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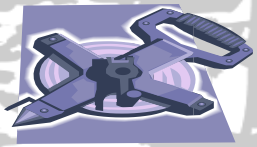
Biology Meets Math

MEASURING A FOREST



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US Department of Homeland Security

USDA

Goals

- Be able to describe the area and distribution of forests in the United States
- Understand why it is important to measure and monitor forests
- Define terms: biomass, crown, dendrologist, DBH
- Find out what π (pi) has to do with measuring a tree
- Define and calculate stand density

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Area of Forests in US

- In 2010, there were 304,022,000 ha of forest in the United States
- The United States is 982,667,500 ha
- What percent of the United States' area is forested?

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

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

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Where are the forests?

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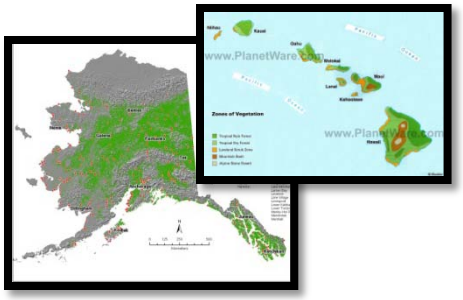
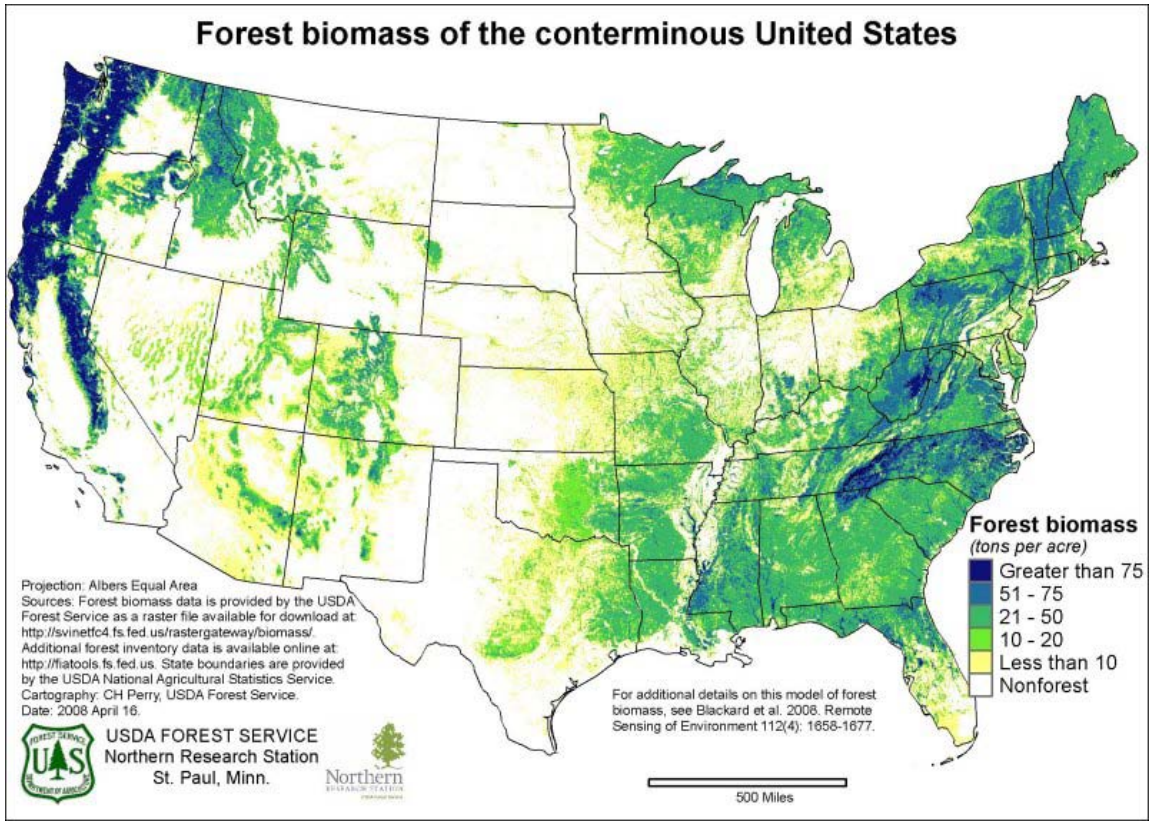
Distribution of Forests in the US

Biomass: Biological material from living or recently living organisms (mass per unit area)





What areas have the most forest **biomass**?

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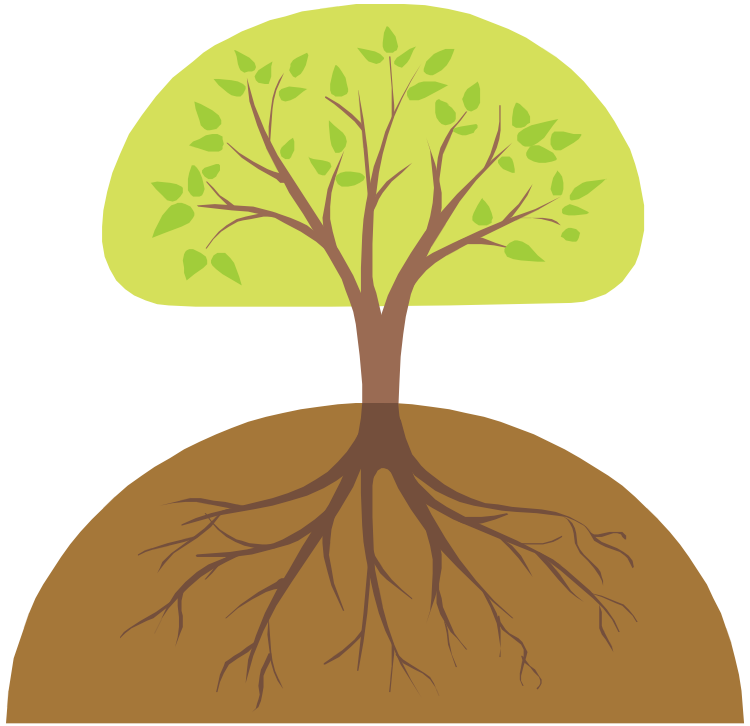
Why do we measure and monitor forests?



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Why do we measure and monitor forests?

- Timber and pulp

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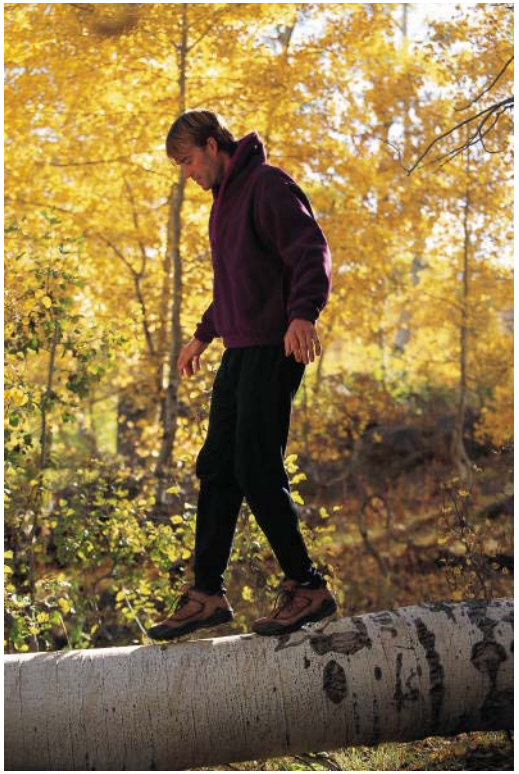
Why do we measure and monitor forests?

- Timber and pulp
- Recreation



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Why do we measure and monitor forests?

- Timber and pulp
- Recreation
- Fire Management

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Why do we measure and monitor forests?

- Timber and pulp
- Recreation
- Fire Management
- Ecological Reasons
  - Wildlife habitat

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Why do we measure and monitor forests?

- Timber and pulp
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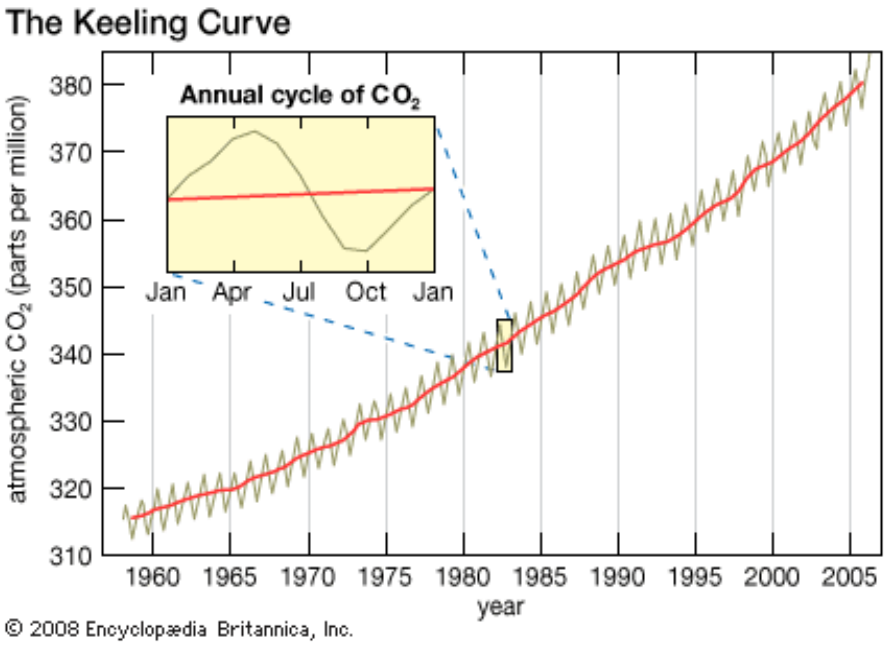
Why do we measure and monitor forests?

- Timber and pulp
- Recreation
- Fire Management
- Ecological Reasons
  - Wildlife habitat
  - Air quality
  - Climate change



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The Many Names of Forest Scientists

- A forest scientist can have many different titles
- One is a **dendro**logist, a person who studies trees and other woody plants

Dendro = (Greek: Tree or Tree-like)

Dowan Grant, Senior Forester and Dendrologist, Jamaican Forestry Department
http://www.virtualherbarium.org

Emily Moran, Forest Ecologist, National Institute for Mathematical and Biological Synthesis

Jennifer Franklin, Tree Physiologist, University of Tennessee

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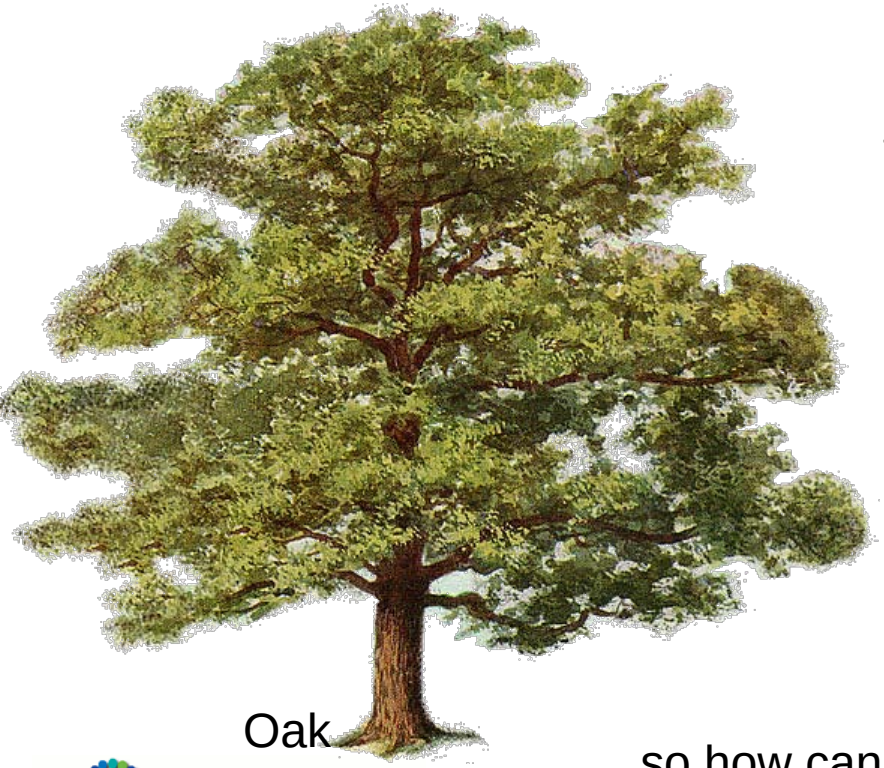
Measuring a Tree

We can see that trees come in all shapes and sizes …



Oak

Birch

Elm

… so how can we measure how they're different?

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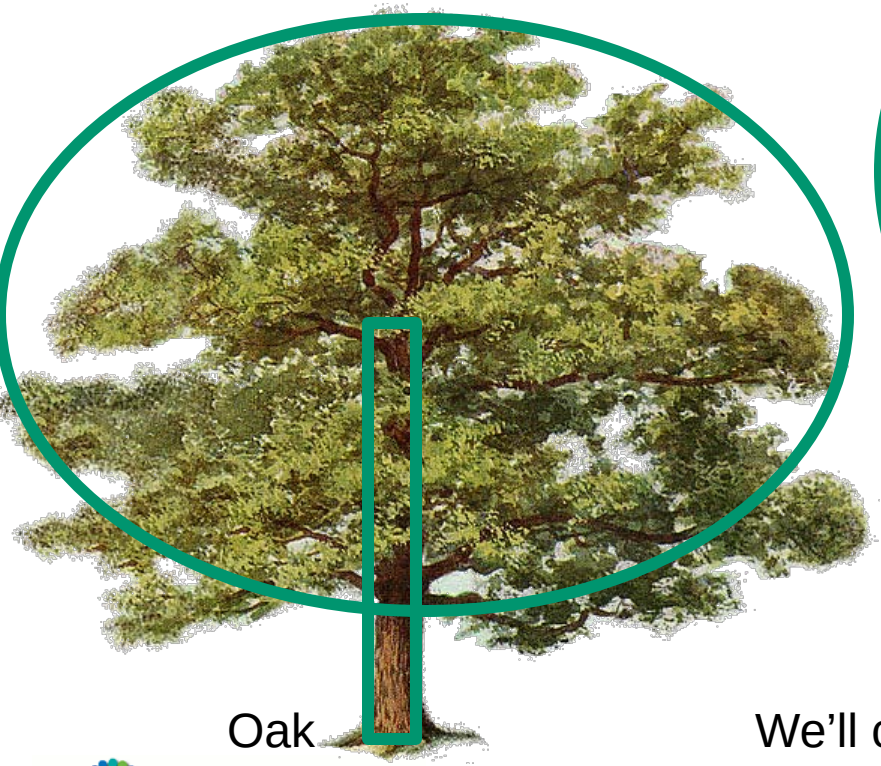
Parts of the Tree

Pretend it's a cylinder with an ellipsoid



Oak

Birch

Elm

We'll call the ellipsoid the "**crown**"
And the cylinder the "trunk"

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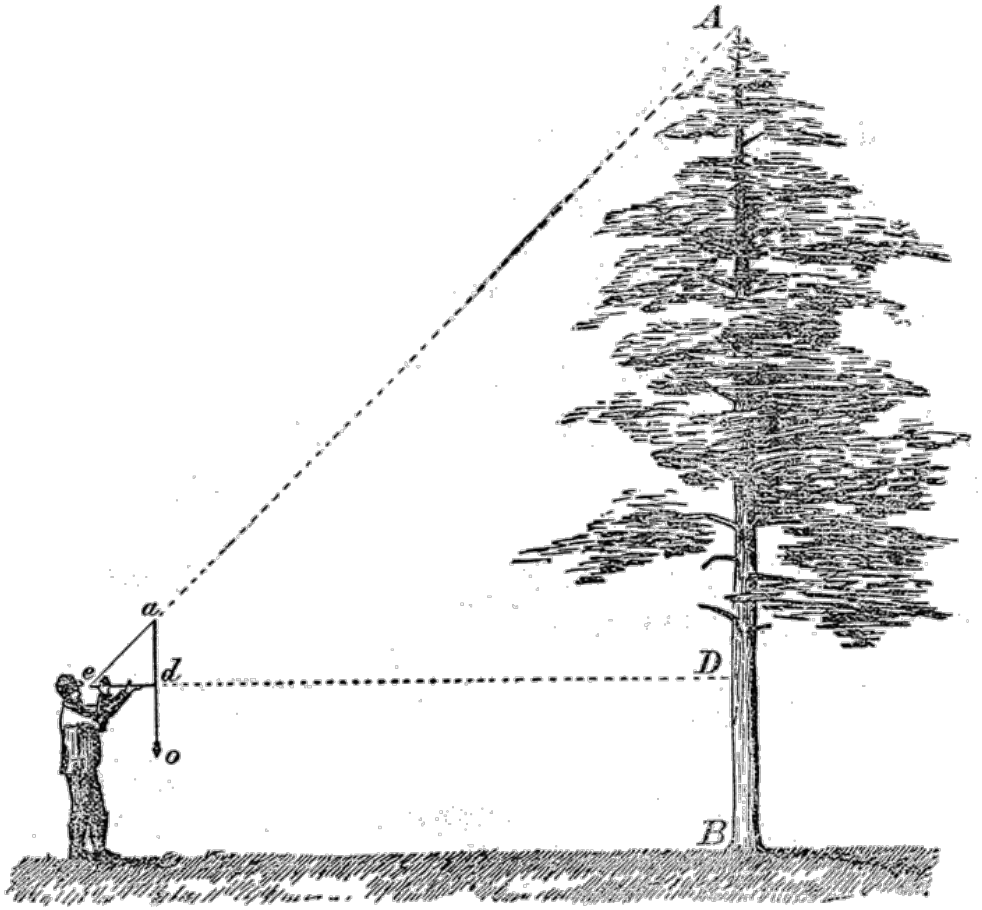
How do we measure something so big?



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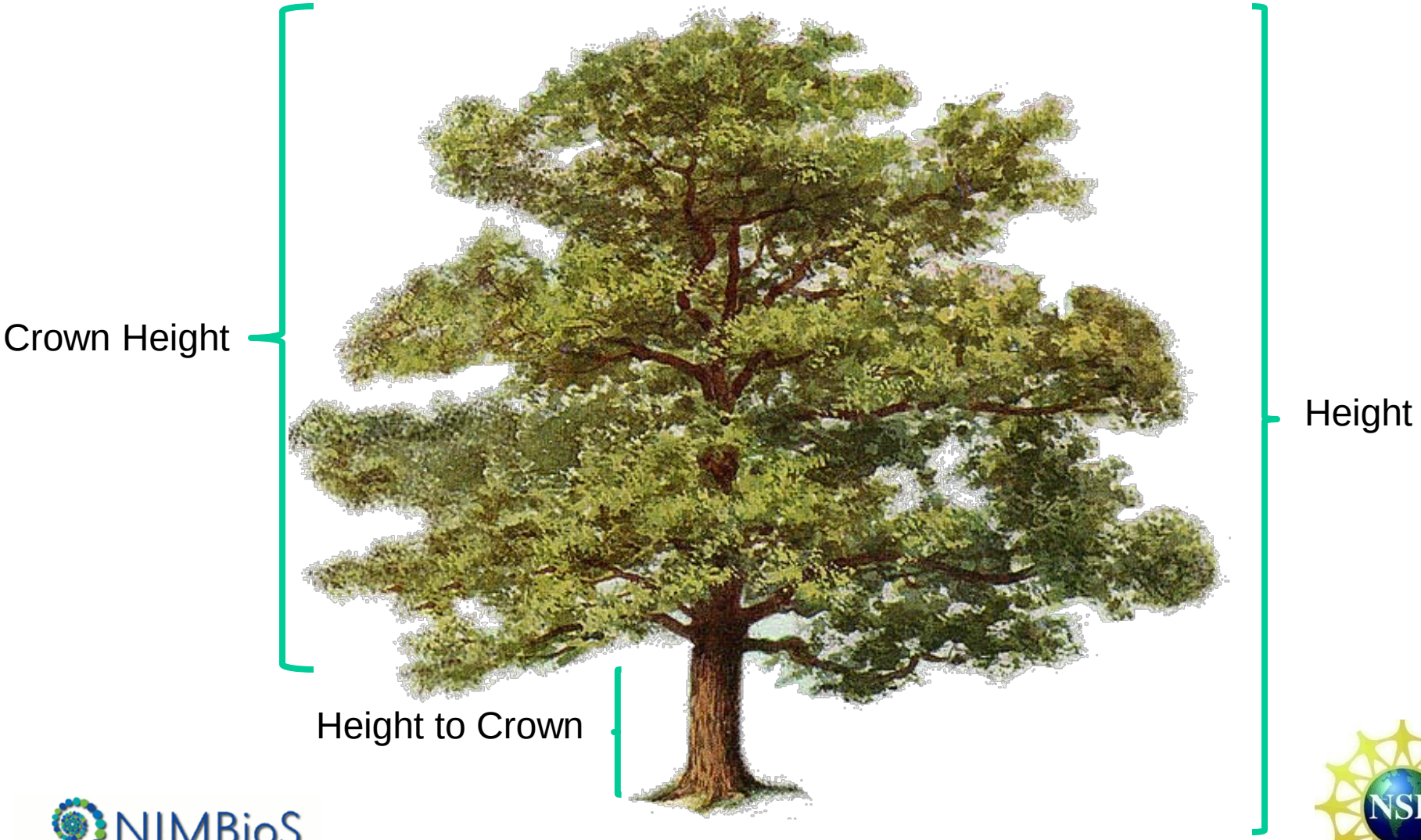
Common Height Measurements Dendrologists Make



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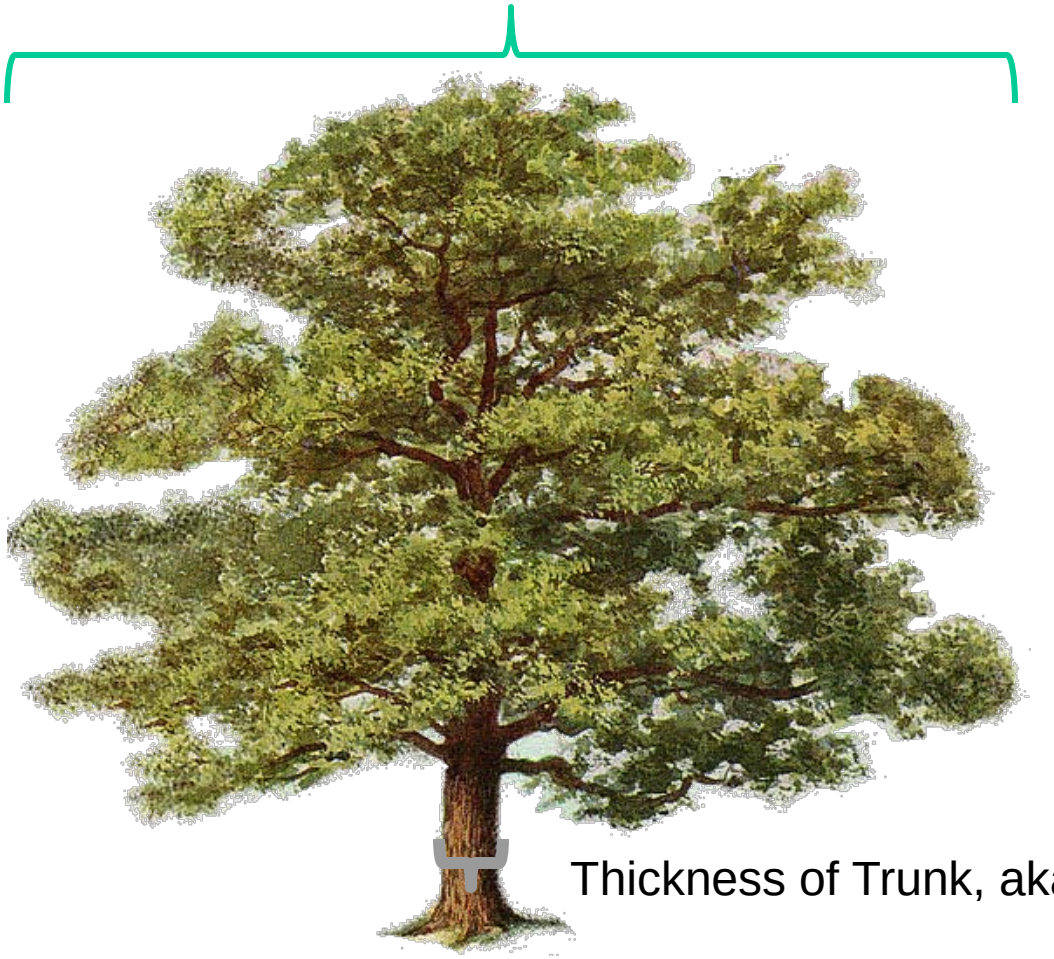
Common Width Measurements Dendrologists Make

Width of Crown



Thickness of Trunk, aka “DBH”

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What is DBH?

Diameter at
Breast
Height

- Diameter of the tree 4.5 feet above forest floor on the uphill side
- Avoids the swell at the base of the trunk

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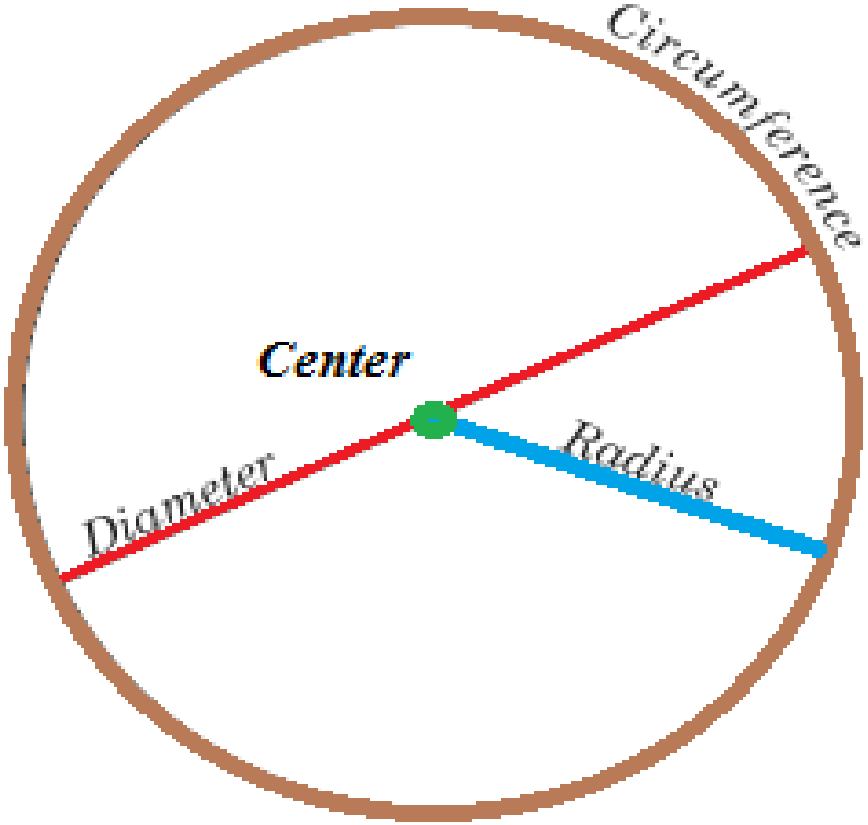
How can you use circumference to find diameter?



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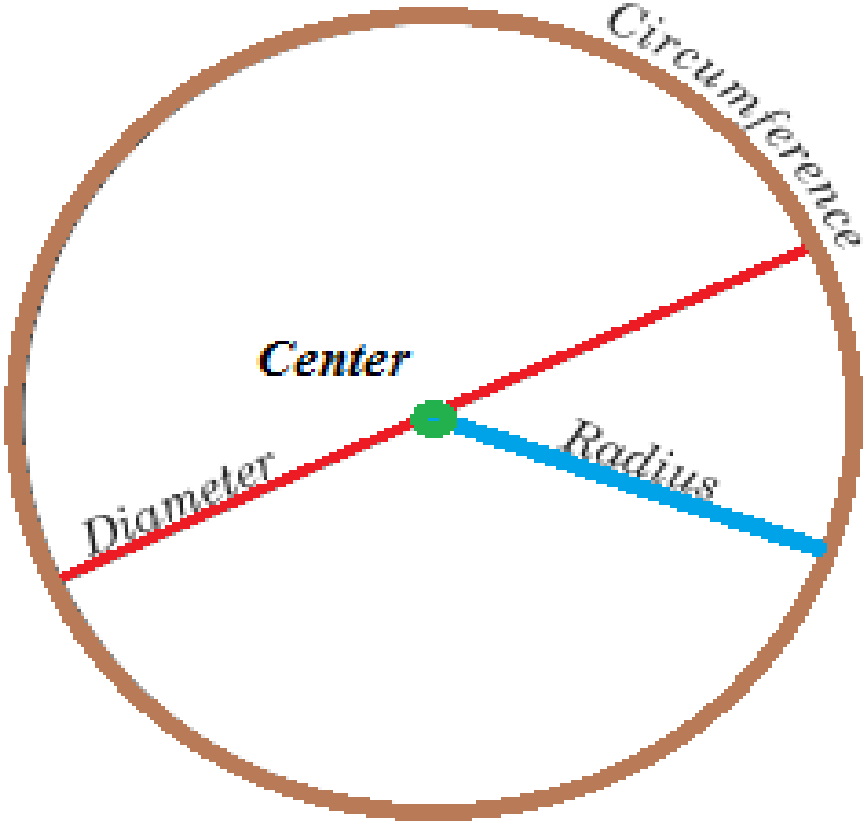
How can you use circumference to find diameter?



$$C = \pi D$$

$$C/\pi = D$$

Let's Practice!

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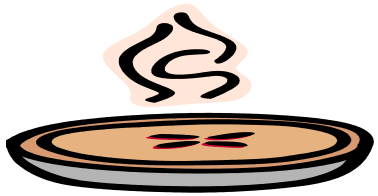
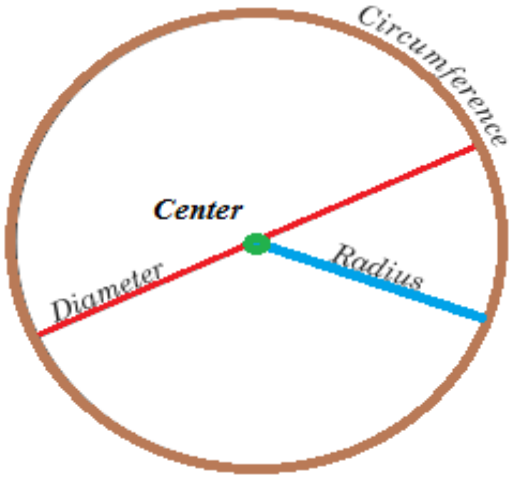
Practice with 

Practice using $C = \pi D$

C = circumference

D = diameter

$\pi \approx 3.14$



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.

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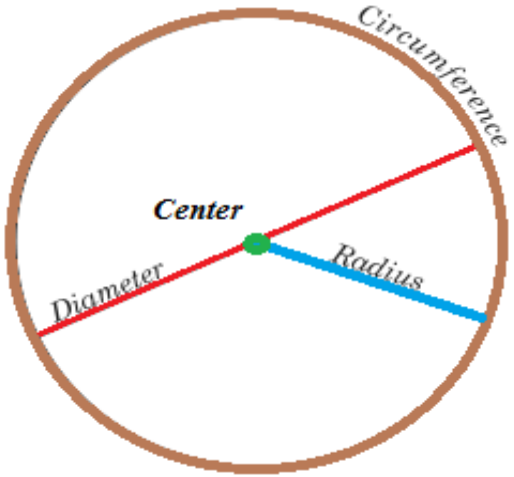
Was it easy as *π?*

Practice using $C = \pi D$

C = circumference

D = diameter

$\pi \approx 3.14$



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.

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Problem & Solution

- You are a forester collecting tree DBH data
- You'd rather not bring a calculator into the field with you
- Can you invent something that, if you use it to measure the circumference, it automatically gives you the diameter?

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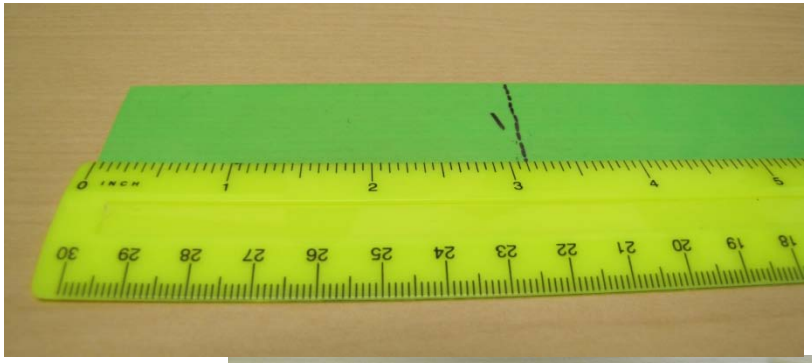
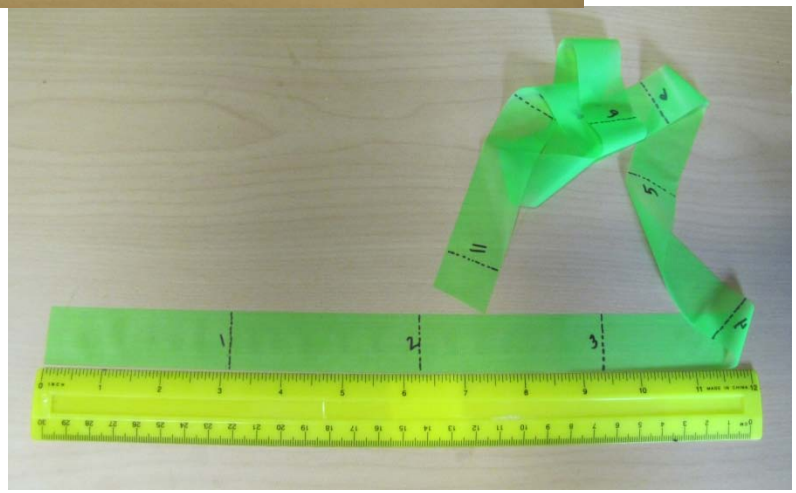
Make Your Own DBH Tape





- Mark off every pi (3.14) inches
- What is 0.14 of an inch?
- Somewhere in between 1/8” and 3/16”
- Test it out!

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Test Your DBH Tape

- What is the diameter of your tree cookie using a ruler?
- What is the diameter of your tree cookie using your DBH tape?
- What is the diameter of your head?
- What is the diameter of your leg?

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A Forest is Many Trees

Chequamegon National Forest, WI

Mendocino Pygmy Forest, CA

How to describe the difference with numbers?

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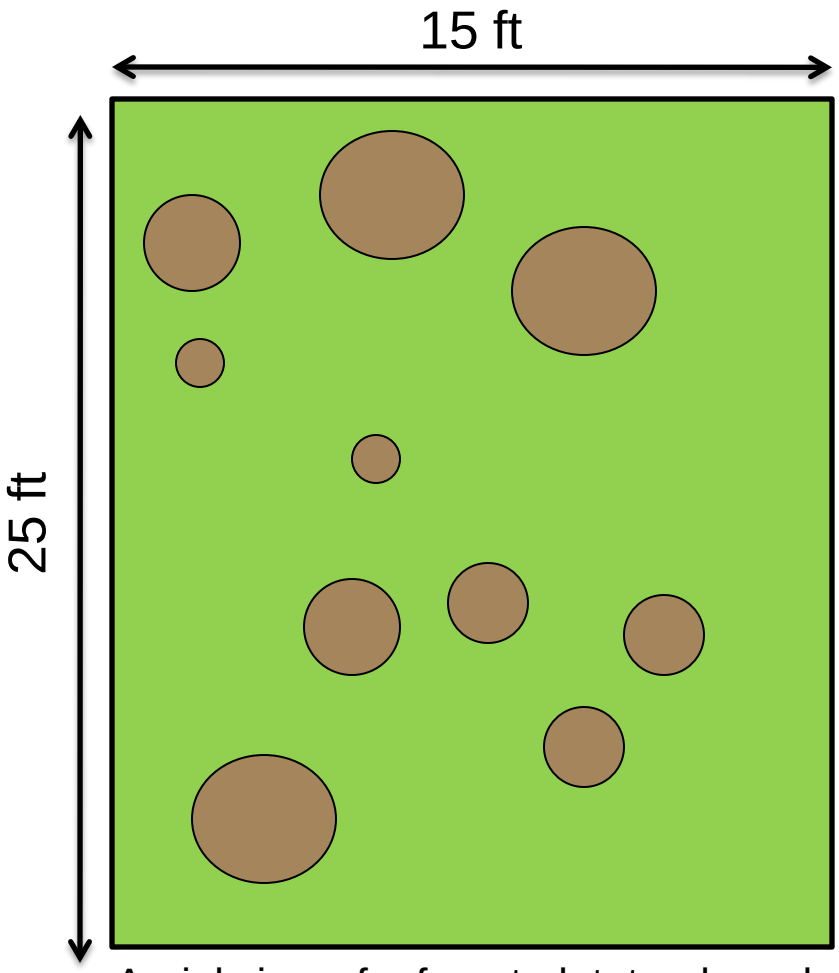
Stand Density



Aerial view of a forest plot, trunks only

$$\text{Stand Density} = \frac{\text{number of trees}}{\text{area of stand}}$$

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

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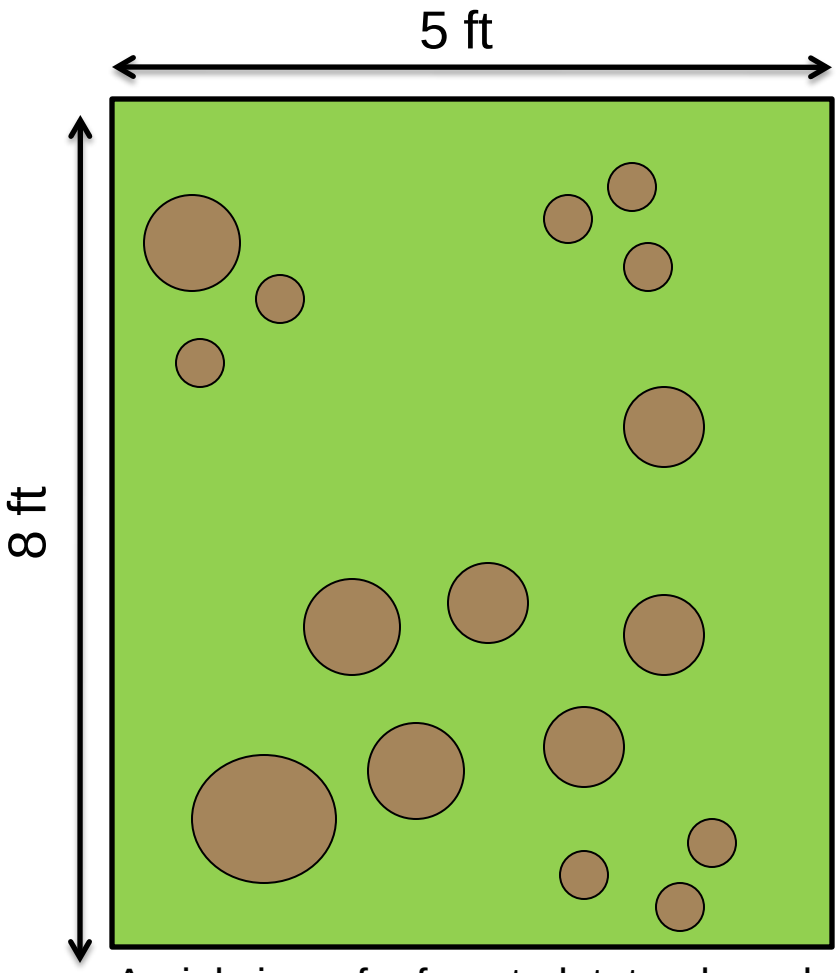
Your Turn!



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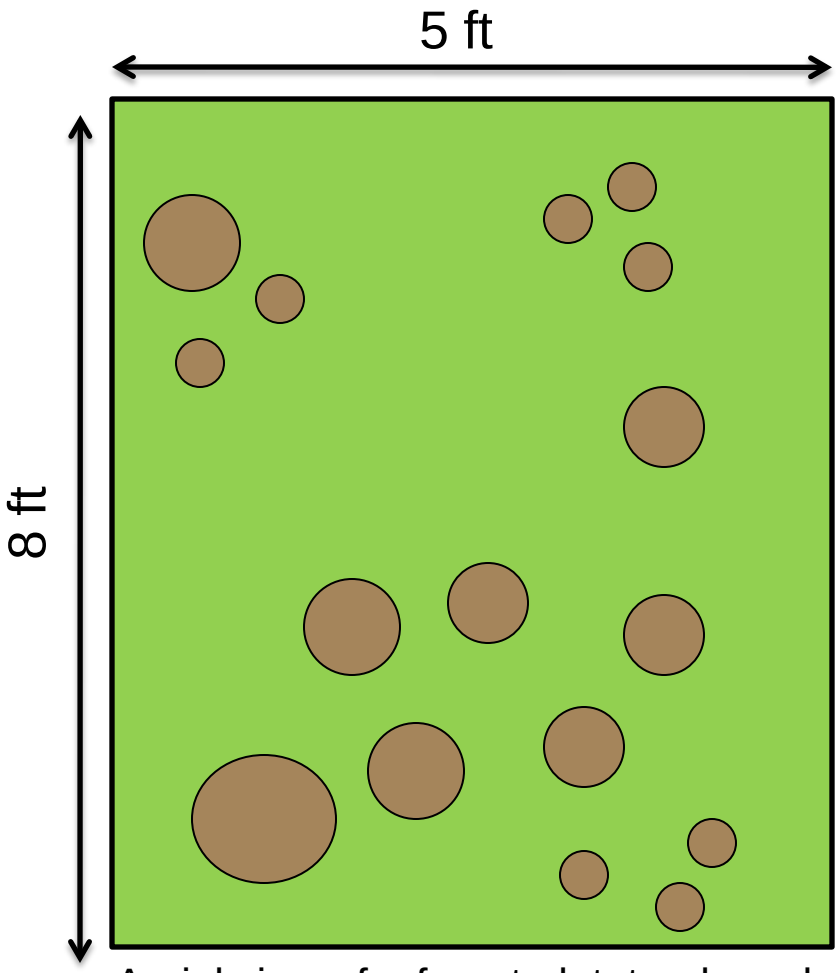

Aerial view of a forest plot, trunks only

$$\text{Stand Density} = \frac{\text{number of trees}}{\text{area of stand}}$$

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

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Which one has greater stand density?

Chequamegon National Forest, WI

Mendocino Pygmy Forest, CA

Probably Forest B!

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A “Forest” of Humans

If the people in this classroom were trees, and this classroom were our plot …

What would be our stand density?

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Looking for More?

- Check out our modules on calculating biodiversity!
- Real forest monitoring data available at

http://daac.ornl.gov/OTTER/guides/Runnings_Forest_BGC_Model.html

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For this Module & More:

- Website: www.nimbios.org
- See what we're all about
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