

# Winter Tree Math

## In a Nutshell



Students will use a variety of methods to measure the size of trees. The activities will help them to understand why scientists have established standardized measuring techniques for data collection. Through a hands-on activity, students will use forestry equipment and techniques used to collect tree data.

**Grade** 2 - 3  
**Season** Winter  
**Location** Visitor Center

### Literature Connections

Measuring Penny by Loreen Leedy (AD500)

How Long or How Wide? A Measuring Guide by Brian P. Cleary (730L)

Grand Trees of America: Our State Champion Trees by Lisa Jorgenson

The Big Tree by Bruce Hiscock

### Pre-Activities

In Project Learning Tree activity, *How Big Is Your Tree* students use a variety of simple techniques to estimate height, length, and circumference of a variety of items found in the classroom or of trees on the school ground.

### On-site Activities

Students will record the height, circumference and crown spread measurements from a variety of large refuge trees using established scientific methods and tools. They will learn different methods

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that scientists use to “age” trees and determine the importance and value of trees to wildlife and people. **There must be at least 6 inches of snow for students to use snowshoes for this activity.**

### Classroom Connections

#### Calculate Champion Tree Points

Back in the classroom have students use the refuge tree measurements they collected during the fieldtrip to calculate **Champion Tree Points** for each tree species. To determine Champion Tree points use this equation:

**Tree’s Circumference (inches) + the trees’ height (feet) +  $\frac{1}{4}$  the trees’ average crown spread = pts.**

Compare the points to the values below. Do any refuge trees come close to the size of a state record holder? To find the location of Minnesota’s Champion Trees go to <http://www.dnr.state.mn.us> and search “big tree registry”.

Tree Species	Points	Tree Species	Points
American Elm	319	Eastern Cottonwood	528
Basswood	307	Green Ash	288
Bur Oak	335	Northern Red Oak	261
Box Elder	258	Sugar Maple	244

#### Start a Tree Growth Data Base

Using the same schoolyard trees from the pre-activity, measure the trees using the new techniques and standards students learned during their visit to the refuge. Compare how close the students’ original estimates were to the actual measurements. Create a data log where students can record and compare measurements over time. How much do the trees in the schoolyard grow from year to year? Do the trees grow more some years than other years? What could account for the differences in growth rates?

### Teacher Resources

Minnesota Trees by Minnesota Department of Natural Resources

All About Minnesota’s Forests and Trees: A Primer by Minnesota Department of Natural Resources

Winter Tree Finder by Mary Theilgaard and Tom Watts

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## Tree Math Pre-Visit Activities

### Materials

#### Option 1: Measuring Trees on the School Grounds

If you choose to measure trees on the school grounds, select and flag (using bright colored flagging tape) the trees for students to measure prior to this activity. If possible choose trees in close proximity to the school building that vary in size and height. Before engaging in the activity, divide students into teams with one adult leader for each team.

#### 1 Backpack per team filled with the following equipment

- Clipboards (1 per team)
- Pencils (2 per team)
- Tree Math data sheet (1 per team)
- 12" Ruler (2 per team for grades 3)
- String for measuring circumference (four - 3 foot pieces per team)
- 4- three foot pieces of string for measuring circumference: (2 per team)

#### Option 2: Measuring in the Classroom or School

- Pencils (1 per team)
- Classroom Math data sheet (1 per team)
- Ruler (1 per team)

### Introduction

Follow the Project Learning Tree Activity # 67: *How Big Is Your Tree?* (page 284) with the following adjustments:

Ask students to think about when they visit a doctor for a checkup. What body measurements do doctors (or nurses) collect (head, weight, height)? Biologists use similar measurements for plants and animals. Ask students to imagine being a biologist working on a National Wildlife Refuge. When working with plants, what part of a plant do you think a biologist might want to measure and why? List the responses on the board. If the students don't include tree measurements add the category to the list.

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Ask students why they think a refuge biologist would ever need to measure a tree?

- Biologists measure size of trees for health. Healthy sized trees provide for a healthy wildlife habitat. Bigger trees can produce a larger food crop for wildlife to eat and more cover for wildlife protection.
- Biologist measure size of trees to determine how long they have been living. Older and more mature trees are a sign that the land has not been disturbed. This is the best habitat for wildlife. Bigger trees are usually found in areas that have been undisturbed by development (for farms, homes and shopping malls). Undisturbed areas are more likely to be places where biologists may find endangered species of plants, animals, insects, or amphibians.
- Biologists measure the quantity of trees to determine if an area would be ideal to protect for a wildlife habitat.

### Understanding Professions

**Wildlife Biologists** manage the health of the land (habitat) for the benefit of wildlife. Trees that make up a refuge habitat are not harvested for homes, paper, or firewood. Wildlife Biologists often work at wildlife refuges.

**Foresters** have special knowledge in how to manage large forest areas. They often monitor the health of a forest and make determinations whether a forest is healthy enough to survive a harvest. Some foresters specialize in estimating how much lumber (used to build homes, for paper, toilet paper and many other things) a selected harvest area will produce. Foresters may work for the US Forest Service or lumber companies.

**Arborists** specialize in the health of individual plants, trees and shrubs. An arborist is called upon when a disease breaks out in a specific tree or when a city government or city residents need suggestions on the best species of trees to plant in the area. Many cities/communities hire arborists.

Explain to students that people in the past often used their hands or their feet to measure things. Why do you think these tools were used? People in the past didn't have the scientific measuring tools we use today (like rulers) so they had to use tools available to them to estimate measurements.

### Option 1: Measuring Trees in the School Yard

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Prior to going outside demonstrate how to do the measuring using volunteers. Ask for a student volunteer to stand in front of the class like a tree. Ask another volunteer to estimate the height and circumference of the tree by using the hand span method (counting the number of hands it takes to go around the tree). Reference the datasheet where students will record the measurement. Next, ask another volunteer to use the 3-ft. measuring string to find a more accurate tree circumference, record on datasheet. Select 2 student volunteers to use the ruler for a more accurate tree height and record their data on the datasheet.

Lead students to selected trees. Pass out the backpack filled with the field equipment to each group. Send students with their adult leaders outside to measure trees.

Compile the results of all the teams on the board using the data sheet set up. Compare team measurements for at least two of the trees. Did the teams all come up with the same measurements? What could account for these differences? (hands, arm spans, or feet are not the same length; not everyone took the circumference measurements at the exact same height on the tree trunk (students will be introduced to **DBH during fieldtrip activity**); techniques vary, some teams might have been more careful to be accurate, etc.)

### Option 2: Measuring in the Classroom

Ask students to pick a partner. Pass out a Measuring in the Classroom data sheet to each team. Plan 10 minutes for teams to measure and record the results for as many items on the list as possible. Instruct them to use their hands or feet to measure first, then the rulers.

Compare the results on the board. Ask students to talk about the accuracy of each measurement. If students do not make the connection between hand or foot size and the number of hand or foot spans needed have those that came up with very different measurements compare the size of their feet or hands. Were the measurements recorded using rulers more often the same? How does using rulers improve accuracy?

## Wrap-Up

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Review the terms estimate (an educated guess) and measurement (accurate, precise, correct answer) with the class. Discuss with students whether or not estimating is a good tool to for accuracy. Is **estimating** a good method to use? It depends on the accuracy needed as there can be a lot of variation with estimates. Ask each student to estimate the height of his/her foot. Ask for their answers. Discuss why one person's estimate may be different from another's persons estimate? Pass out a ruler to each student. Ask each student to measure his/her foot again. Are the measurements the same? An estimate is a guess compared to a ruler which is use for an accurate measure. This is why scientists use standard measurement tools. Without standards for measurement there can be differences in a measuring tool, depending on where one person chooses to take a measurement. Ask students how they can be more confident that their measurements are consistent and accurate (starting at the exact same spot each time, same person measures/reads the measurement).

If biologists were going to compare tree measurements from one site to another, would it be important to have a "plan" or a standard technique to ensure measurements were accurate? Explain that when they visit the refuge they will learn the methods biologists use to measure trees and compare some of the trees on the refuge with State Champion Trees – the largest trees in the state. It's a possibility that students may find a champion tree on the refuge!

Remind students to wear appropriate clothing like warm jackets, scarves, mittens, hats, snow pants.....and most important snow boots. If condition allow, students will use snowshoes for the outdoor activities.

# Winter Tree Math

## School Tree Measurements

Record your estimates in the table.  
Select a new table for each tree you measure.

<b>Tree #</b>	<b>Measurement</b>
<b>Height</b> Ruler estimate	
<b>Circumference</b> Estimate using hand span	
<b>Circumference</b> Using 3-foot string	

<b>Tree #</b>	<b>Measurement</b>
<b>Height</b> Ruler estimate	
<b>Circumference</b> Estimate using hand span	
<b>Circumference</b> Using 3-foot string	

<b>Tree #</b>	<b>Measurement</b>
<b>Height</b> Ruler estimate	
<b>Circumference</b> Estimate using hand span	
<b>Circumference</b> Using 3-foot string	

# Winter Tree Math Classroom Measurements

Record your estimates in the table.  
Select a new table for each thing you measure.

Your Desk	Measurement
<b>height</b> Foot Span	
<b>height</b> Hand Span	
<b>height</b> Ruler	

Your Chair	Measurement
<b>height</b> Foot Span	
<b>height</b> Hand Span	
<b>height</b> Ruler	

A Wall	Measurement
<b>length</b> Foot Span	
<b>length</b> Hand Span	
<b>length</b> Ruler	

Your Locker	Measurement
<b>height</b> Foot Span	
<b>height</b> Hand Span	
<b>height</b> Ruler	

	Measurement
<b>length</b> Foot Span	
<b>length</b> Hand Span	
<b>length</b> Ruler	

	Measurement
<b>height</b> Foot Span	
<b>height</b> Hand Span	
<b>height</b> Ruler	

## Tree Math On-site Activities

### Materials

1 Backpack per team filled with the following equipment

- Clipboards (1 per team)
- Pencils (1 per team)
- Calculator (1 per team)
- Tree Math data sheet (1 per team)
- Student Worksheet (1 per team)
- Erasable markers
- 6' tape measures (1 per team)
- 100' measuring tape reels (1 per team)
- Tangent Height Gauges (12 divided between group leaders)
- Rapids Lake Tree Guide

### Introduction

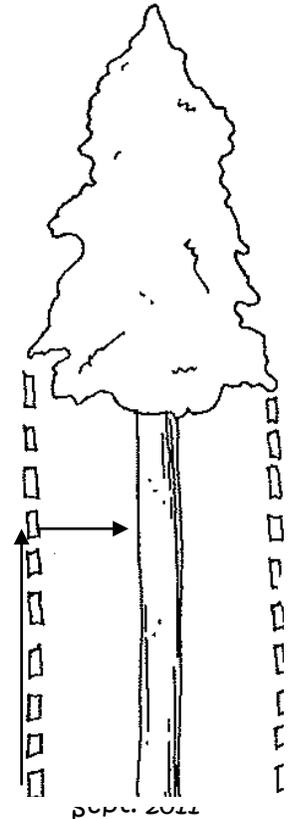
Inside Visitor Center, (45 minutes)

Prior to the students' arrival to the Refuge, designate which refuge trees the class will measure outside.

Review with the students the challenges measuring accurately without proper tools and directions. Explain to students that they will be using real scientific measuring tools (tangent height gauges and tape measures) and techniques (circumference at breast height) to get take accurate measurements of refuge trees. Using a student volunteer to simulate a tree, demonstrate the how to take each of the following measurements.

### To measure the Circumference at Breast Height, use the small 6' tape measure.

1. Ask for a tall student or adult volunteer to be your tree trunk. Measure from the base of the trunk (ground level) up  $4\frac{1}{2}$

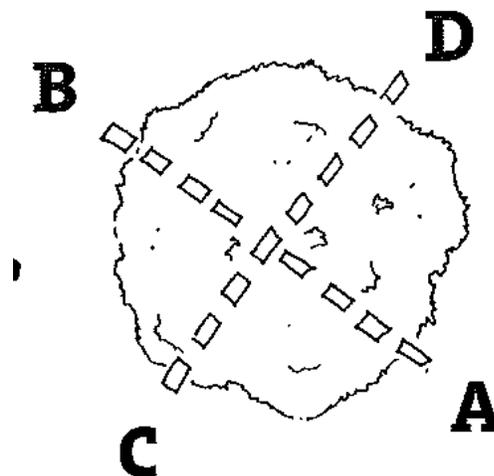


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- feet high (breast height for an average adult). Reason for measuring up 4 ½ feet is because not all trees are shaped the same. This number provides a standard of measuring. Have the volunteer keep their finger on the 4 ½ foot mark.
2. At breast height (the volunteer's finger) use the tape reel to circle around the simulated tree to measure circumference. Record this number on the data sheet.

To measure the Crown Spread, use the large 100 foot tape reel. Students will look at the branching of the tree and then take the average of two measurements where the tree looks the widest. As illustrated below,

1. Ask another volunteer to be a tree. Ask them to spread their arms out to simulate branches. Then ask for 2 more students volunteers. Request 1 student to stand under the farthest branch from the trunk on one side (A) and the request the other student to stand under the farthest branch from the trunk on the opposite side (B).
2. Ask the third student to hold the tape measure, pull the tape across to the second person and ask him/her to figure out the distance between the two students (points). Record the number on the data sheet.
3. Request the student "tree" to change directions and the other 2 students to move to the new farthest point locations and repeat the procedure above using the new points (C and D) under the opposite side of the crown. Record the number on the data sheet.
4. Add the two measurements together and divide by 2 for an average. Record this number on your data sheet as **Crown Spread**.



**To measure Tree Height use the Tangent Height Gauge.**

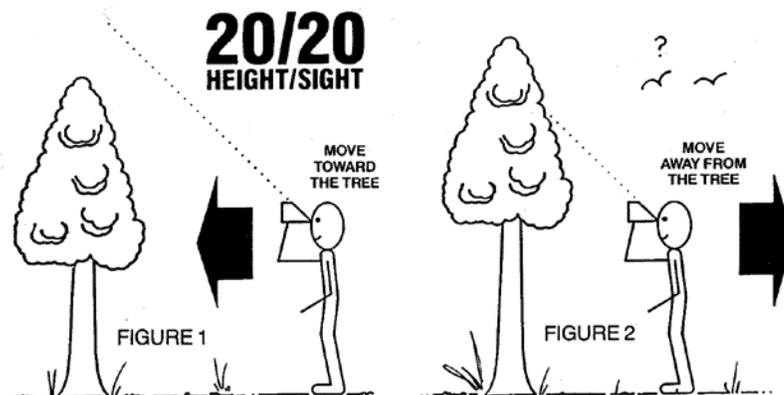
Start with a guided discovery of the Height Gauge. Ask students to select a partner. Provide each pair with a Tangent Height Gauge. Give the students 10 minutes to work in teams to discover the answers to the following questions written on the white board.

1. How do you hold it?
2. Where is the level and how do you use it?
3. Where is the mirror and how do you use it?
4. What is a sight ring?
5. How do the sight rings help you measure the height of a tree?

Ask the students to look at the picture on the side of the height gauge. What other tools will they need to use together with the gauge to measure the height of the tree (a tape measure and possibly a calculator to do the math).

After collecting student responses to the guided discovery questions, demonstrate for the class and parent chaperones, how to properly use the gauge to measure tree height.

1. Stand straight and measure the height of your eyes from the ground. Write down this number on your data sheet; it is needed for the final tree height calculation.



2. While holding the gauge using the handle, line up the top of the tree through both sight rings (holes) on the top. Keep the bubble inside the level centered. Ask another student to tell you when it's level or look in the mirror. If the top of the tree is below your view, move closer to the tree. If the top of tree is above your view, move away from the tree.

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3. Once the top of the tree is centered in the sight rings and the bubble is centered in the level tube, measure the distance between you and the base of the tree trunk. Write this number on your data sheet.
4. Add your distance from the tree to the height of your eye. The answer is the height of the tree you measured. Record the **Tree Height** on the data sheet.

### Hike

**On refuge, (45 minutes)**

Divide students into groups equal to the number of adult leaders. Lead students outside for the measuring activity. Each group **MUST** have an adult with them. Pass out the backpacks with all their equipment (Clipboard, data sheet, pencil, tree height gauge, measuring tape and calculator) to the leaders.

Explain how to use the Refuge Tree Guide. After completing all the measurements for a tagged tree, look up the corresponding number in the Refuge Tree Guide to compare your measurements with those of the Minnesota Champion. The guide also includes pictures of the leaves, bark and fruit as well as some interesting facts about the tree the group measured that chaperones can share with their students.

Head outside to the area of marked trees. Have each group finish all measurements for a tree before moving onto another. When each group has measured at least one tree, lead students back to the classroom. If there is enough time, allow students to measure multiple trees.

### Data Analysis

**Inside Visitor Center (25 minutes.)**

Ask each group to inform you of their tree measurements. Record the data on the board. Compare the trees to determine which tree measured the tallest, the widest circumference and the broadest crown spread. Did any team have difficulty measuring that might have affected their accuracy?

### Wrap-Up Management Connection

## Forest Management

Why would it be important for a wildlife biologist to know how to use these specific measurements of trees when managing wildlife in the refuge? These skills are important for biologists who manage the wildlife that depend on forest habitats for several reasons.

- Bald eagles prefer large cottonwood trees along the Minnesota River. Biologist can measure tree diameter and height to determine if the present trees are meeting nesting requirements for bald eagles.
- Biologist may measure a variety of trees in a forest to estimate food resources. Biologists know that larger trees will produce more food necessary for many types of wildlife.
- Dead trees are an important food source for Woodpeckers. They eat the insects living under the bark of the dead and dying trees. Biologist count and compare the number of dead and dying trees to live healthy trees to identify good woodpecker habitat.
- Measuring trees is also important to determine if there is adequate shelter for larger animals that depend on forests (deer, foxes, owls, turkey, and bear for example).

# Winter Tree Math Student Worksheet

**Circumference: How big around is your tree?** (Use tape reel)  
Measure 4  $\frac{1}{2}$  feet from the base of your tree. At that spot, wrap the tape measure completely around the tree and record the measurement.

Tree Circumference \_\_\_\_\_nearest inch

**Height: How tall is your tree?** (Use Tangent Height Gauge)  
Hold the gauge at eye level. Close your RIGHT eye. Look through both rings on the top of the gauge and find the top of the tree. Center the tree top in the middle of both rings. Now look in the mirror. Is the bubble in between the black lines? If it is, then your gauge is level. If it is not, then walk backwards or forwards until the bubble is between the black lines. Once it is between the black lines, have a group member measure from your height from your feet to your eyes. Then measure the distance from where you are standing to the base of your tree.

Height of student from feet to eyes: \_\_\_\_\_nearest foot

Distance from feet to tree base: \_\_\_\_\_nearest foot

Add the two together. Your tree is: \_\_\_\_\_feet tall

**Crown Spread: How wide is the top of your tree?** (Use Tape Reel)  
Students stand on opposite sides under the widest parts of the crown and take the following measurements.

Distance from (A) to (B): \_\_\_\_\_ to nearest foot

Distance from (C) to (D): \_\_\_\_\_ to nearest foot

Total: \_\_\_\_\_feet  
 $\frac{1}{2}$  of total: \_\_\_\_\_crown spread

