marks your line of sight between your eye and the object you are measuring.
2. Look through the glass meter. The glass meter contains a dial with two rows of measurements, a left-hand scale and a right-hand scale. Keep BOTH EYES OPEN.
3. Walk away from tree 50 feet. (Use a measuring tape.)
4. Face tree. Hold the clinometer near your eye with red dot pointing away from you. (You may want to put a finger on the red dot to remind you that this is the line of sight you are following to the top and bottom of tree.)
5. Look through the level clinometer until you see the scale reads "0" on both sides.



Point the clinometer at the top of the tree. Record the number from the right-hand scale that corresponds with your line of sight at the top of the tree.



Without moving your head, tilt the clinometer down to the base of the tree. Try to keep the glass eyepiece steady in at the same point from where you took the top reading. Record the number from the right-hand scale that corresponds with your line of sight at the bottom of the tree.



For example, while looking through the clinometer, the scale on the right-hand scale is – 16.

Add the numbers. For example:

top measurement 100
bottom measurement 16 (ignore the negative sign)
116

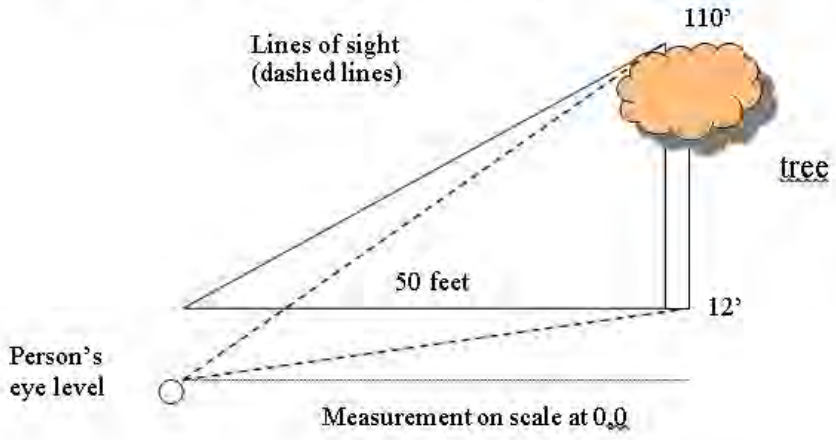
116' is the estimated height of the tree using the clinometer.

Since you took the measurements at 50 feet away, you will have to divide your total by 2. For example, 116 feet divided by 2 is 58 feet. The tree is actually 58 feet tall.

Other notes:

- If the forest is not too dense, you can also take measurements at 100 feet away, and get more accurate readings. If you are able to take measurements 100 feet from the tree, then you will not need to divide numbers.
- Foresters use the left-hand scale when they want to take measurements at 33 feet or 66 feet away from the tree.
- In surveyor's terms, 66 feet = 1 chain.
- Clinometers can also be used to determine grade or slope in an area.

How to measure tree height if standing on a slope.



If you are standing on a slope below the tree, then you subtract the number on the scale taken at the bottom of the tree from the number on the scale taken at the top of the tree.

For example,
110 – 12 = 98 feet

98 feet divided by 2 = 49 feet

The tree is 49 feet tall.

Forestry Suppliers Lesson Plan

Tree Study

Forestry Suppliers' Tree Study F.I.E.L.D. Kit™
Fundamental Investigation of the Environment Leading to Discovery™
Study Kit Correlated to National Science Education Content Standards

If you're interested in tree studies for classroom activities, consider the Forestry Suppliers' Tree Study F.I.E.L.D. Kit. Use the kit for the exercises outlined in this Lesson Plan, as well as other related activities (see "Further Studies" section for a few ideas).

This F.I.E.L.D. Kit is available exclusively from Forestry Suppliers and includes some of the items used in this lesson plan. All kit items may also be purchased individually. Call our Sales Department at 1-800-647-5368 or visit us on the web at www.forestry-suppliers.com.

Fields of Study:

- Biology
- Forestry
- History
- Mathematics

National Science Education Content Standards Correlation

Grades	A	B	C	D	E	F	G
K-4	✓		✓		✓		✓
5-8	✓		✓			✓	✓
9-12	✓					✓	✓

Tree Study Kit Contents Stock Number 36849		Required For This Lesson Plan			
Qty.	Description	K-4	5-8	9-12	Stock Number
1	Increment Borer - 8″, 3-Thread	✓	✓	✓	63081
1	Tangent Height Gauge				36953
1	Diameter Tape	✓	✓	✓	39480
1	Tree Finder Book				94711
1	Doyle Tree and Log Scale Stick	✓	✓	✓	59750
1	100' Tape				40057
1	Increment Core Holders, Pack of 10	✓	✓	✓	63395
3	Enviro Flagging, Blue				58036
3	Enviro Flagging, Orange				58037
1	Stake Flags, Blue				39287
1	Stake Flags, Orange				39288
6	English/Metric Ruler - 12″/30cm Long				47460
6	Tree Cookies, Pack of 6				36858
6	Handheld Magnifiers				61233

Grades K-4

Background

In a group of similar trees, are the tallest trees really the oldest? Since some trees are naturally taller than others are, several factors must be considered. Pine, oak, sweet gum, cottonwood, Douglas fir and the giant sequoia are all examples of tall trees. Trees that when full-grown are not very tall include the apple tree, peach tree, hackberry, elm, Osage orange and horseapple. To determine if there is a correlation between age and height, several factors must be considered. The height of the tree must first be found. This can be done by using a clinometer or a tangent height gauge. The diameter of the tree must also be determined.

Next, a core sample must be taken and viewed to determine the actual age of the tree. When studying a core, you will notice that the wood has light and dark bands. These are used to determine the age of the tree. Just as the growth rings of a tree are visible in a crosscut log, each light or dark band visible on the core represents a year in the life of a tree. The light bands are the springwood that the tree added during the growing season in spring. The dark bands beside each light band represent the late summer and fall growing season for each tree. Trees grow very little if any during the cold months of winter.

When studying trees it is important to consider the total value of the tree. All trees are valuable. Trees are a very important part of many ecosystems and our total environment. Some trees are valued because of the great beauty that they add to the forest or landscape. Other trees provide a much needed home or niche for certain small animals or insects. Particular trees yield compounds or substances that are used as medicines and in chemical products. Specific types of trees are used to build our homes and other wood structures and products. Tree farmers and foresters need to know the market value of the trees that are used to supply wood for human use. Much consideration must be given to the cutting of trees prior to the actual cutting. Experienced and knowledgeable foresters can best determine which trees should be harvested. A Tree and Log Scale Stick may be used for many applications including diameter measurements, determining merchantable tree height and finding volumes for standing and felled trees. Even younger students need to understand the basics of determining the age and value of a specific tree. Understanding this can truly make students of all ages better stewards of our environment.

Procedure

1. In a group of similar trees, are the tallest trees necessarily the oldest? To study this, locate 4 to 7 trees of the same species growing near each other that are no more than 14 inches in diameter. (Note: Before you bore trees on private property, be sure to obtain the permission of the landowner.)
2. Measure the heights of the trees using a clinometer, a tangent height gauge or a classroom-made height finder. (Older students will be able to follow the instructions given on the tangent height gauge.)
3. Measure the diameter of the trees using a diameter tape or a log scale stick. (Older students will be able to use the log scale stick on their own; refer to Correlated Lesson Plan for grades 5-8 for detailed use of a Tree and Log Scale Stick.)
4. Capture a core sample using an increment borer. Bore the tallest tree at about 4.5 feet above the ground. Teachers may need to assist students in lower grades in obtaining the core sample.
5. Store the core in an increment core holder or in a standard soda straw. Be sure to label the sample appropriately and to handle the cores very carefully so that they don't break.
6. Count the rings on the bored trees. When counting the rings it is helpful to use a pen or marker to note every five or ten rings on older trees. If the rings are difficult to see wet them with water or rub lightly with a highlighter pen or a light-colored marker.
7. Once the rings are counted, 5 to 10 years is often added to the total age of a tree. This makes allowance if the very center of the tree is missed during boring. For this exercise, add 8 years to the age of each tree.
8. Next, examine the last ten years of growth rings (closest to the borer handle) for each tree. This is a gauge of how well the tree is growing now.
9. Compare these rings with the first and middle 10 years of growth.
10. When you are through with the cores, return them back into the tree. This will help deter rot and insect invasion of the tree.
11. Use the Data Collection Sheet provided to record your results. For additional study and to introduce new hypotheses, repeat the exercise for other tree species on your site.

Further Studies

- Students will list the most commonly found trees within the area that they are observing.
- Students will complete library or Internet research, finding facts about trees that grow tallest within a given period of time.
- Students will attempt (with their teacher's help) to locate the oldest and tallest tree within a second group or stand of trees using the procedure used in the first study.
- Students will compare differing characteristics between hard and soft woods when presented with tree cookies of hard and soft wood.

Rubric

- Students will be able to explain the value of various species of trees.
- Students will list trees that are considered tall or short at maturity.
- Students will demonstrate how an increment borer is used.
- Students will demonstrate how a tree height tangent and a clinometer are used. (3-4)

Assessment

- The teacher will have the students prepare a storyboard explaining why taller trees are not necessarily the oldest trees.
- The teacher will provided sample cores and have students judge the age of the tree from the sample.
- The teacher will have the students use the tree height tangent in determining the height of a flagpole, another type of pole or a tree present on the school playground or campus. (3-4)

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Characteristics of organisms
- Life cycles of organisms

E Science and Technology
- Abilities of technological design
- Understandings about science and technology

G History and Nature of Science
- Science as a human endeavor

Additional Materials Needed

Supplied by Teacher/Student(s)

- Data Collection Sheet
- Clear Straws

Optional Items

Optional items available from Forestry Suppliers that can be used to enhance this lesson plan.

- Clinometer **43830**

Grades 5-8

Background

When studying trees, it is important to consider the total value of the tree. All trees are valuable. Trees are a very important part of many ecosystems and our total environment. A forest provides an efficient cooling system as the trees and plants respire or release amounts of water and produce oxygen. Understanding what trees need for optimum growth and health is essential in maintaining a balance in our environment. Some trees are valued because of the great beauty that they add to the forest or landscape. Other trees provide much needed homes or niches for certain small animals or insects. Particular trees yield compounds or substances that are used as medicines and in chemical products. These trees are part of complex ecosystems, which are sustained by the continual presence of all species.

Specific types of trees are used to build our homes and other wood structures and products. Tree farmers and foresters need to know the market value of the trees that are used to supply wood for human use. Much consideration must be given to the cutting of trees prior to the actual cutting. Experienced and knowledgeable foresters can best determine which trees should be harvested. A Tree and Log Scale Stick may be used for many applications including diameter measurements, determining merchantable tree height and finding volumes for standing and felled trees. Even younger students need to understand the basics of determining the age and value of a specific tree. Understanding this can truly make students of all ages better stewards of our environment.

In a group of similar trees, are the tallest trees really the oldest? Since some trees are naturally taller than others are, several factors must be considered. Pine, oak, sweet gum, cottonwood, Douglas fir and the giant sequoia are all examples of tall trees. Trees that when full-grown are not very tall include the apple tree, peach tree, hackberry, elm, Osage orange and horseapple. To determine if there is a correlation between age and height, several factors must be considered. The height of the tree must first be found. This can be done by using a clinometer or a tangent height gauge. The diameter of the tree must also be determined.

A core sample must be taken and viewed to determine the age of the tree. When studying a core, you will notice that the wood has light and dark bands. These are used to determine actual the age of the tree. Just as the growth rings of a tree are visible in a crosscut log, each light or dark band visible on the core represents a year in the life of a tree. The light bands are the springwood that the tree added during the growing season in spring. The dark bands beside each light band represent the late summer and fall growing season for each tree. Trees grow very little if any during the cold months of winter.

Procedure

1. In a group of similar trees, are the tallest trees necessarily the oldest? To study this, locate 4 to 7 trees of the same species growing near each other that are no more than 14 inches in diameter. (Note: Before you bore trees on private property, be sure to obtain the permission of the landowner.)
2. Measure the heights of the trees using a clinometer, a tangent height gauge or a classroom-made height finder. (Older students will be able to follow the instructions given on the tangent height gauge.)
3. Measure the diameter of the trees using a diameter tape or a log scale stick. (Older students will be able to use the log scale stick on their own.)
4. Capture a core sample using an increment borer. Bore the tallest tree at about 4.5 feet above the ground. Teachers may need to assist students in lower grades in obtaining the core sample.
5. Store the core in an increment core holder or in a standard soda straw. Be sure to label the sample appropriately and to handle the cores very carefully so that they don't break.
6. Count the rings on the bored trees. When counting the rings, it is helpful to use a pen or marker to note every five or ten rings on older trees. If the rings are difficult to see, wet them with water or rub lightly with a highlighter pen or a light-colored marker.
7. Once the rings are counted, 5 to 10 years is often added to the total age of a tree. This makes allowance if the very center of the tree is missed during boring. For this exercise, add 8 years to the age of each tree.
8. Next, examine the last ten years of growth rings (closest to the borer handle) for each tree. This is a gauge of how well the tree is growing now.
9. Compare these rings with the first and middle 10 years of growth.
10. When you are through with the cores, return them back into the tree. This will help deter rot and insect invasion of the tree.
11. Use the Data Collection Sheet provided to record your results. For additional study and to introduce new hypotheses, repeat the exercise for other tree species on your site.

Further Studies

- Students may make comparisons among different species of trees concerning the merchantable value. These observations can be made within their own school or home environment. A field study may be necessary if a forested area is not present within the school setting.
- Students can calculate felled log volume and value by using the Tree Scale Stick.
- Students will compare differing characteristics between hard and soft woods when presented with tree cookies of hard and soft wood.

Rubric

- Students should be able to measure the height of a pole or tree using a tangent height gauge.
- Students should be able to determine: tree diameter, merchantable tree height, and volume of tree in board feet.
- Students should be able to determine the board foot volume of a tree that has been felled and cut.

Assessment

- Students will be quizzed concerning how the age of a tree is determined.
- Students will be expected to give the age of a tree if supplied with a core sample as well as give other characteristics that can be determined from such a sample.
- Students will explain how to determine the merchantable value of a tree.
- Students will give examples of trees which, at maturity, are tall or short.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Structure and function in living systems

F Science in Personal and Social Perspectives
- Populations, resources and environments

G History and Nature of Science
- Science as a human endeavor
- History of science

Additional Materials Needed

Supplied by Teacher/Student(s)

- Data Collection Sheet
- Clear Straws

Optional Items

Optional items available from Forestry Suppliers that can be used to enhance this lesson plan.

- Clinometer **43830**

Grades 9-12

Background

When studying trees, it is important to consider the total value of the tree. All trees are valuable. Trees are a very important part of many ecosystems and our total environment. A forest provides an efficient cooling system as the trees and plants respire or release amounts of water and produce oxygen. Understanding what trees need for optimum growth and health is essential in maintaining a balance in our environment. Some trees are valued because of the great beauty that they add to the forest or landscape. Other trees provide much needed homes or niches for certain small animals or insects. Particular trees yield compounds or substances that are used as medicines and in chemical products. These trees are part of complex ecosystems, which are sustained by the continual presence of all species.

Specific types of trees are used to build our homes and other wood structures and products. Tree farmers and foresters need to know the market value of the trees that are used to supply wood for human use. Much consideration must be given to the cutting of trees prior to the actual cutting. Experienced and knowledgeable foresters can best determine which trees should be harvested. A Tree and Log Scale Stick may be used for many applications including diameter measurements, determining merchantable tree height and finding volumes for standing and felled trees. Even younger students need to understand the basics of determining the age and value of a specific tree. Understanding this can truly make students of all ages better stewards of our environment.

In a group of similar trees, are the tallest trees really the oldest? Since some trees are naturally taller than others are, several factors must be considered. Pine, oak, sweet gum, cottonwood, Douglas fir and the giant sequoia are all examples of tall trees. Trees that when full-grown are not very tall include the apple tree, peach tree, hackberry, elm, Osage orange and horseapple. To determine if there is a correlation between age and height, several factors must be considered. The height of the tree must first be found. This can be done by using a clinometer or a tangent height gauge. The diameter of the tree must also be determined.

A core sample must be taken and viewed to determine the age of the tree. When studying a core, you will notice that the wood has light and dark bands. These are used to determine actual the age of the tree. Just as the growth rings of a tree are visible in a crosscut log, each light or dark band visible on the core represents a year in the life of a tree. The light bands are the springwood that the tree added during the growing season in spring. The dark bands beside each light band represent the late summer and fall growing season for each tree. Trees grow very little if any during the cold months of winter.

Procedure

1. In a group of similar trees, are the tallest trees necessarily the oldest? To study this, locate 4 to 7 trees of the same species growing near each other that are no more than 14 inches in diameter. (Note: Before you bore trees on private property, be sure to obtain the permission of the landowner.)
2. Measure the heights of the trees using a clinometer, a tangent height gauge or a classroom-made height finder.
3. Measure the diameter of the trees using a diameter tape or a log scale stick. (Older students will be able to use the log scale stick on their own.)
4. Capture a core sample using an increment borer. Bore the tallest tree at about 4.5 feet above the ground.
5. Store the core in an increment core holder or in a standard soda straw. Be sure to label the sample appropriately and to handle the cores very carefully so that they don't break.
6. Count the rings on the bored trees. When counting the rings, it is helpful to use a pen or marker to note every five or ten rings on older trees. If the rings are difficult to see, wet them with water or rub lightly with a highlighter pen or a light-colored marker.
7. Once the rings are counted, 5 to 10 years is often added to the total age of a tree. This makes allowance if the very center of the tree is missed during boring. For this exercise, add 8 years to the age of each tree.
8. Next, examine the last ten years of growth rings (closest to the borer handle) for each tree. This is a gauge of how well the tree is growing now.
9. Compare these rings with the first and middle 10 years of growth.
10. When you are through with the cores, put them back into the tree. This will help deter rot and insect invasion of the tree.
11. Use the Data Collection Sheet provided to record your results. For additional study and to introduce new hypotheses, repeat the exercise for other tree species on your site.

Further Studies

- Students may make comparisons among different species of trees concerning the merchantable value. These observations can be made within their own school or home environment. A field study may be necessary if a forested area is not present within the school setting.
- Students can calculate felled log volume and value by using the Tree Scale Stick. Comparisons should be made using different tree species.
- Students may complete library research to determine what species of tree has historically had the highest merchantable value.
- Students may complete research concerning rainforest tree species that produce known medicinal compounds.
- Students will compare differing characteristics between hard and soft woods when presented with tree cookies of hard and soft wood.

Rubric

- Students should be able to measure the height of a pole or tree using a tangent height gauge.
- Students should be able to determine tree diameter, merchantable tree height, and volume of tree in board feet.
- Students should be able to determine the board foot volume of a tree that has been felled and cut.
- Students should be able to categorize tree species as tall or short at maturity.
- Students should be able to use a clinometer and make accurate measurements.

Assessment

- Students will be asked to give the steps in determining the age of a tree.
- Students will be expected to give the age of a tree if supplied with a core sample as well as give other characteristics that can be determined from such a sample, such as possible information concerning the moisture availability during a particular year.
- Students will explain how to determine the merchantable value of a tree.
- Students should be familiar with the merchantable value of local species of trees.

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Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

F Science in Personal and Social Perspectives
- Natural Resources
- Environmental Quality

G History and Nature of Science
- Science as a human endeavor
- Historical perspectives

Additional Materials Needed

Supplied by Teacher/Student(s)

- Data Collection Sheet
- Clear Straws

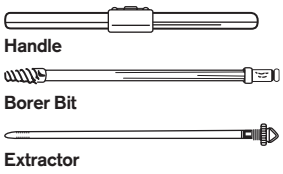
Optional Items

Optional items available from Forestry Suppliers that can be used to enhance this lesson plan.

- Clinometer **43830**

Using an Increment Borer

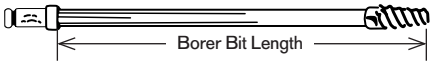
The Increment Borer is essential for extracting a core of wood from trees, logs, poles or timbers. The core extracted is used for many purposes including determination of growth rate, age, tree soundness, penetration of chemicals in the wood treating business, and specific gravity studies of wood.



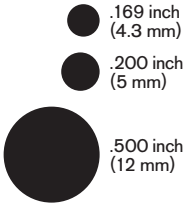
An increment borer consists of three parts: a handle, a borer bit, and an extractor. When not in use, the borer bit and extractor fit inside the handle and form a compact unit. Most increment borers have Teflon® coated bits. This coating helps reduce friction, protects against rust, and keeps the bit clean to extend bit life.

Making the Right Selection

There are three things to consider when you choose an increment borer. They are length, diameter, and style.



Borer bit length depends on the size of the trees you will be boring. Length is measured from the tip of the threads to the end of the round section of the borer bit. This is the maximum depth the bit will penetrate.



Core Diameter of the wood sample is determined by the inside diameter of the opening at the threaded end of the bit. .169″ is commonly used for general forestry use, .200″ for wood preserving testing and .500″ for large amounts of wood for qualitative analysis.

2- or 3-Thread style is a matter of personal preference. A 2-thread borer has two threads on the cutting edge of the bit, each originating 180° apart.

A 3-thread borer has three threads, each originating 120° apart. The 3-thread borer, due to its higher pitch, will penetrate the wood deeper per revolution than a 2-thread and also produce less friction because more threads are pushing against the wood.

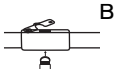
It is important to remember, the ease at which a borer penetrates wood depends on wood hardness, friction properties and capability/strength of the user.

Taking an Increment Core

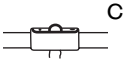
Follow these seven steps to take a core:

1. Remove the borer bit and extractor from inside the handle. Place the extractor in a pocket of your cruiser vest for convenience and protection of the extractor.
2. Assemble the handle and borer bit by:

A Pushing the locking latch away from the handle with your thumb



B Inserting the square end of the borer bit into the handle, then



C Returning the locking latch completely around the borer bit "collar."

You're now ready to start boring. However, we suggest you apply beeswax to the threads and shank before you begin.

3. Align the borer bit and the handle so that the bit will penetrate through or towards the center of the tree and at right angles to the tree. In any other alignment, the annual growth rings seen in the extracted core will be distorted and could result in erroneous growth rate analysis.

4. Place the borer bit threads against the tree (Fig.1), preferably in a bark fissure where the bark is thinnest.

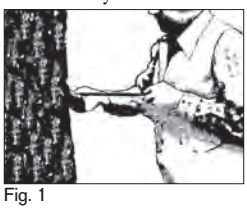


Fig. 1

Hold the threads in place with one hand. With your other hand, push forward on the handle and simultaneously turn it clockwise until the bit threads penetrate the wood enough to hold the bit firmly in place.

5. Place both hands, palms open, on the ends of the handle and turn the handle clockwise until the bit reaches the desired depth (Fig. 2).


Fig. 2

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Jackson, MS 39201

WD041000 5/04-3M

6. With the bit at the desired depth, insert the full length of the extractor, concave side down "◠" (Fig. 3).

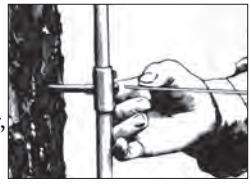


Fig. 3

Then turn the handle one-half turn counterclockwise to break the core from the tree and also to turn the extractor concave side up like this: "◡."

7. Pull the extractor from the borer bit (Fig. 4). The core will be resting in the channel and held in place by the small "teeth" at the tip of the extractor. Before examining the core sample, promptly remove the borer bit from the tree. Clean it and place it and the extractor back in the handle.


Fig. 4

Care and Maintenance

Follow these suggestions to maintain the efficiency and extend the life of your increment borer.

Lubricate with Beeswax

A block of beeswax is provided with every increment borer. Penetration and removal of the borer bit will be easier if beeswax is liberally applied to the threads and shank before each boring.

Clean with WD-40

WD-40 is an excellent cleaner and rust preventative for an increment borer. It will also prevent sap acid-etching of the borer. Spray it on as well as inside the bit and on the extractor at the end of each working day. Wipe clean.

Be Quick!

Obtain your core samples as rapidly as possible. It's best to remove the bit from the tree even before examining the core sample. This will reduce the possibility of the bit becoming stuck or locked in the tree.

Avoid Compression & Tension Wood

Never bore into suspected compression or tension wood. To explain: a tree leaning towards the North will have compression wood on the North side. If you bore into compression wood, the bit could be locked into the tree by the force of the "compressed" wood. If you bore into the South side, you are boring into "tension" wood, where the ring width may not be representative. We recommend boring on the East or West side, or if possible, select another tree.

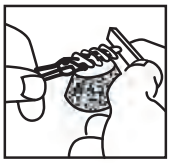
Increment Borer Sharpening

Increment borers become dull or nicked with use. A borer is dull if it does not easily engage the wood and if it will not cut a clean-edged hole when rotated on a sheet of paper.

How to Sharpen Borer Bits

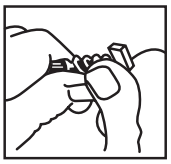
See Increment Borer Sharpening Kit for stones described here.

1. True Cutting Edge Using Pocket Stone



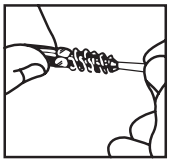
If cutting edge is uneven when placed lightly against a flat surface, it needs to be trued up. Place a few drops of oil on wide face of pocket stone. Hold borer bit steady on cork rest and pass stone back and forth across cutting edge, turning bit slightly after each pass. Repeat until true.

2. Sharpen Cutting Edge Using India Stone



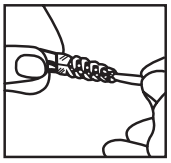
Holding bit in left hand and India stone in right hand, slowly rotate bit away from you and against stone while holding stone parallel to and firmly on beveled edge of bit. Continue until sharp. If nicks are present, use pocket stone to work them out, then follow with the India stone.

3. Hone Inside of Cutting Edge Using Conical Stone



Put a few drops of oil on conical stone and insert tip of stone into cutting end of bit until it occupies about 3/4ths of core hole. Very lightly rotate stone against inside of cutting edge, keeping the edge of the stone parallel to the long axis of the bit.

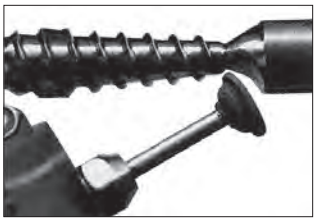
4. Hone Outside Beveled Portion of Cutting Edge Using Conical Stone



Hold borer bit with threads on cork rest and place just the tip of conical stone on and parallel to bevel. Use very light strokes back and forth over a small arc of beveled edge. Turn bit and repeat until entire edge has been honed. To test sharpening, cut circular holes in a sheet of paper.

Increment Borer Sharpening Kit

Includes everything needed to sharpen borers: India Stone to sharpen lead cutting edge; Conical Stone to sharpen inside cutting edge, outside beveled edge; Pocket Stone to "true" cutting edge, remove chips and nicks; can of Sharpening Stone Oil to lubricate, clean stones; and Cork to use as a work rest. To order, specify number 63399, Sharpening Kit.



Professional Increment Borer Repair Service

Extend the life of your increment borer. Have the cutting edge sharpened, threads reshaped near cutting tip, and nicks removed. Your bit will be returned to you in "like-new" condition. Note: Nicks, chips and cracks greater than 1/16" deep cannot be repaired. For more information, call our Customer Service Department toll-free at (800) 752-8460.

Worksheet

Student Name: _____ **Date:** _____

	Tree #1	Tree #2	Tree #3	Tree #4	Tree #5	Tree #6	Tree #7
Height (inches)	_____	_____	_____	_____	_____	_____	_____
Diameter (inches)	_____	_____	_____	_____	_____	_____	_____
Total Age (from core + 8)	_____	_____	_____	_____	_____	_____	_____
Core Growth	_____	_____	_____	_____	_____	_____	_____
Length of first 10 years (inches)	_____	_____	_____	_____	_____	_____	_____
Length of middle 10 years (inches)	_____	_____	_____	_____	_____	_____	_____
Length of last 10 years (inches)	_____	_____	_____	_____	_____	_____	_____

Conclusions and Questions	**Yes**	**No**
1. Does the tallest tree have the largest diameter?	☐	☐
2. Did the tallest tree have the longest core length during its first ten years?	☐	☐
3. Did the tallest tree have the longest core length during its middle ten years?	☐	☐
4. Did the tallest tree have the longest core length during its last ten years?	☐	☐
5. How many dark rings did you count from the bark to the center ring?	☐	☐
6. Was the tree alive when World War II ended?	☐	☐
7. Was the tree alive when you were born?	☐	☐

Year you were born _____

8. How many inches did your borer have to travel to reach the center of the tree? _____

9. Does this have any relationship to its diameter?	☐	☐

If yes, what is it? _____

10. Does taller also mean older?	☐	☐

Why/why not? _____

_____

_____

11. List any other conclusions you determined: _____

_____

_____

_____

Lesson 6: Measuring Trees

Review and Introduction

In Lesson 4 and Lesson 5, you learned how to establish either a **fixed plot** or a **variable plot**. With your plot established and your "in" trees tallied, now it is time to measure the trees in the plot as representative samples of the trees in your **stand**.

Learning Objectives:

By the end of this lesson, you will be able to:

1. Measure tree **diameter at breast height (DBH)**
2. Measure total tree height
3. Determine the **live crown ratio**
4. Determine tree age

Materials Needed:

1. **Diameter tape** or **woodland stick**
2. **Clinometer** or woodland stick
3. **Increment borer** (optional)
4. Data recording sheets

I. Getting Started

You will need to record data about the trees in your plot. We suggest downloading and printing a plot data recording sheet to help you organize your data. You can print a sheet for each plot that you plan to do, and they can even be printed on waterproof paper (available from forestry suppliers) to create durable, all-weather plot cards. The data recording sheet with this lesson was specifically designed for use with the **LMS Inventory Wizard** software (which will be covered in Lesson 8), but it is useful even if you do not plan to use the software.

First record tree species for each tree in your plot. Books on tree identification are commercially available and may also be available at your local library. Your Local Extension Forester is another good source for tree identification resources, some of which may be available at no charge from your local Extension Service.

II. Measuring tree diameter

After recording tree species, the next step is to measure the diameter of each tree. **Diameter** is the width of a circle or cylinder; in this case the stem of the tree. Tree stems have **taper** (they are slightly cone-shaped), such that they are wider at the base and narrower further up. Thus, diameter will vary based on how high up on the stem of the tree you measure it.

A standardized height for measuring tree diameter has been established. This is known as **breast height**, which is defined as 4.5 feet (54 inches) above the ground, on the uphill side of the tree.

Use a measuring tape to figure out how high up breast height is on you. Memorize this spot (e.g. the next to the top button on your shirt or coat[1]) so that as you stand next to a tree, you know where to measure diameter.

Using a diameter tape

We will talk about two ways to measure **diameter at breast height (DBH)**. The most accurate way is to use a special measuring tape known as a diameter tape. A diameter tape is calibrated such that **circumference** measurements are automatically converted to diameter (i.e. the measurement units have been divided by the constant **Pi** so that you do not have to do the mathematical conversion from circumference to diameter). Thus while you are physically measuring the circumference of the tree, you are reading the measurement in diameter units.[2] If you do not have a diameter tape, you can use a regular cloth measuring tape and divide your circumference measurement by Pi (3.14) to convert to diameter.

To measure DBH, wrap the diameter tape around the tree at breast height, making sure the tape is level and not twisted. Most diameter tapes will give you diameter to the nearest 1/10th inch. The diameter measurement is read where the tape overlaps with the zero marker (*Figure 6-1*). If the tree is large, it is helpful to work with a partner to wrap the tape around the tree. Many diameter tapes also have a nail or hook on the end that you can stick into the tree to hold the end of the tape in place while you wrap it around.

Figure 6-1: To measure DBH, wrap a diameter tape around the tree at breast height, making sure the tape is level and not twisted. The diameter measurement is read where the tape overlaps with the zero marker. In this case, the DBH of this tree is 34.0 inches.

Watch a video clip of how to use a diameter tape:
mms://www.ruraltech.org/virtual_cruiser/dbh.wmv

Using a woodland stick

A second way to measure DBH is to use a **woodland stick** (also called a Biltmore stick or a cruiser stick). These special measuring sticks are inexpensive compared to diameter tapes and they are quick and easy to use, but they are not as accurate as a diameter tape.

To use a woodland stick, find the side of the stick that is marked for tree diameter. With this side facing you, hold the stick up against the tree at breast height. The stick should be 25 inches away from your eye, which is a comfortable arm's reach for an average person. Keeping the stick level and perpendicular to your line of sight, visually line up the left side of the stick with the left edge of the tree. Now, keeping your head still, move your eyes to the right edge of the tree and read where it falls on the stick (*Figure 6-2*). Note that woodland sticks usually only measure to the nearest inch (not as precise as the diameter tape). Since trees are not perfect cylinders, you should measure two adjacent sides of the tree and average the values together to estimate DBH.

Quick steps – Measuring DBH with a woodland stick

1. Hold the stick against the tree at breast height, 25 inches from your eye.
2. Visually line up the left edge of the stick with the left edge of the tree.
3. Moving your eyes (not your head!) read where the right edge of the tree falls on the stick.
4. Repeat the measurement for a different side of the tree and take the average.

Figure 6-2: To measure DBH with a woodland stick, hold the stick against the tree at breast height, 25 inches from your eye. Keeping the stick level and perpendicular to your line of sight, line the end up visually with the left side of the tree. Then move your eyes (not your head) to read diameter on the right side of the tree. In this case, the tree whose DBH measured 34.0 inches with the diameter tape in *Figure 6-1* measures between 33 and 34 inches with the woodland stick.

Watch a video clip of how to measure DBH with a woodland stick:
mms://www.ruraltech.org/virtual_cruiser/woodland_stick_dbh.wmv

III. Measuring tree height

After recording diameter for each tree, the next step is to measure tree height. Unlike with diameter, you may not need to measure the height of every tree in the plot if you are going to be using the **Landscape Management System (LMS)** computer program (Lesson 8 and Lesson 9) with your inventory data. However if you plan to manually compute variables such as tree volume per acre (Lesson 10), you may need to measure every tree height.[3]

If you are using LMS, in general you should plan to measure a minimum of one tree height per plot. As with other aspects of inventory sampling, it is desirable to be systematic when selecting a tree to take a height measurement. One method is to start from either north or whatever direction you were traveling to reach your plot, go clockwise around your plot and select the first "in" tree to use for your height measurement. The tree should be representative of your plot in terms of species and size. For instance, if your plot is predominantly comprised of large, dominant conifers and the first tree you come to is a suppressed hardwood or a tree with a broken top, do not use that tree for your height measurement. Rather, keep moving clockwise until you find the first tree that is adequately representative of the trees in your plot.

If you have several key species present in your plot, you may wish to work your way around the plot and select the first adequately representative tree of each species. If you wish to compute **site index** (see Lesson 7), make sure you include height measurements for several **dominant trees** of whatever species you wish to compute site index for.

Using a clinometer

As with DBH, we will talk about two different ways to measure height. The first way is to use a tool called a **clinometer**. A clinometer is a vertical angle gauge that measures the slope from your eye to either the top or bottom of the tree. Looking with one eye into the hole of the clinometer, you will see a graduated scale showing the slope measurements. The scale will move up or down as the clinometer is tilted up or down. Different clinometers measure slopes in different units, so it is important to consult the instructions for your clinometer to confirm what units are being measured. Commonly clinometers list the slope in degrees on the left half of the scale and in percent on the right half of the scale. The steps described below correspond to **percent slope** measurements. By definition, percent slope is the distance up or down per 100 feet of horizontal distance. Thus a reading of 30% means a height or depression of 30 feet, when measured at 100 feet horizontal distance.

When measuring the height of a tree, you will need to move away from the tree to a place where you can see the top. While you can choose any distance at which you can see the top of the tree and the clinometer reading is not off the scale (usually 150%, though accuracy may deteriorate beyond 120% or so), because you are working in percent a distance of exactly 100 feet will greatly simplify the calculation to determine tree height. For trees that are tall enough such that 100 feet is not far enough back to accommodate the scale of the clinometer (or to see the top of the tree), you will have to move back further to obtain an accurate reading. For very short trees, you may only need to move back 50 or 75 feet.

You can measure your distance away from the tree using a cloth measuring tape or a retractable **logger's tape**. When choosing a spot from which to measure a tree, if you are on a slope try to stay on the same level as the tree. If you go significantly uphill or downhill from the tree, your distance measurement (and subsequent height measurement) will not be accurate.

Quick steps – Measuring tree height with a clinometer

1. Move back a measured distance from the tree, preferably 100 feet.

2. Looking at the top of the tree with one eye and through the clinometer with the other, line up the marker in the clinometer with the top of the tree and read the value on the percent scale.

3. Repeat this for the bottom of the tree. If the percentage to the bottom is on the negative part of the scale, add it to the percentage from Step 2; if it is positive, subtract it.

4. Multiply the combined percentage by the distance back from the tree to determine total tree height.

Example:

- Distance from tree = 100'
- Tree top reading = +90%
- Tree bottom reading = -5%
- Combined reading = 90% + 5% = 95%
- Tree height = 95% x 100' = 95'

Once you have measured the distance from the tree, you can use the clinometer to measure the slope between your eye and both the top and bottom of the tree (*Figure 6-3*). Looking into the clinometer with one eye (you cannot actually look through the clinometer) and sighting the top of the tree with your other eye, visually line up the horizontal marker in the clinometer with the top of the tree (*Figure 6-4*). It may take some practice to get your eyes to work together for this. Once the horizontal marker in the clinometer is lined up, read the corresponding value on the percent scale. Now repeat this procedure for the bottom of the tree.[4]

Assuming the angle to the top of the tree reads a positive value, if the angle to the bottom of the tree reads a negative value, you add the bottom value to the top value to get the total percent slope. In the case where the angle to the bottom of the tree also reads a positive value, such as when you are standing downhill from the tree (*Figure 6-5*), you would instead subtract the bottom value from the top value to get the total percent slope.

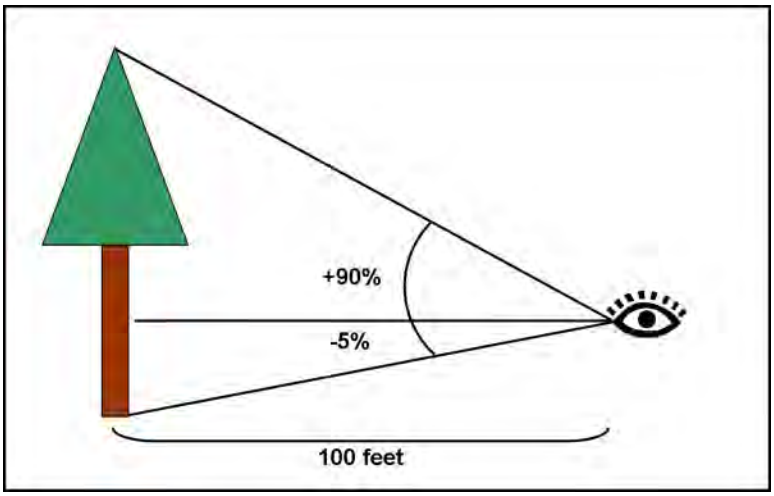


Figure 6-3: A clinometer measures the percent slope between your eye and both the top and bottom of the tree. In this case the clinometer reads 90% up and 5% down, for a total of 95%. Since the tree is 100 feet away, the height of the tree is 0.95 x 100 = 95 feet.

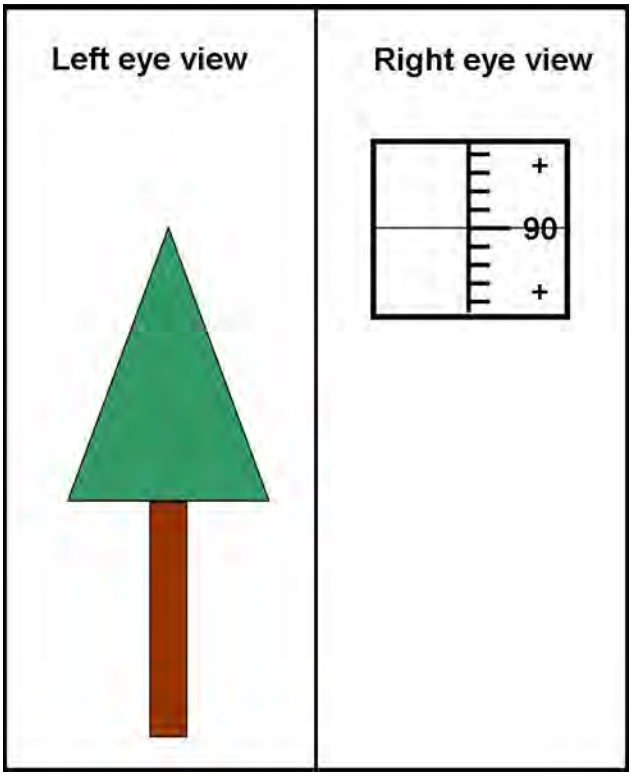


Figure 6-4: When using a clinometer, look into the clinometer with one eye and look at the top of the tree with the other. Line up the horizontal marker in the clinometer with the top of the tree and read the value (in this case 90%).

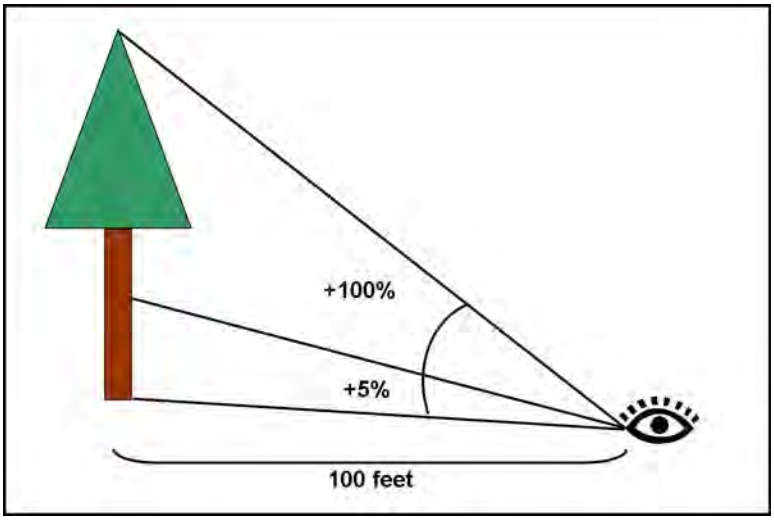


Figure 6-5: When standing downhill from the tree, the clinometer may read up to the bottom of the tree rather than down. In this case the 5% up to the bottom of the tree would be subtracted from the 100% up to the top of the tree for a total of 95%. Since the tree is 100 feet away, the height of the tree is 0.95 x 100 = 95 feet.

The total percent slope is equal to vertical distance (i.e. the total height of the tree from top to bottom) divided by the horizontal distance away from the tree. Since we know the horizontal distance and the total percent slope, we can solve for tree height by multiplying the percent slope (expressed as a decimal) by the horizontal distance (*Figures 6-4 and 6-5*). This is why being exactly 100 feet away makes for the simplest calculation—a total slope of 95% (0.95 if expressed as a decimal) means the tree is 95 feet tall (e.g. *Figure 6-4*). When using horizontal distances other than 100 feet, such as in brushy conditions, it may be helpful to have a hand calculator to assist with the calculation.

Watch a video clip of how to measure tree height with a clinometer:
mms://www.ruraltech.org/virtual_cruiser/clinometer.wmv

Using a woodland stick

You can also measure tree height using a woodland stick. This is an inexpensive option if you do not have a clinometer, though it is not as accurate. Similar to using a clinometer, you will need to use a cloth tape or logger tape to measure back from the tree a specified distance. With the woodland stick, though, this is a fixed, prescribed distance, usually 66 feet or 100 feet depending on your region and the stick you are using. Find the side of the woodland stick that is marked for tree height, and with this side facing you, hold the stick vertical. The stick should be 25 inches away from your eye, which is a comfortable arm's reach for an average person. Keeping the stick straight, visually line up the bottom of the stick with the bottom of the tree (*Figure 6-6*). Now, keeping your head still, move your eyes to the top of the tree and read where it falls on the stick (*Figure 6-7*).

Figure 6-6: When measuring height with a woodland stick, hold the stick 25 inches from your eye and keep the stick vertically straight.

Quick steps – Measuring tree height with a woodland stick

1. Stand the prescribed distance away from the tree (usually 66’ or 100’ depending on the woodland stick).
2. Hold the stick vertically, 25 inches from your eye
3. Visually line up the bottom edge of the stick with the bottom of the tree
4. Moving your eyes (not your head!) read where the top of the tree falls on the stick

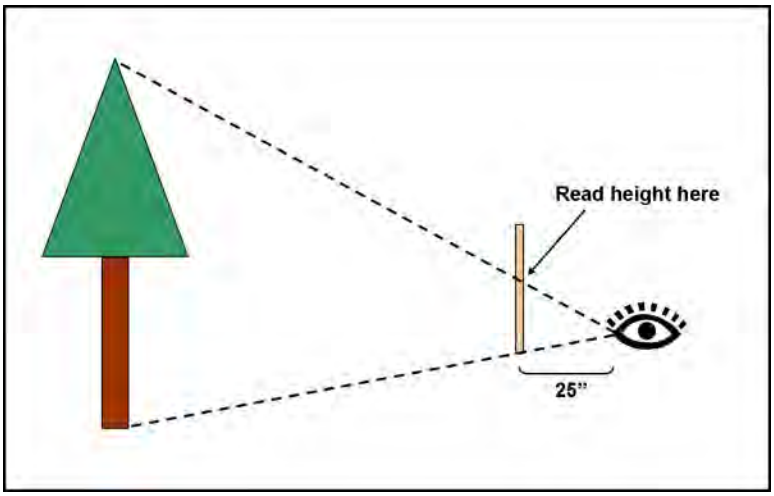


Figure 6-7: When measuring height with a woodland stick, visually line up the bottom of the stick with the bottom of the tree and then, moving your eyes and not your head, see where the top of the tree falls on the stick and read the corresponding height value.

Watch a video clip of how to measure tree height with a woodland stick:
mms://www.ruraltech.org/virtual_cruiser/woodland_stick_tree_height.wmv

IV. Determine live crown ratio

The live crown ratio is the proportion of a tree's height that is green or in crown (*Figure 6-8*). This can be determined with a simple visual estimate. Live crown ratio should be estimated for each tree in the plot.

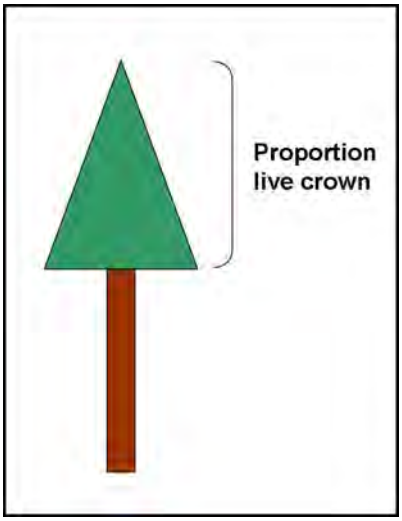


Figure 6.8: The live crown ratio is the proportion of the height of the tree that is green; in this case approximately 50%, which is commonly recorded as 0.5.

V. Determine tree age (optional)

While tree age is not a required part of forest inventory, it may be useful to gather this information. You can determine the age of a stand by taking ages of several dominant trees from different plots and computing the average of these values. You may also want to measure the ages of the same **dominant trees** for which you measured height, in order to compute the **site index** of your stand (Lesson 7).

To determine the age of a tree, you will need a special tool called an **increment borer**. An increment borer is a hollow drill that allows you to extract a thin segment of wood called an **increment core** from the stem of the tree. The increment core will show the annual rings (*Figure 6-9*), which can be counted to determine tree age.

Figure 6-9: An increment borer allows you to extract a small core sample from the stem of the tree with which you can determine age by counting the annual rings.

An increment borer has 3 parts: the handle, the bit, and the extractor (*Figure 6-10*). To assemble the increment borer, the back end of the bit fits into a notch in the center of the handle and clips into place (*Figure 6-11*). The extractor should be kept separate.[5]

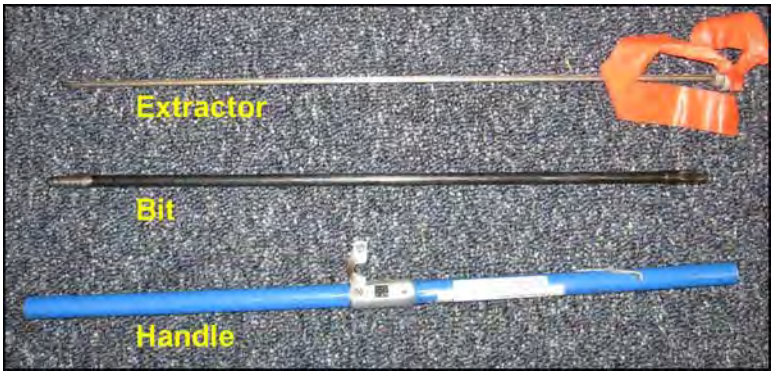


Figure 6-10: An increment borer has three parts: the handle, the bit, and the extractor.

Figure 6-11: An increment borer is assembled by inserting the back end of the bit into a notch in the center of the handle and clipping into place.

To use the increment borer, begin drilling into the tree at **breast height** by turning the handle clockwise. Make sure to keep the increment borer level and drill straight in toward the center of the tree (*Figure 6-12*). You may need to apply pressure towards the tree when first starting until the bit catches on the wood (i.e. push and turn at the same time). You may hear creaking or popping sounds as you drill into the tree. Be sure to drill in far enough to reach the center of the tree.

Figure 6-12: When using an increment borer, drill in straight toward the center of the tree at breast height.

Once you have drilled far enough to reach the center of the tree, carefully insert the extractor into the bit. You will feel some resistance. Once the extractor is all the way in, back the bit out one full turn (counterclockwise). Now slowly pull the extractor out; the increment core should come with it. If the core does not come out on the first try, reinsert the extractor and try again.

Once you have extracted the increment core, set it and the extractor aside. Be careful with the increment core, as it is delicate and may fall apart easily. You should immediately begin removing the bit from the tree by turning the handle counterclockwise, as the increment borer may become stuck if left in the tree too long.

Once the increment borer has been removed from the tree, you can return to your increment core and begin counting rings. If you successfully reached the center of the tree, you should see a round or oval shaped ring on the increment core that marks the center (*Figure 6-13*). Begin counting with this center ring and count outward to end of the increment core. Note that you are counting **breast height age**, which is typically the value of interest. If you also wanted to know the **total age**, adding 4-5 years to the breast height age will in most cases give you a reasonable approximation.

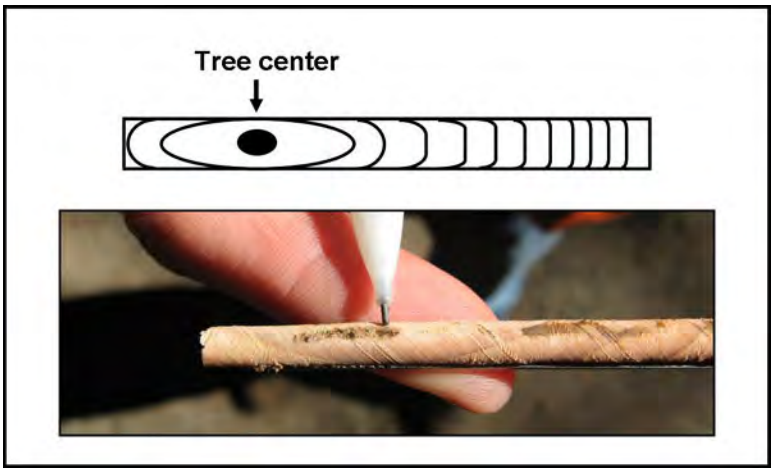


Figure 6-13: Begin counting rings with the round or oval shaped ring that marks the center of the tree.

Quick steps – Determine tree age with an increment borer

1. Assemble the increment borer by attaching the bit to the handle; set the extractor aside.
2. Drill in toward the center of the tree at breast height.
3. When you have gone far enough to reach the center of the tree, insert the extractor and reverse the bit 1 full turn.
4. Slowly remove the extractor. If the increment core does not come out the first time, try again.
5. Once the core is out, set it and the extractor aside.
6. Immediately remove the increment borer from the tree, before it becomes stuck.
7. Once the increment borer is back out of the tree, count the rings on the increment core to determine breast height age. Add several years to estimate total age.

Watch a video clip of how to determine tree age with an increment borer:
mms://www.ruraltech.org/virtual_cruiser/increment_bore.wmv

When you have finished counting the rings, you may save or discard the increment core. Inserting the core back into the tree is not recommended, as this may introduce pathogens into

the stem of the tree. The tree should be able to heal from this small wound on its own and is not likely to suffer any ill effects.

It is important to take care of your increment borer so that it will last you for many uses. Make sure to always protect the sharp end of the bit from getting chipped or dented. Do not let it come in contact with metal or rock. Should you need to sharpen the bit, consult the instructions that came with your increment borer for proper procedures. After you have finished using the increment borer, you can clean it by wiping down the pieces with a soft cloth. Rubbing beeswax on the exterior of the bit will protect the surface and provide lubrication for future uses. You may also wish to spray a small amount of aerosol lubricant inside the bit for protection, lubrication, and to dissolved tree pitch.

On your own:

Measure all the "in" trees in your plot. Identify the species of each tree and measure each tree's DBH. Estimate the crown ratio of each tree. Select at least a couple of trees per plot to measure for height, representing different species and diameter classes. If you wish to compute age and/or site index, select a dominant tree to measure both height and age. Record the data on your plot data recording sheet. Repeat these steps for the rest of the plots in your stand

Next Steps:

- Test your knowledge by taking a Short Quiz.
- Go to the Next Lesson.

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[1] If you always wear the same cruiser vest, you can permanently mark a spot on it that is 4.5 feet above the ground as you are wearing it.

[2] Note: in many European countries, foresters use the circumference, called "girth", but in the US and Canada, our forestry measurements are based on diameters.

[3] If you are going to compute volume manually using a volume table or volume equation (see Lesson 10), you may need the height of each tree. Some volume tables only require DBH, and there are also some inventory systems, such as the Tariff System in the Pacific Northwest, which allow volume to be computed using detailed measurements such as height from only a few trees. If you plan to compute volume manually, get help from your local Extension Forester to determine what tree height information you will need to utilize a locally applicable volume table.

[4] It may be helpful to have a partner stand at the base of the tree you are measuring. This will help you determine where the base of the tree is. Your partner can also shake the tree to help you identify the top—you would be surprised at how seemingly insignificant thrusts against even a large tree can cause the top to noticeably move.

[5] The extractor is easily bent or lost in heavy brush. We suggest that you tie a piece of bright-colored ribbon on to the extractor that will make it easier to find in the event it is dropped.

FIELD ENHANCEMENT 1
Tree Identification

OBJECTIVES
Upon completion of this lesson, students will be able to:

- Recognize and describe characteristics that differentiate trees.
- Recognize common trees of Wisconsin by examining their characteristics.
- Use a dichotomous key to identify trees.

SUBJECT AREAS
Language Arts, Science

LESSON/ACTIVITY TIME
- Total Lesson Time: 85 minutes
- Time Breakdown:

Introduction.....10 minutes
Activity 1.....20 minutes
Activity 2.....40 minutes
Conclusion.....15 minutes

TEACHING SITE
Schoolyard, school forest, or park with a variety of native Wisconsin trees.

NOTE: If you are unsure about the trees in your area, it is advised that you contact your local forester. Some trees in urban areas may be decorative hybrids or of different varieties than trees commonly found in Wisconsin. Your city or municipal forester can help you identify these trees.

CLASSROOM LESSON CONNECTIONS
This lesson ties closely with Classroom Lesson 1, *Discovering Wisconsin's Forests*.

NUTSHELL
In this lesson, students learn to use a dichotomous key to identify Wisconsin trees. Students also participate in hands-on activities that help them learn tree identification vocabulary. Students work in groups to study and identify trees and discover the process is not difficult when broken into steps.

BACKGROUND INFORMATION
Tree identification is a useful skill for people of any age and background. Imagine you are trying to research your family history. You need to know a family name to begin identifying your family members. In the same manner, you need to know the names of trees in order to learn about them. All trees have different requirements. Knowing a tree's requirements can help determine what tree should be planted in an area, why a particular tree may be unhealthy, or why certain trees are not found in a particular location. These requirements include environmental factors like the amount of sunlight or shade tolerated, temperature requirements, and water and nutrient levels needed for growth. The requirements can also include such things as space or salt tolerance in the soil. Trees may be affected by pests or disease. Certain pests and diseases only affect certain species of trees. Knowing what kind of tree is being affected might help to determine what the pest or disease is. Tree identification is also useful in management. Decisions for planting, harvesting, thinning, conducting prescribed burns, etc., are all based on the tree species present and what the site can support. Finally, tree identification is important for communicating with others. If two people know tree characteristics and can identify species, they share a common language and can each understand what the other is trying to communicate.

(Continued on page 184.)

MATERIALS LIST

FOR EACH STUDENT

- Copy of Student Page **2**, *Tree Identification Terms*
- Copy of Student Pages **5A-C**, *Tree Identification Key*
- Clipboard/notebook to use as a writing surface

FOR EVERY 2 TO 3 STUDENTS

- Copy of Student Page **4**, *Tree ID Data Sheet*

FOR THE CLASS

- Student Page **1**, *Dichotomous Key to Identify Students* (as an overhead or one per student)
- Examples of dichotomous keys (choose your own adventure books, basketball tournament diagram) (optional)
- Set of Student Pages **3A-B**, *Tree ID Vocabulary Cards*
- Paper shopping bag and grab bag items: comb, piece of lined paper, newspaper (in place of money), lollipop, glove, etc. (optional)
- Samples of leaves, branches, etc. that represent the vocabulary terms on the *Tree ID Vocabulary Cards* (optional)
- Student Pages **6A-B**, *Tree Identification Cards*. Laminate for durability (optional)
- Chalk/marker board

FOR THE TEACHER

- Tree and plant identification books (optional)
- String and scissors (optional)

TEACHER PREPARATION

- Determine if you will do the introduction inside or outside. If inside, make an overhead of Student Page **1**, *Dichotomous Key to Identify Students*. If outside, make a copy for each student.
- Familiarize yourself with how to use a dichotomous key.
- Copy and cut out a set of Student Pages **3A-B**, *Tree ID Vocabulary Cards*. As an option you can replace some of the cards with grab bag items. If possible, gather actual leaves and branches that represent the vocabulary terms.
- Choose an area where students can easily move from tree to tree. Be aware of the distance between students and the trail length, as this may affect the lesson time needed. Become familiar with uncommon trees along the trail that students may have questions about.
- Choose an example tree to identify.
- Print and laminate a set of Student Pages **6A-B**, *Tree Identification Cards*. Four sample cards are printed in this lesson for reference. A full set of cards in color is available on the LEAF website at www.uwsp.edu/cnr/leaf. Cards are good reference when leaves, fruit, or seeds are not present or are too high on the tree to be examined. Identify common native Wisconsin trees in your outdoor teaching area. Place cards on some or all of the trees to be identified.
- Prepare a chalk/marker board for the concluding *Jeopardy Game* (see page 187).

SAFETY PRECAUTIONS

Visit the teaching site ahead of time to locate any hazards such as holes, hanging branches, protruding tree roots, poison ivy, etc. Encourage students to walk at all times. Consider these:

- Are you in sight or earshot of students?
- Are boundaries for students marked?
- Have you set expectations for being out of the classroom?
- Do you have a whistle, first aid kit, insect repellent, and sunscreen?
- Is everyone dressed appropriately?

VOCABULARY

BRANCHING

Alternate Branching: A branching pattern where branches, leaves, and leaf scars do not grow directly across from each other.

Opposite Branching: A branching pattern where side branches, leaves, and leaf scars grow directly across the stem from each other.

CONIFERS

Bundles: Groups of needles held together at the base by a small papery wrap called a fascicle.

Coniferous: A tree that bears cones and has needles. Also called evergreen.

Evergreen: A tree that bears cones and has needles. Also called coniferous.

Scaly: Conifer needles that are flat and overlapping, like fish scales.

DECIDUOUS

Broad-leafed: A tree that sheds all its leaves annually. They have leaves as opposed to needles. These trees are also called deciduous.

Compound Leaf: A type of leaf that has one stem and many smaller leaflets. A leaf begins where the petiole attaches to the twig.

Deciduous: A tree that sheds all its leaves annually. These trees are sometimes called broad-leafed.

Leaflets: Smaller parts of compound leaves that often resemble leaves themselves. They join together along the petiole. The petiole attaches to the twig.

Petiole: The stalk that supports a leaf and attaches the leaf to the twig. They can be round, flat, or square.

Simple Leaf: A type of leaf that has one blade attached to a twig by a petiole.

Veins: Distinct lines of tissue that form the framework of a leaf. Used for food and water transport.

LEAF MARGINS

Entire: A type of leaf edge that is smooth and has no wavy or rough edges.

Lobed: A type of leaf edge that has large rounded parts. The spaces between the lobes are called sinuses.

Margin: The outer edge of the leaf.

Sinuses: The spaces in between lobes on a leaf.

Toothed: A type of leaf edge that has small points or bumps along it (teeth). Single-toothed means that all the teeth are about the same size. Double-toothed means that on each tooth there is a smaller tooth.

(Continued from page 182.)

There are estimated to be more than 20,000 kinds of trees in the world. Can you imagine the size of a field guide with all of those trees? It would be enormous! How would we ever identify a tree in our yard with a book like that? How do we go about accurately identifying trees with so many trees in the world? Simple – we have to break it down into steps.

The first step is to identify our geographic location. For this lesson we are only looking at Wisconsin trees. There are upwards of 80 species of trees in Wisconsin. Additionally, there are non-native trees planted for landscaping, hybrid trees, and shrubs that look like trees. For this lesson, we've chosen common trees in Wisconsin. Depending on your location, you may not have some of the trees listed on our

tree list. Select the ones that you do have for your lesson purposes. LEAF has an on-line tree key to help you learn about other common trees in Wisconsin. (www.uwsp.edu/cnr/leaf)

To identify a tree, you can use a field guide and compare the picture to the real thing. A more precise method is to use a dichotomous key. A dichotomous key contains a series of choices that lead the user to the correct name of an item. For trees, the key works by comparing and contrasting important characteristics of that tree. The key is based on a simple two (di) choice method. The key will ask a question like, "Does the tree have opposite branching?" The answer will determine which question you go to next, and eventually lead to the species name. A dichotomous key can be more accurate than visual estimation. Dichotomous keys can also be used to identify other things such as wildlife and plants.

PROCEDURE

INTRODUCTION

NOTE: The Introduction and Activity 1 can be done inside or at your outdoor teaching location.

1. Ask students if they think everyone in the class is exactly the same. Give some examples of features that differentiate people and have them come up with a few. *(Eye color, straight or curly hair, base of earlobes attached or unattached.*) Tell students that we can use these characteristics to separate the class into groups. Let's try one as a class. Take out Student Page **1**, *Dichotomous Key to Identify Students* (use as an overhead if you are inside) and key out a student using the steps below.

    - Choose a student to key out.
    - Start with number one and follow the instructions on the key.
    - When you get to line with a blank space, fill in the student's name.

2. Have a student volunteer key out another person in the class. The goal is to help students understand the process of using a dichotomous key. Continue until all students have had an opportunity to participate or until you feel there is a general level of understanding.

3. Explain to the students that the tool they have been using with the class is called a dichotomous key. A dichotomous key gives you two choices, and your answer will lead you to a correct identification. Remind them that the "di" in dichotomous means two. Examples of items similar to dichotomous keys they may be familiar with are choose your own adventure books and basketball tournament diagrams. Show students how these work if you have examples.

4. Explain that today they will be studying trees in a forest. Ask why it is important to know about trees in a forest. *(To determine what products they can be made into, what wildlife might depend on them, types of recreation that would be favorable, aesthetics, etc.)* Explain that even though they may not live in a forest, they may be part of the large percentage of Americans that live in an urban forest. Whether you visit a forest, live near a forest, or live in a city, trees are an important part of your life. Ask if all trees have the same characteristics. *(No.)* Ask how we can tell them apart. *(Type of leaf, shape of leaf, type of branching.)* Explain that we can use a dichotomous key for trees just like we did for the students in the class. The first step in using a dichotomous tree key is to determine characteristics that differentiate trees, just as we did with students. Explain that trees have special names for characteristics that might not be familiar. The next activity will help them learn some of those words.

ACTIVITY 1

1. Divide your students into groups of two or three. Hand out Student Page **2**, *Tree Identification Terms* to each student and have group members take turns reading the words and definitions aloud.

2. Bring out Student Pages **3A-B**, *Tree ID Vocabulary Cards or* grab bag full of items. One at a time, ask a member from each group to come up and choose a card or pull an item out of the grab bag and show the class.

3. Once a card or item is chosen, the student's teammates need to decide which vocabulary word the item represents. If they don't have the answer, then the item passes to the next group, etc., until the vocabulary word is determined.

4. Once all the cards or items have been identified, quickly review the object and why it represents a certain word relating to tree species. If possible, compare the items with actual collected examples of tree leaves, needles, and branches.

Key to Tree ID Vocabulary Cards

A: Toothed	E: Opposite	I: Sinuses
B: Scaly	F: Bundle	J: Vein
C: Margin	G: Stem	K: Coniferous
D: Alternate	H: Lobed	L: Compound

ACTIVITY 2

1. Set expectations, rules, safety considerations, and boundaries for the tree identification course. Have students work in the same groups that they did for Activity 1. Hand out Student Page **4**, *Tree ID Data Sheet* to each group. Tell students the number of trees on the course and that they will be using a dichotomous key to identify each tree. They should also fill in additional information on each tree they identify. Go over the *Data Sheet*. Show students where to check if the tree is coniferous or deciduous, opposite or alternate. Review the terms if necessary. They should note any signs of wildlife they see, describe the bark, and draw the overall shape of the tree. Explain that it works best to share roles and allow each group member an opportunity to identify trees and make observations.

2. Hand out Student Pages **5A-C**, *Tree Identification Key* to each student. Point out that there are two keys, one for deciduous trees and one for coniferous trees. Make sure students also have Student Page **2**, *Tree Identification Terms* with them.

3. Use the key to identify one tree as an example for the group.

4. Start each group at a different point along the tree ID trail you have marked. Tell the students to meet back at the start tree at the end of the allotted time, or when they hear your whistle.

5. At the end, walk the trail with the entire class. Ask what they had for tree names and observations for each tree. It is also helpful to point out some unique characteristics that may make it easy for students to remember a tree. Consult tree field guides for suggestions.

CONCLUSION

This activity works best in a classroom with a chalk/marker board, unless you have a portable option.

1. Divide the class up into four groups and have each group choose a spokesperson.

2. Play the game just as is done in *Jeopardy*. You will be the host, "Alex Treebark."

   a. Choose a team to go first.
   b. The team chooses a category and point value.
   c. The team must give the correct answer in the form of a question. (Example: If the clue is, "Conifers have these." Students answer, "What are needles?")
   d. If an incorrect answer is given, the next group has the opportunity to answer.
   e. Play passes to the next team after each question, regardless of if a correct answer was given or not.
   f. Keep score for each team on the board.
   g. Play until all questions have been answered or time runs out.

3. The last question is the final *Jeopardy* question for all the groups. The groups can wager any amount of the points that they have earned. Answers should be written on a piece of paper. The final *Jeopardy* question should by chosen by the instructor based on the class. (Example: A tree we identified today with scaly, flattened needles and fan-like branches. "What is a northern white cedar?")

4. Read the question and allow 30 seconds to answer the question. Have each group share their answer. Tally the scores.

DRAW THIS CHART ON THE BOARD.

Kinds of Branching	Leaf Me Alone	Hodgepodge	Key Features
5 Points	5 Points	5 Points	5 Points
10 Points	10 Points	10 Points	10 Points
15 Points	15 Points	15 Points	15 Points
20 Points	20 Points	20 Points	20 Points

JEOPARDY GAME

You read the **ANSWER** and the students must give the **QUESTION**.

KINDS OF BRANCHING	LEAF ME ALONE	HODGEPODGE	KEY FEATURES
ANSWER When leaves grow directly across from one another. **QUESTION** *Opposite*	**ANSWER** Conifers have these. **QUESTION** *Needles*	**ANSWER** Type of key used to identify trees. **QUESTION** *Dichotomous*	**ANSWER** Conifers with needles in bundles of two or five. **QUESTION** *Pine*
ANSWER Sugar maple have this. **QUESTION** *Opposite*	**ANSWER** Entire, toothed, lobed. **QUESTION** *Leaf Margins*	**ANSWER** Group of trees that have cones. **QUESTION** *Conifers*	**ANSWER** A kind of tree that may have pointed or rounded lobes. **QUESTION** *Oak*
ANSWER Alternate **QUESTION** *Leaves or branches that do not grow directly across from one another.*	**ANSWER** Sinus **QUESTION** *The space between lobes.*	**ANSWER** Another name for a deciduous tree. **QUESTION** *Broad-leafed*	**ANSWER** A kind of tree with a papery bark. **QUESTION** *Birch*
ANSWER Oaks have this. **QUESTION** *Alternate*	**ANSWER** Ash, hickory, and locust have these. **QUESTION** *Compound Leaves*	**ANSWER** They can be flat, round, or square. **QUESTION** *Petiole*	**ANSWER** A kind of tree with opposite branching and simple leaves. **QUESTION** *Maple*

SUMMATIVE ASSESSMENT

Have students select 10 items from their desk or locker and develop a dichotomous key for the objects.

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Kupkowski, G., et al. Urban Forestry Laboratory Exercises for Elementary, Middle, and High School Students. USDA Forest Service.

Strathe, S., Hylla, N., Kiser, S., Boyd, E., & Dreier, P. (2000). Wisconsin Forestree – Bridging the Gap Between Environment and Economy. Central Wisconsin Environmental Station.

Tree Identification. [Lesson Plan]. Eagle River, WI: Trees For Tomorrow.

Sebastian, K. (2002, October). Tree Trivia and Tree Myths. Wisconsin Natural Resource Magazine. (World Wide Web: www.wnrmag.com/supps/2002/oct02/trivia.htm)

RECOMMENDED RESOURCES

●●● WEBSITES ●●●

Dragonfly Web Pages
www.units.muohio.edu/dragonfly/index.htmlx
Choose the link for trees and seeds. Read about tree shapes and play a game to design your own tree for three different environments.

LEAF On-line Tree Key
www.uwsp.edu/cnr/leaf
Visit the LEAF site to use our on-line tree ID key. Identify a tree of your choice or use one of our mystery trees to learn basic ID skills.

University of Wisconsin-River Falls Agriculture Education Forestry Manual
www.uwrf.edu/ag-education/forestry/
Read Chapter 4, Forest Ecology, to learn more about how trees grow and access an illustrated dichotomous tree key.

University of Wisconsin-Green Bay Herbarium
www.uwgb.edu/biodiversity/herbarium/
Click on the Trees of Wisconsin link for a long list of tree species with many pictures.

Wisconsin Department of Natural Resources - Division of Forestry
www.dnr.state.wi.us/org/land/forestry/treeid/index.htm
Click on the Tree ID link for beginner and advanced tree and shrub identification keys.

Wisconsin Department of Natural Resources - Division of Forestry
www.dnr.state.wi.us/org/land/forestry/Look/highlights1996.htm
Read the highlights of Wisconsin's 1996 forest inventory to get statistics on specific types of forests and trees in the state.

●●● BOOK ●●●

Trees of North America and Europe by Roger Phillips (New York: Random House, 1978.) This book features great colored photographs of leaves, bark, seeds, flowers, silhouettes, and descriptions of many trees.

●●● BOOKLET ●●●

Forest Trees of Wisconsin: How to Know Them. (Wisconsin Department of Natural Resources PUBL-FR-053, 1990.) This tree ID booklet contains a dichotomous key, illustrations of Wisconsin trees, and tree uses.

1

DICHOTOMOUS KEY TO IDENTIFY STUDENTS

1. Female 2
   Male.....17

2. Brown hair 3
   Not brown hair.....6

3. Brown eyes.....4
   Not brown eyes 9

4. Earlobes attached 5
   Earlobes unattached.....11

5. Freckles .....student is_____
   No freckles.....student is_____

6. Brown eyes.....7
   Not brown eyes 12

7. Earlobes attached 8
   Earlobes unattached 14

8. Freckles .....student is_____
   No freckles.....student is_____

9. Earlobes attached 10
   Earlobes unattached 15

10. Freckles .....student is_____
    No freckles.....student is_____

11. Freckles .....student is_____
    No freckles.....student is_____

12. Earlobes attached 13
    Earlobes unattached 16

13. Freckles .....student is_____
    No freckles.....student is_____

14. Freckles .....student is_____
    No freckles.....student is_____

15. Freckles .....student is_____
    No freckles.....student is_____

16. Freckles .....student is_____
    No freckles.....student is_____

17. Brown hair 18
    Not brown hair.....21

18. Brown eyes.....19
    Not brown eyes 24

19. Earlobes attached 20
    Earlobes unattached 26

20. Freckles .....student is_____
    No freckles.....student is_____

21. Brown eyes.....22
    Not brown eyes 27

22. Earlobes attached 23
    Earlobes unattached 29

23. Freckles .....student is_____
    No freckles.....student is_____

24. Earlobes attached 25
    Earlobes unattached 30

25. Freckles .....student is_____
    No freckles.....student is_____

26. Freckles .....student is_____
    No freckles.....student is_____

27. Earlobes attached 28
    Earlobes unattached 31

28. Freckles .....student is_____
    No freckles.....student is_____

29. Freckles .....student is_____
    No freckles.....student is_____

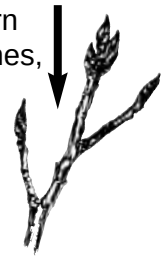
30. Freckles .....student is_____
    No freckles.....student is_____

31. Freckles .....student is_____
    No freckles.....student is_____

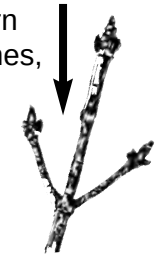
TREE IDENTIFICATION TERMS

BRANCHING

ALTERNATE BRANCHING: A branching pattern where side branches, leaves, and leaf scars do not grow directly across from each other.



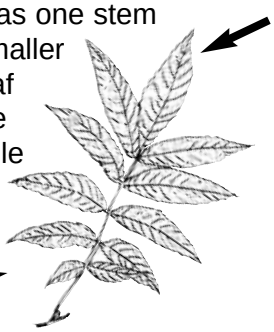
OPPOSITE BRANCHING: A branching pattern where side branches, leaves, and leaf scars grow directly across the stem from each other.



DECIDUOUS

BROAD-LEAFED: A tree that sheds all of its leaves annually. They have leaves as opposed to needles. These trees are also called deciduous.

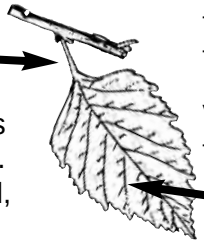
COMPOUND LEAF: A type of leaf that has one stem and many smaller leaflets. A leaf begins where the leaf petiole attaches to the twig.



DECIDUOUS: A tree that sheds all of its leaves annually. These trees are also called broad-leafed.

LEAFLETS: Smaller parts of leaves that often resemble leaves themselves. They join together along the petiole. The leaf petiole attaches to the twig.

PETIOLE: The stalk that supports a leaf and attaches the leaf to the twig. They can be round, flat, or square.



SIMPLE LEAF: A type of leaf that has one blade attached to a twig by a petiole.

VEINS: Distinct lines of tissue that form the framework of a leaf. Used for food and water transport.

CONIFERS

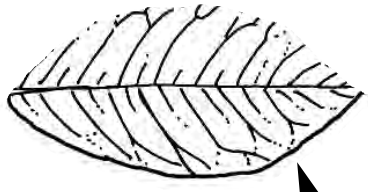
BUNDLES: Groups of needles held together at the base by a small papery wrap called a fascicle.

CONIFEROUS: A tree that bears cones and has needles. Also called evergreens.

EVERGREEN: A tree that bears cones and has needles. Also called coniferous.

SCALY: Conifer needles that are flat and overlapping, like fish scales.

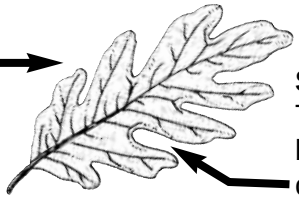
LEAF MARGINS



ENTIRE: A type of leaf edge that is smooth and has no wavy or rough edges.

TOOTHED: A type of leaf edge that has small points or bumps along it (teeth). Single-toothed means that all the teeth are about the same size. Double-toothed means that on each tooth there is a smaller tooth.

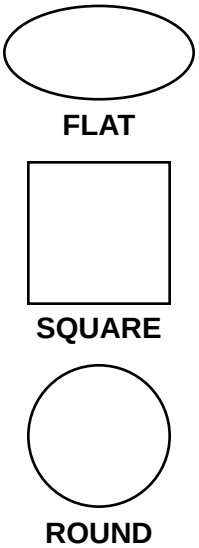
LOBED: A type of leaf edge that has large rounded parts.



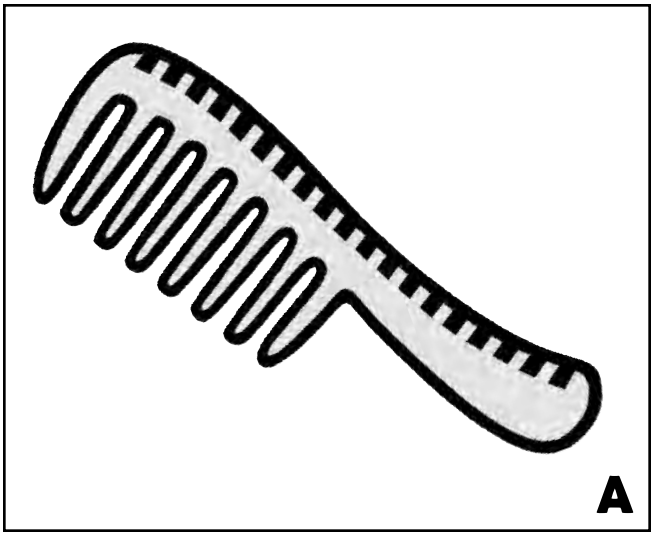
MARGIN: The outer edge of the leaf.

SINUSES: The spaces in between lobes on a leaf.

PETIOLE AND NEEDLE SHAPE CROSS-SECTIONS



TREE ID VOCABULARY CARDS



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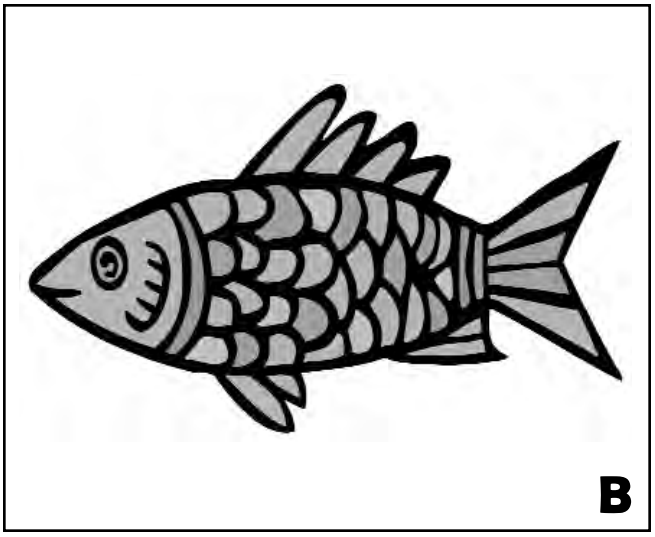

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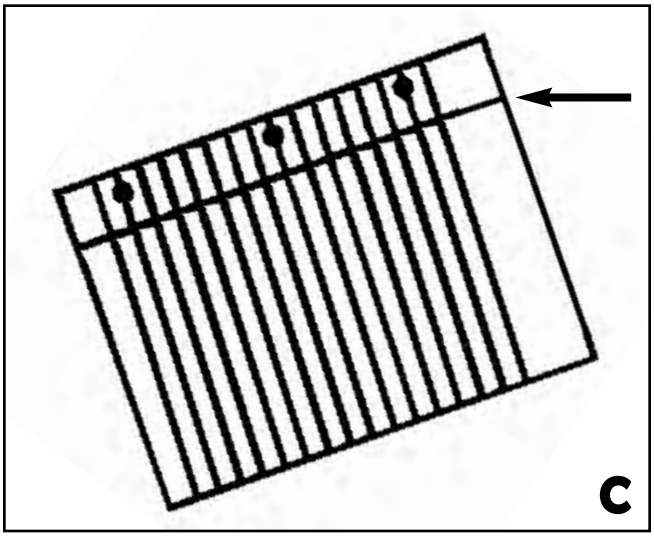

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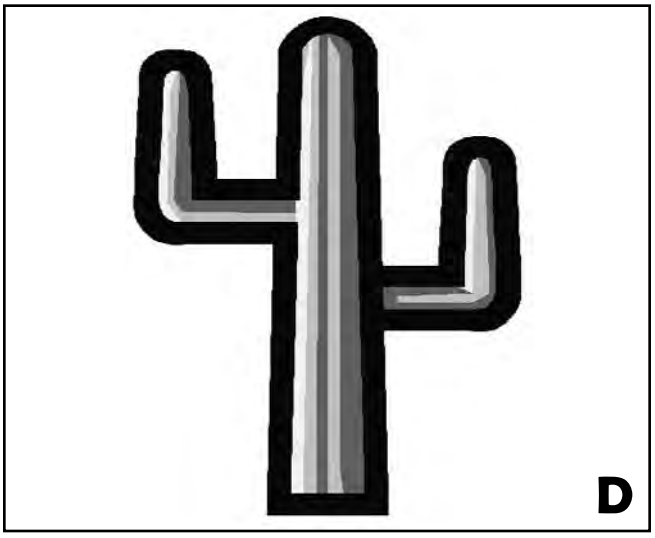

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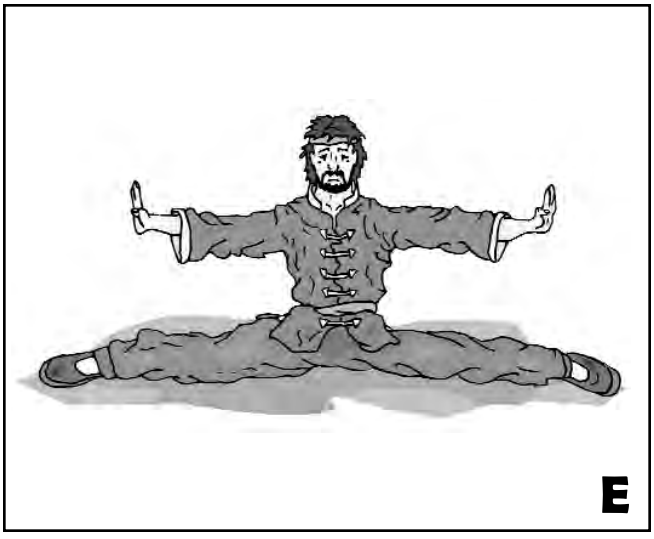

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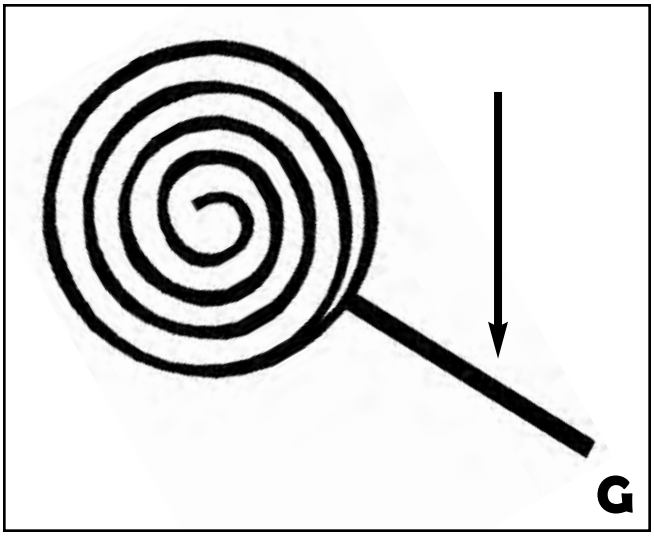
TREE ID VOCABULARY CARDS



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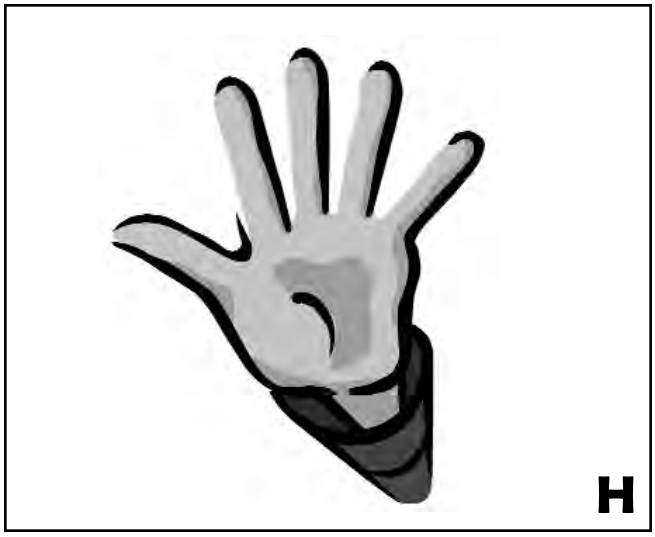

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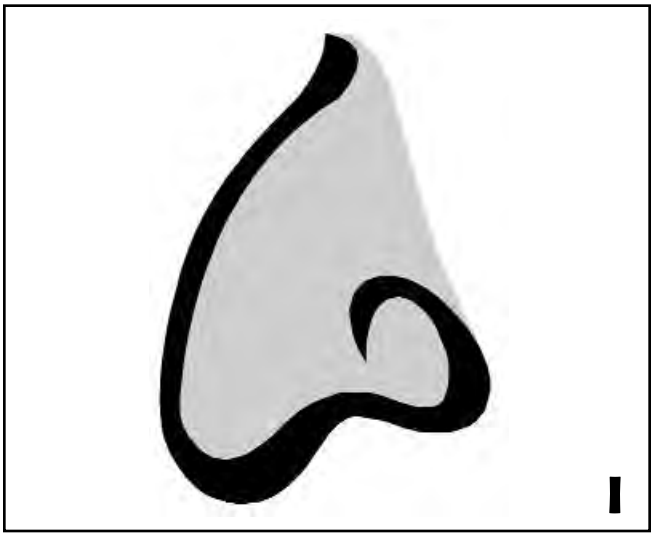

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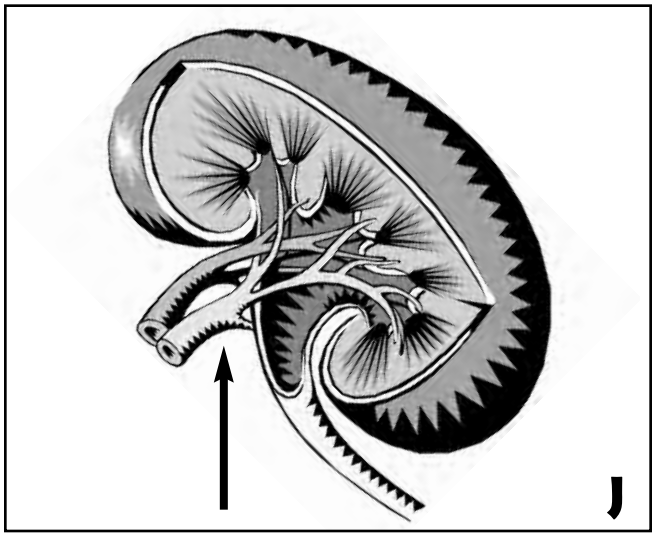

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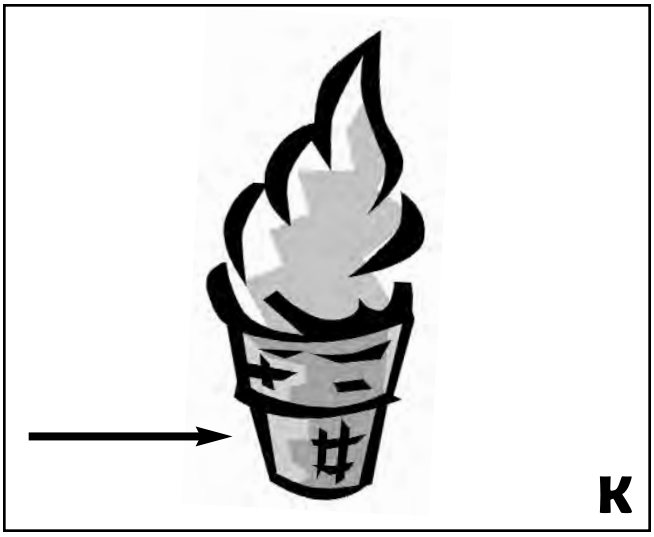

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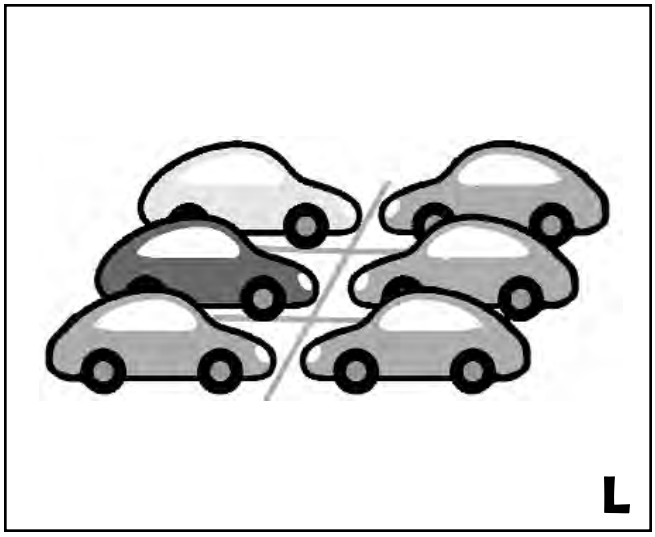


L

TREE ID DATA SHEET

Tree Number	Tree Type		Branching Pattern		Tree Name	Wildlife Observations (nest, droppings, food remains, etc.)	Describe the tree bark (rough, scaly, dark, smooth, light, etc.)	Sketch the overall shape of the tree
	Coniferous	Deciduous	Opposite	Alternate				
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Group Member Names:_____

TREE IDENTIFICATION KEY

BEGIN HERE:

Tree has needles use.....use **CONIFEROUS TREE KEY**

Tree has broad leaves.....use **DECIDUOUS TREE KEY**

CONIFEROUS TREE KEY

1. Needles in bundles or groups (2)
1. Needles single or flattened and scaly (3)
   2. Needles in clusters of more than 5 needles.....**Tamarack* *(Larix laricina)***
   2. Needles 2 to 5 per bundle: Pine species (see a-c below)

      a. Five needles per bundle.....**White Pine *(Pinus strobus)***
      b. Needles in pairs, 3 to 4 inches long.....**Red Pine *(Pinus resinosa)***
      c. Needles in pairs, under 2 inches long, bark dark gray.....**Jack Pine *(Pinus banksiana)***

3. Needles scaly and flattened (4)
3. Needles single (5)
   4. Has cones, scales flat, branches fan-like.....**Northern White Cedar *(Thuja occidentalis)***
   4. Has berries, may have scaly and prickly needles on same tree, scales rounded.....**Eastern Red Cedar *(Juniperus virginiana)***
5. Needles flat (6)
5. Needles square, 4-sided, stiff, sharp: Spruce species (see a-b below)

   a. Needles 1/3 to 3/4 inch long, twigs hairless.....**White Spruce *(Picea glauca)***
   b. Needles 1/3 to 3/4 inch long, twigs have hair, grows in wet areas.....**Black Spruce *(Picea mariana)***

6. Needles 1/2 inch long with short petiole.....**Eastern Hemlock *(Tsuga canadensis)***
6. Needles 3/4 inch to 1 1/4 inches long, no petiole, bubbles in bark.....**Balsam Fir *(Abies balsamea)***

*Note: A tamarack is a deciduous conifer.

5B

TREE IDENTIFICATION KEY
DECIDUOUS TREE KEY

1. Opposite branching (2)
1. Alternate branching (4)
   2. Compound leaves (3)
   2. Simple leaves: Maple species (see a-c below)

      a. Leaf margins smooth, 5 lobes .....**Sugar Maple *(Acer saccharum)***
      b. Leaf margins double-toothed, 3 to 5 lobes.....**Red Maple *(Acer rubrum)***
      c. Leaf margins single-toothed, 3 to 5 lobes, lobes separated by deep, angular openings .....**Silver Maple *(Acer saccharinum)***

3. 3 (rarely 5) leaflets.....**Box Elder *(Acer negundo)***
3. 5 to 11 leaflets: Ash species (see a-c below)

      a. 9 to 11 leaflets, leaflets do not have petiole.....**Black Ash *(Fraxinus nigra)***
      b. 5 to 9 leaflets, leaflets have petiole, smile-shaped leaf scar extending up sides of new bud .....**White Ash *(Fraxinus americana)***
      c. 7 to 9 leaflets, leaflets have petiole, leaf scar ends at base of new bud.....**Green Ash *(Fraxinus pennsylvanica)***

   4. Compound leaves (5)
   4. Simple leaves (8)
5. 7 or fewer (usually 5) leaflets, egg-shaped nut .....**Shagbark Hickory *(Carya ovata)***
5. 7 or more leaflets (6)
   6. Leaflets rounded .....**Black Locust *(Robinia pseudonacacia)***
   6. Leaflets pointed (7)
7. Leaf 6 to 8 inches long .....**Mountain Ash *(Sorbus americana)***
7. Leaf 8 to 24 inches long .....**Black Walnut *(Juglans nigra)***
   8. Leaves not lobed (9)
   8. Leaves lobed: Oak species (see a-f below)

      a. Rounded lobes, 5 to 9 deep even lobes and sinuses, leaves hairless .....**White Oak *(Quercus alba)***
      b. Rounded lobes, pair of deep sinuses near middle of leaf, hairy underside of leaves .....**Bur Oak *(Quercus macrocarpa)***
      c. Rounded lobes, leaf narrow at base and broad near middle, hairy underside of leaves .....**Swamp White Oak *(Quercus bicolor)***
      d. Pointed lobes, sinues extend halfway to mid-vein, leaves hairless, dull green .....**Red Oak *(Quercus rubra)***
      e. Pointed lobes, deep sinues extend 3/4 of the way to mid-vein, leaves hairless, bright green and shiny .....**Northern Pin Oak *(Quercus ellipsoidalis)***
      f. Pointed lobes, deep sinues, young leaves hairy underneath, dark green and shiny, leathery .....**Black Oak *(Quercus velutina)***

TREE IDENTIFICATION KEY
DECIDUOUS TREE KEY

9. Bark not papery (10)
9. Bark papery: Birch species (see a-c below)

> a. Leaves single-toothed, white peeling bark .....**White Birch *(Betula papyrifera)***
> b. Leaves double-toothed, dull green leaves, yellow or bronzed bark .....**Yellow Birch *(Betula alleghaniensis)***
> c. Leaves double-toothed, shiny green leaves, reddish-brown to silvery-gray bark.....**River Birch *(Betula nigra)***

10. Leaf petioles flat (11)
10. Leaf petiole round (12)

11. Leaf triangular-shaped with coarse teeth .....**Eastern Cottonwood *(Populus deltoides)***
11. Leaf oval: Aspen species (see a-b below)

> a. Leaves have small, fine teeth less than 1/16 inch .....**Trembling Aspen *(Populus tremuloides)***
> b. Leaves have large teeth.....**Big-toothed Aspen *(Populus grandidentata)***

12. Leaves nearly as wide as long (13)
12. Leaves longer than wide (14)

13. Leaves finely toothed .....**Balsam Poplar *(Populus balsamifera)***
13. Leaves coarsely toothed.....**Basswood *(Tilia americana)***

14. Leaf less than 3 times as long as wide (15)
14. Leaf at least 3 times as long as wide.....**Willow species (Common species include Weeping Willow and Black Willow)**

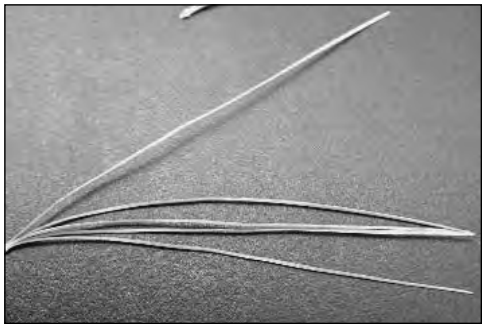
15. Leaf veins thin and branch often (16)
15. Leaf veins thick and run from center to edge of leaf without branching (17)

16. Fine blunt teeth, leaves 2 to 6 inches long, bark dark .....**Black Cherry *(Prunus serotina)***
16. Sharp pointed teeth, leaves 2 to 4 inches long and hairy.....**Hackberry *(Celtis occidentalis)***

17. Leaf shiny and leathery (thick), coarse sharp teeth.....**Beech *(Fagus grandifolia)***
17. Leaf dull and rough (18)

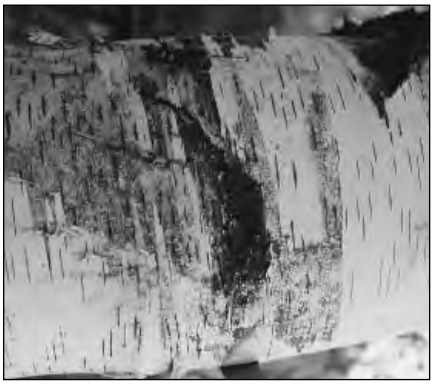
18. Most leaf bases even, seed in elongated clusters.....**Ironwood *(Ostrya virginiana)***
18. Leaf base uneven, seeds flat and papery.....**Elm species (Common species include American Elm, Rock Elm, and Slippery Elm)**

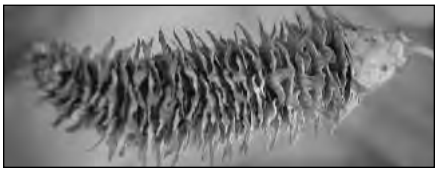
A



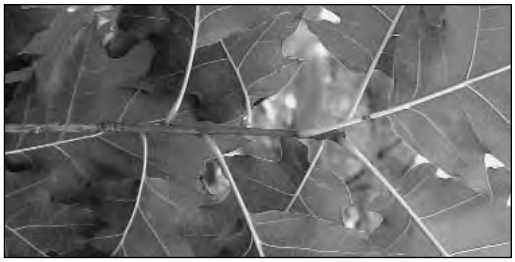
B

C





D



Use of Wedge Prism

The prism is a piece of a wedge-shaped rectangular glass which causes a distortion of light, displacing the image towards the thinner edge. It is used to estimate the basal area of a stand.

Basal Area

1. Hold prism (not your eye) over the selected point at a comfortable distance from the eye, with the long side horizontal. Hold prism with right hand by lower part of the thicker edge.

2. With one eye closed, point with the upper part of the prism so as to divide the tree in question at breast height. Refraction of light through the prism will cause the portion of the tree below breast height to appear separated. Count as 1 all of the trees whose figures are superimposed, as 1/2, or measure for accuracy those which touch only at the edge. If they do not touch each other they are not counted.

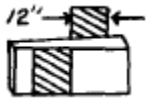
3. Turn in a circle, checking each visible tree, making sure not to count the same tree twice.

4. The number of trees counted, multiplied by basal area conversion factor of prism gives us the basal area per stand acre.

BA/Acre = (Total number of trees counted X BAF of prism)/(Number of samples)

====Basal Area Factor.==== Set up a target exactly one foot wide. Fro an approximate 10 BAF prism, sight about 33 feet from target. Move toward or away from target until right edge of target (as seen in prism) jibes with the left edge of target (just above prism). Measure

exact distance prism to target. Take several readings and use average.



Calculate BAF by formula:
BAF = $(43560)/[(1+4)(D/W)^2]$
D is distance prism to target
W is width of target
or: BAF = $(43560)/[(1+4)(D)^2]$
Where target "W" is exactly 1 foot wide
or: BAF = $10890(W/D)^2$
A close approximation

Plot Radius Factor

The distance from a sampling point to the borderline tree equals DBH times PRF. For a BAF 10.0 prism the PRF is 2.75. A 10-inch tree times 2.75 gives a critical distance of 27.5 feet, a 14-inch tree is 38.5 feet, etc. The number of trees per acre that each tallied 10-inch tree represents 18.35; each 14-inch tree is 9.35, etc. The basic formula: PRF = $\sqrt{(75.625/BAF)}$

Borderline Trees

Always measure borderline trees more than a casual check on basal area. A short cut method counts borderline trees as 1/2.

1. Measure horizontal distance from sample point to center of tree at BH.
2. Get DBH.
3. Multiply DBH by prism PRF. When this product is more than taped distance, the tree is "In".

Example: (PRF is 2.75, DBH 10.0)
2.75 X 10.0 = 27.5 feet, taped distance is 27.2 feet; tree is "In".

Precautions

1. Prism must be in center of plot, not the eye. Walk around the prism; do not stand in one place and move the prism around you.
2. Always hold the face of the prism at right angel to eyesight, horizontally and vertically. (Except for leaning trees and when correcting for slopes).
3. For leaning trees move prism forward then backward on its vertical axis according to the inclination of the tree trunk.
4. Correct for slope by rotating prism to the same amount of slope between the prism and the tree, but at right angles to the eye.
5. If there is an object between you and the tree to be checked, move one step sideways, keeping a constant distance between you and the tree.
6. In dense strands be careful not to confuse or incorrectly associate the trunks. (If a tree is "In" above the brush, it is "In" at BH).
7. Remember that each diameter size has its own plot radius, the radius varies directly with the tree diameter. Therefore, the largest and most valuable trunks are usually sampled more

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intensely than the smaller trunks.
  --The prism helps to train the eye to estimate the basal area of stands, use it.
```

Volume Per Acre

Volume: Volume is related to basal area and merchantable or total tree height. The average basal area per acre in each height class multiplied by the volume factor gives us the volume per acre. The factors can be for any scale- board feet by any rule, cubic feet, or cords. If the available factors cannot be relied upon, they can be developed as necessary.

Volume Factors

Estimate the volume per acre by multiplying the number of trees measured in each length class by the following factors:*

Pulpwood			Sawlogs				
Merchantable height	**Cubic Vol. (w/bark)**	**Cords(w/bark)**	**Merchantable height1/**	**Int.1/4**	**Scribner**	**Doyle**	**Cubic(w/o bark)**
10	7	.08	1	7	6	4	1.2
20	14	.16	2	13	11	8	2.0
30	20	.22	3	18	16	12	2.7
40	26	.29	4	23	20	15	3.4
50	31	.34	5	28	25	21	4.0
60	36	.40					
70	39	.43					
v = 10 (sum of products/number of points			**v = 100 (sum of products/number of points)**				

* For a 10 factor prism
1/ Merchantable height is in 16 foot logs

Local volume factors

Pulpwood factors are fairly consistent. Sawlog factors are not very reliable in different localities. The procedure to prepare local factors is as follows:

```
1. Write down the sample trees according to diameter class and number of logs. (The total trees
tallied divided by the number of points or samples.)
2. Obtain the number of plots per acre from the table at page 54.
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3. Multiply in order to obtain trees per acre.
4. Write down volume for each tree.
5. Multiply to obtain volume per acre.
6. Total volume per acre for each length class.
7. Write down the basal area per acre (trees per plot for each length class multiplied by the basal area factor).
8. Volume factor is the volume per acre divided by basal area per acre.

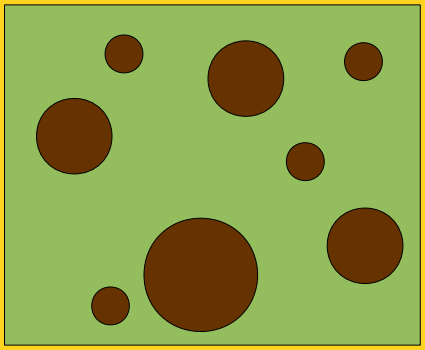
Refer to following example

Basal Area Factor: 10

Dbh Class	Trees per point			Plots per acre	Trees per acre			Volume per tree			Volume per acre		
	1-log	2-log	3-log		1-log	2-log	3-log	1-log	2-log	3-log	1-log	2-log	3-log
10	0.136	0.136		18.349	2.5	2.5		40	60	70	100	150	
12	0.785	0.628	0.157	12.739	10.0	8.0	2.0	50	90	120	500	720	240
14	0.428	0.534	0.107	9.355	4.0	5.0	1.0	80	130	170	320	650	170
16	0.140	0.419	0.140	7.163	1.0	3.0	1.0	100	170	230	100	510	230
Total	**1.489**	**1.717**	**1.404**		**Boardfeet per acre**						**1020**	**2030**	**640**
					Basal Area per Acre						**14.89**	**17.17**	**4.04**
					Volume Factor						**68.5**	**118.2**	**158.4**

Measuring Basal Area with a Wedge Prism

Basal Area (BA), measured in m^2/ha, is the area of a given piece of land that is occupied with the cross section of tree trunks. It is a measure of how much wood is in a forest.



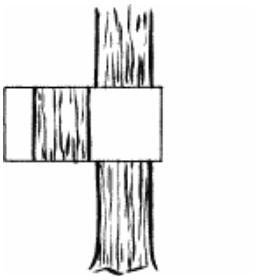
Cross-section of tree trunks from above

1) Mark a spot on the ground and keep the prism over that spot – move yourself around the prism.

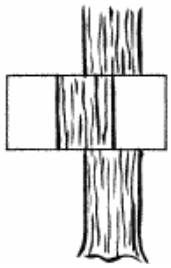
2) Hold the prism at arms length.

3) Move in a complete circle around the prism, looking at every tree through the prism. Count all the trees that are "in" and every second tree that is "borderline."

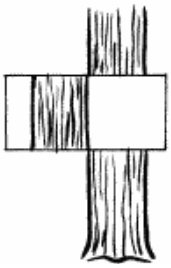
4) Multiply the count by the factor of your prism.



Out – do not count



In - count



Borderline – count every 2nd tree