**Project Area:** Environmental Science
**Tags: Forestry**

**Skill Level:** Intermediate—Advanced

**Learner Outcomes:**
-Define biomass, crown, dendrologist, DBH, stand density
-Practice calculations with π (pi)
-Understand how to use a DBH tape
-Calculate stand density

**TN Science Curriculum Standard GLEs:**

TNCore Math:
6.RP. Understand ratio concepts
6.G. Solve problems involving area and volume
6.SP. Describe distributions
7.RP. Analyze proportional relationships
7.SP. Comparing two populations

**Science Skills:** Develop hypothesis, observe, collect data, interpret

**Math Skills:** Solve real-world problems using numerical and algebraic equations; apply multiple operations on rational numbers (add, subtract, multiply, divide)

**Life Skills:** Observing, Reasoning

**Time Needed:**
Set up: 5 minutes
In class: 30 minutes

**Materials:**
–Calculator
–Ruler
–Measuring tape
–Pencil
–Permanent marker
–Plastic flagging tape

# Environmental Science — Measuring the Forest

**W 331-D**

**In this activity, students will learn about how forests are measured.**

## Set Up

In this activity, students will learn why forests are important to monitor and how forest scientists (e.g., dendrologists) measure forests. Activity 1 introduces some information about U.S. forests; Activity 2 teaches students to measure a single tree using Diameter at Breast Height (DBH); and Activity 3 teaches students to calculate stand density. All activities can be done indoors, though going outside to measure real trees is a fun way to get kids outside! (See Extensions.) Activity 2 is best done with "tree cookies": slices of tree trunks of different diameters. These can be made easily, borrowed (try a university or local forest service), or purchased. But if you don't have tree cookies, you can use the students themselves (they can measure their own or a partner's diameter at ankle, waist or chest height).

## Introducing the Activity

**Ask:** Why are forests important?

*Possible answers:* Timber, pulp, wildlife habitat, air quality, $CO_2$ consumption

Discuss the possible answers and explain how a forest works to provide these important services.

## Activity 1: Where are the forests?

1. What percentage of the United States' land area is covered in forest? Provide your students with the following numbers:
   - In 2010, there were 304,022,000 hectares (751,254,723 acres) of forest.
   - The United States is 982,667,500 hectares (2,438,108,490 acres).

**Ask them to calculate the percent of forested land. Answer:**

$$\frac{Part}{Whole} \times 100\% = \frac{304{,}022{,}000}{982{,}667{,}500} \times 100\% = 30.9\%$$

2. On the map, have your students shade the areas you think are forests. Once students have finished, provide them with the map on the following page showing where the forests are located. Explain that darker colors indicate higher **biomass.** Explain that **biomass = biological material from living or recently living organisms** (mass per unit area).

## Activity 2: Measuring Trees

Have your students look at some different trees (show the picture in the handout or take them outside to some trees). Point out that they come in all shapes and sizes.

**Ask:** How can we measure how they are different?

Let students brainstorm and share their ideas with the group. As they bring up ideas, ask them if these measurements would be easy or difficult to make.

1. Explain that trees can be seen as a **crown** (the ellipsoid where the leaves are) and a **trunk** (a cylinder). Ask them to draw a circle around the crown and a rectangle for the trunk in their handout.

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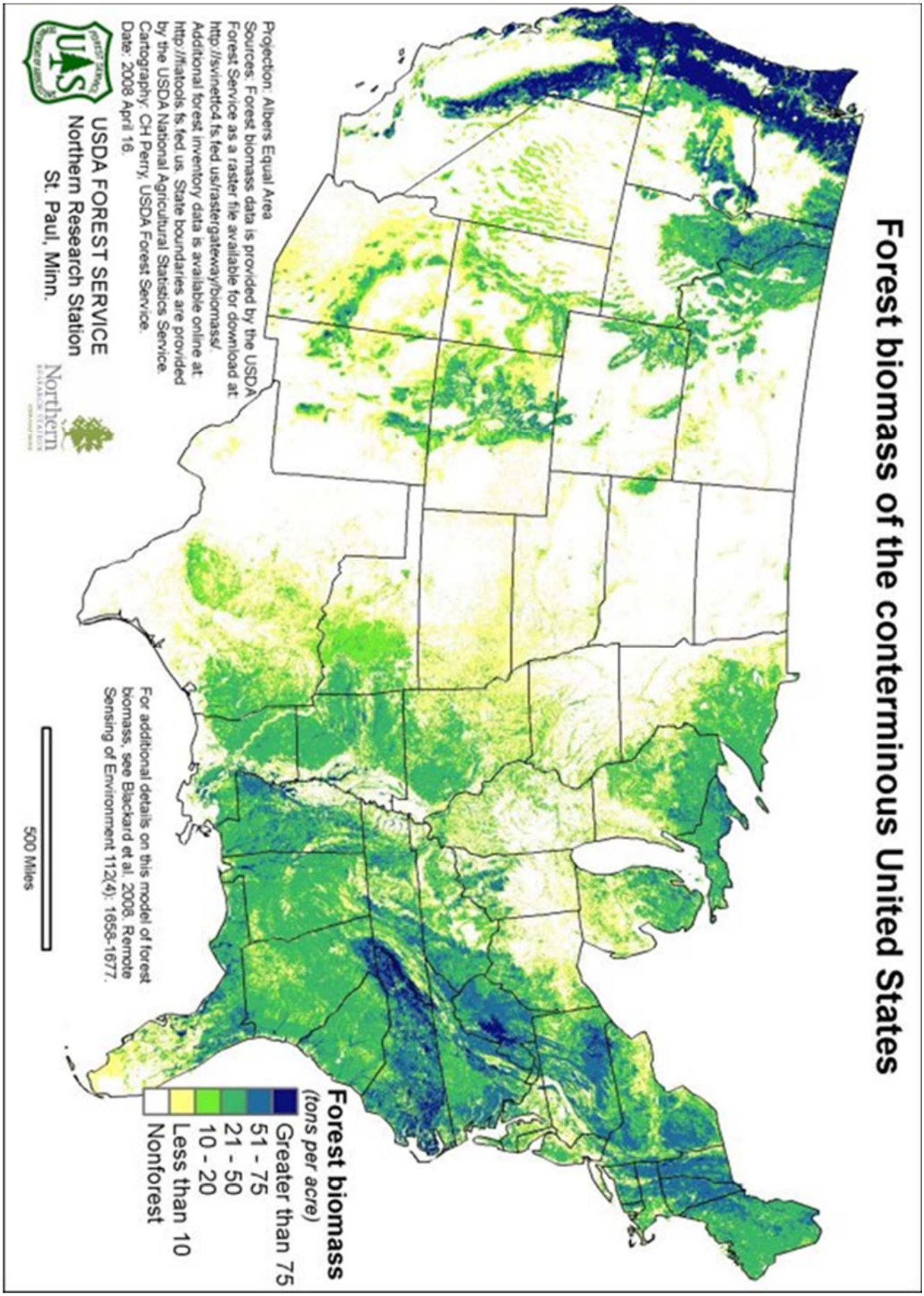
Forest biomass of the conterminous United States
Forest biomass
(tons per acre)
Greater than 75
51 - 75
21 - 50
10 - 20
Less than 10
Nonforest
500 Miles
For additional details on this model of forest biomass, see Blackard et al. 2008. Remote Sensing of Environment 112(4): 1658-1677.
Projection: Albers Equal Area
Sources: Forest biomass data is provided by the USDA Forest Service as a raster file available for download at http://svinetfc4.fs.fed.us/rastergateway/biomass/
Additional forest inventory data is available online at http://fiatools.fs.fed.us. State boundaries are provided by the USDA National Agricultural Statistics Service.
Cartography: CH Perry, USDA Forest Service.
Date: 2008 April 16.
USDA FOREST SERVICE
Northern Research Station
St. Paul, Minn.
Northern

**Activity 2 (continued)**

2. Explain that dendrologists (tree scientists) can measure crown height and width, total height, or height of trunk to crown to compare trees. But the most common measurement is **DBH = Diameter at Breast Height.** Explain that this is the diameter of the tree 4.5 feet above the forest floor on the uphill side. This avoids the swell at the base.

3. Explain circumference and diameter. Have the students do the practice problems:

   **Answers:**

   1. D = 2, C = ? **π * 2 ≈ 6.28**
   2. D = 6, C = ? **π * 6 ≈ 18.84**
   3. D = 1, C = ? **π * 1 ≈ 3.14**
   4. C = 3.14, D = ? **3.14 / π = 1**
   5. Radius (R) = 3, D = ? **D = 2R, so … 2 * 3 = 6**
   6. For every 1 inch increase in diameter, the circumference increases **3.14** inches.

4. Have your students make and test their own DBH tape.

   1. Give each student a 3-foot length of flagging tape, a ruler and a Sharpie.
   2. Using a ruler, mark off every π (3.14 inches). 0.14 of an inch is between 1/8" and 3/16".
   3. Have your students test it out on tree cookies and their heads.
   4. Optional: Take your students outside and have them measure some real trees!

## Activity 3: Measuring Forests

Have your students look at different forests (pictures or take them outside). Ask students to notice or think about how some forests are more "dense" with many trees close together, such as an overgrown thicket, or less dense with fewer trees further apart, like an open woodland. How would one describe these differences with numbers?

1. Explain that forest scientists calculate stand density = number of trees per area.
2. Calculate the stand density of the plot. Show them an example calculation for **Plot A:**

   Count the number of trees (10)
   Find the area (L*W) of the stand (15 ft * 25 ft = 375 $ft^2$)
   Divide the numerator by the denominator (10/375 = **0.03 trees/$ft^2$**)

   **Answer: Plot B:** Number of trees = 16 trees; Area of Stand: 5 ft * 8 ft = 40 $ft^2$
   Stand Density = 16 trees/40 $ft^2$ = **0.4 trees/$ft^2$**

## Extension and Variations:

- Take this activity outside! Have students practice with their DBH tapes and stand calculations in a real forest.
- Determine how much carbon dioxide a particular tree is taking up by using the USDA Forest Service Tree Carbon Calculator at fs.fed.us/ccrc/tools/ctcc.shtml. This is a small downloadable (free) program. Input your climate zone, tree species and tree size (DBH), and the program will calculate $CO_2$ stored in the tree, above ground biomass, and other things.

### Resources


- NIMBioS Education Module "Measuing a Forest" (nimbios.org/education)
- Golden, Barry, Sturner, Kelly, and Suzanne Lenhart "Modelling the Forest." *Science Scope.* September 2013: 70-79
- Project Learning Tree (plt.org)



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W 331-D

# Environmental Science — Measuring the Forest

**Words to Explore**

Biomass
Crown
Dendrologist
DBH
Stand Density

**Did You Know?**
Over a year, an acre of forest consumes the amount of $CO_2$ produced by two cars annually.

**Did You Know?**
Two trees provide enough oxygen for one person per year.

**Check It Out!**
USDA Forest Service CUFR Tree Carbon Calculator

## Can you measure forests?

Forest are an important part of our planet. They provide us with timber and pulp, recreation, habitat for wildlife, and improve the air quality. In this activity you'll learn how forest scientists, such as **dendrologists**, measure and monitor forests.

## Activity 1: Where are the forests?

1. What percentage of the United States' land area is covered in forest?

$$\frac{Part}{Whole} \times 100\% =$$

2. On the map, shade in the areas you think are forested.

3. What is biomass? _____

4. Where are the areas of greatest forest biomass in the USA?

_____

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## Activity 2: Measuring Trees

1. For these three trees, circle the crown and draw a rectangle for the trunk.


Oak


Birch


Elm

2. What is DBH? _____

3. Practice using C = πD (where C = circumference, D = diameter, and π ~ 3.14):

   1. D = 2, C = ?

   2. D = 6, C = ?

   3. D = 1, C = ?

   4. C = 3.14, D = ?

   5. Radius (R) = 3, D = ?

   6. For every 1 inch increase in diameter, the circumference increases _____ inches.

4. Your leader will show you how to make your own DBH tape. Test it out!

   What is the diameter of the tree cookie using a ruler?_____

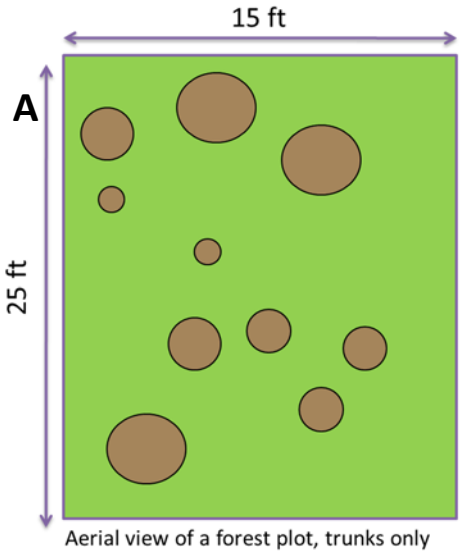
   What is the diameter of the tree cookie using DBH tape? _____

   What is the diameter of your head? _____

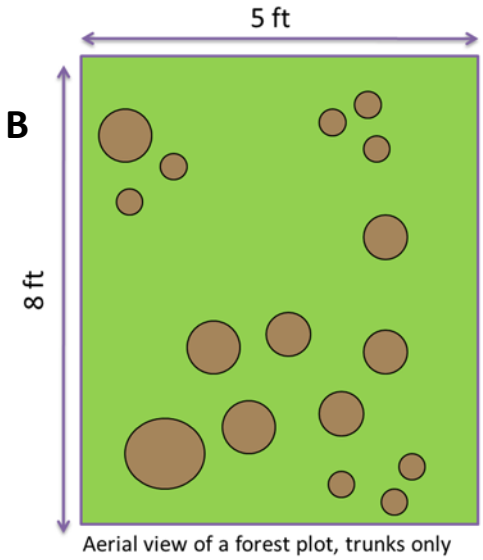
## Activity 3: Measuring Forests

1. Stand density is: _____

2. Calculate the stand density of these plots:



Aerial view of a forest plot, trunks only



Aerial view of a forest plot, trunks only

3. If everyone in this room were trees, what would our stand density be?

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