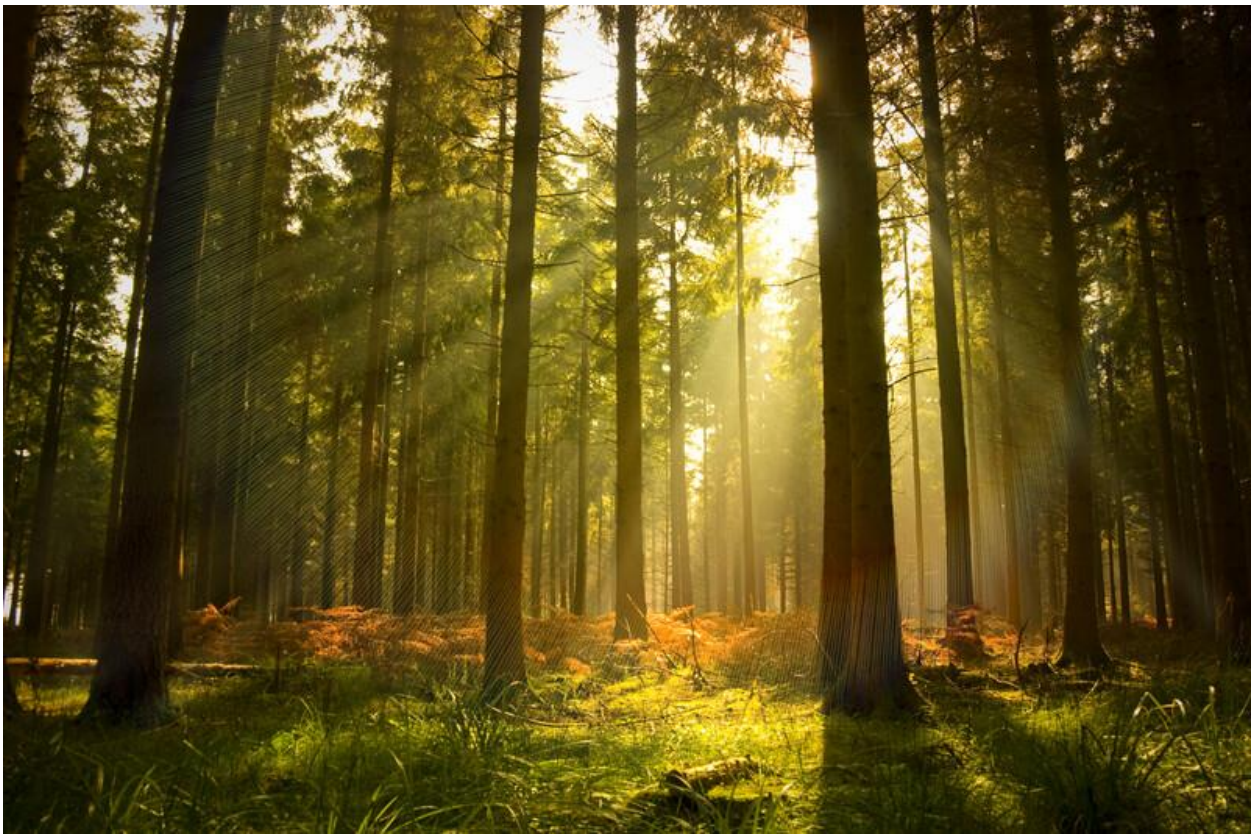
Math: Forestry Lab



by Supercharged Science

Create a Map of your Forest

First, we need to know what your local area looks like, so find an aerial image of your property and print it out. We're going to draw over it, so make sure it's got enough detail for you to be able to tell tree density. The best way to make a map of your trees in your local area is to use the aerial images taken by your local county and also through any of the following internet-mapping sites:

- Google Maps gives you the option of searching for an address and viewing satellite imagery.
- Google Earth is a free tool you can download that can show you printable images of a given address/location.
- Terra Server is another free site that you can use to search for your location and see what aerial images are available.

Scale of your Image

Before you print your image, take a look to see how easy it will be to figure out the scale.

Can you find something you already know the size of? If not, you may have to zoom out (or zoom in) to include something you know the size of, like the length of a house or a street.

How much acreage does your forest cover in your photo? We need to first determine the scale of your image. Scale = Actual ÷ Measured, so write this down here:

One acre is 43,560 sq feet

Forest Stands

A forest is made of individual *stands*, which are groups that look different from each other. They can even be of the same kind of tree. For example, one stand might be newly planted trees, another stand might be the same species of trees that are 80 years old. Or they could all be same age, but one stand is conifers and the other is hardwoods.

You can imagine that not everyone is going to agree as to how these boundaries are drawn on maps, so consider a stand as the area of trees that you could manage independently.

When people draw their boundaries, they not only look at aerial photos, they also walk through the forest to see things that the aerials cannot show, like the vegetation that grows under the canopy, called the understory.

Look at these two images:

Do you see how the right has more diverse growth than the left image, even though the forest area looked the same when viewed from above? Once you have your aerial picture, it's time to walk through the area and see if you can figure out how to best draw your boundaries to identify different stands in your area.

This is a sample of the stand boundaries which is now our *stand map*. Do you notice the difference in color and texture between each area?

Stand 3 is a dense forest of conifers (this was left image shown above), and stand 2 is more diverse and mixed (right image above).

You can name your areas (like "5-year-old pines" or "Dad's Picnic Forest") if you don't want to use numbers.

Go ahead and draw and label these boundaries on your own aerial photo of your area. Using your best "eyeball" estimate, what fraction of your forest does each stand cover? Write the fractions right on your map.

Make sure all your fractions add up to one whole unit!

Types of Trees

What types of trees do you have in your area that are on your map?

If you don't know what kind of trees they are, you can often get help from a neighbor, local ranger or forester, or even a local nursery.

Attach your map to this page and indicate species on the map.

Measuring the Diameter of Trees

Diameter is the width of a circle, and trees are not really perfect circles or cylinders, they're more like oval cones, tapering as they go up. Most trees are wider at the base and narrower further up, so the diameter is going to depend on how high up the tree you measure.

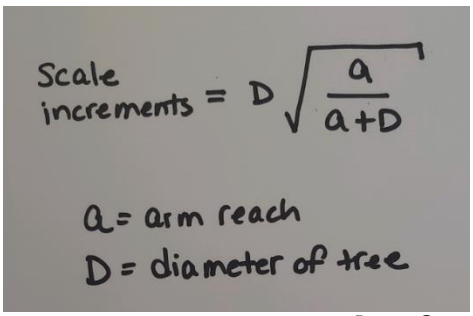
Most adults use a Woodland stick, which is calibrated for a 25" arm reach and meant to be used at chest height (called *DBH for Diameter at Breast Height)*, they measure the tree at 4 ½ feet above the ground. Since that's taller than most kids, we're going to teach you how to make your own Woodland stick from a broom handle, and it will be calibrated for kids to use. If you can stand on a chair or stool to reach high enough up a tree where it doesn't taper quite as much, you'll get more accurate measurements.

To make your own Woodland stick, use a broom handle or long dowel.

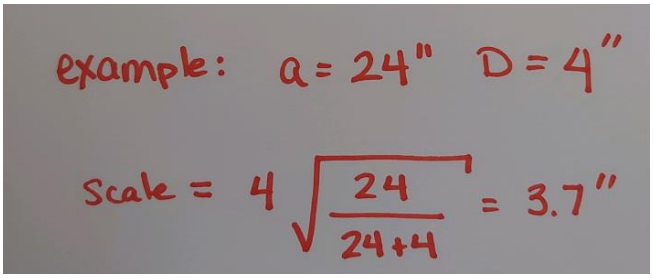
1. Hold it horizontally out at arm's length, comfortably against a tree.

2. Now have someone measure the distance from your eye to the stick. This is your own personal reach for your stick.

3. Now we need to figure out the increment in inches. Use the formula to calculate your scale increments:



4. You will use this formula (above) to calculate the scale increments and complete the data table below. Here's an example of how this works:



What is your arm length, *a* ?

_____ (inches)

Note that "a" is not going to change, so we're not going to put it in the table. We are going to change *D* for the range of trees you are going to use the stick to measure. What you use for *D* is going to depend on what size the trees are that you plan to measure. The table below assumes that the trees we're going to measure are between 4 to 10" in diameter. Feel free to change *D* in the table below to match your local tree choice!

D (inches)	Scale graduation / increment (inches)
4	
5	
6	
7	
8	
9	
10	

5. Mark the "zero" on your stick about 6 inches from one end of the stick with a pencil. You can also make one end of the stick your "zero" if it's flat (not curved or rounded).

6. Measure and mark the appropriate length for each *D*.

   For example, if you calculated the increment for the 4" tree to be 3.7", you'd mark the 3.7" mark on the stick as shown below and put a "4" by the second mark:

7. After you have marked your stick, find a utility pole (these are easier to measure than trees!) and check to be sure your marks are accurate. Once you've checked for accuracy, you can use a permanent marker to make the lines darker.

Now go out and use your personal Woodland stick and quickly (and accurately) measure tree diameters!

Here's how: hold your Woodland stick horizontally above the ground, arm straight out in front of you, with the back of the stick against a tree. Hold your head steady and don't move your head when you read the stick.

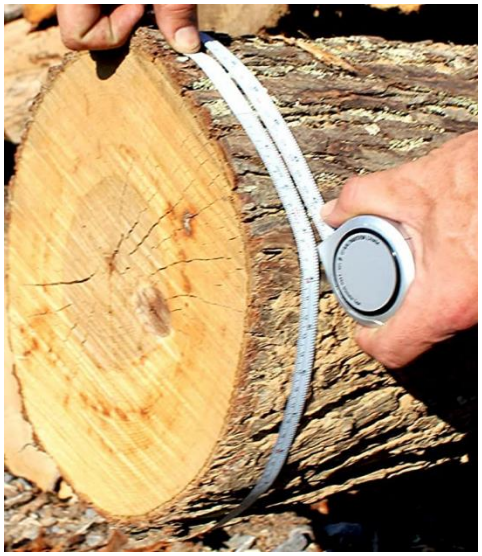
Close one eye and slide the stick until the zero on the stick lines up with the edge of the tree.
(In the example below, the zero is also at the edge of the stick.)

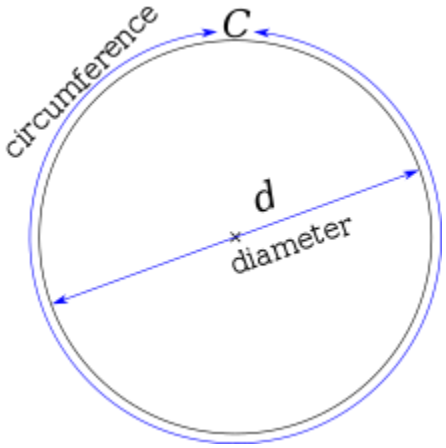
Now *without moving your head*, look to the right and find where the right edge of the tree crosses the stick and read it on the scale. On this commercially made Woodland stick, we read 17 ½ " for a tree diameter.

Remember that most trees are not perfect circles, they tend to be stretched and squished into an oval shape. Because of this, if you want to get a more accurate reading, walk a quarter-circle around the tree (90 degrees from where you took your first measurement) and take a second reading. You can average the two together to get a more precise measurement.

There's a second way to make tree diameter measurements, and that's with a *Diameter Tape*. The circumference of a circle is related to the diameter of the circle through a special number, *p* "pi" (pronounced "pie"). We'll learn more about this amazing number *p* when we get to geometry.

Diameter tapes are special measuring tapes that have already had *p* divided out by every number shown on the tape so you can just read the diameter straight off the tape itself. Contractors and rangers use these so they can quickly read the diameter.





$$\frac{\text{Circumference}}{\text{Diameter}} = \pi = 3.14159.....$$

Tree Data Table

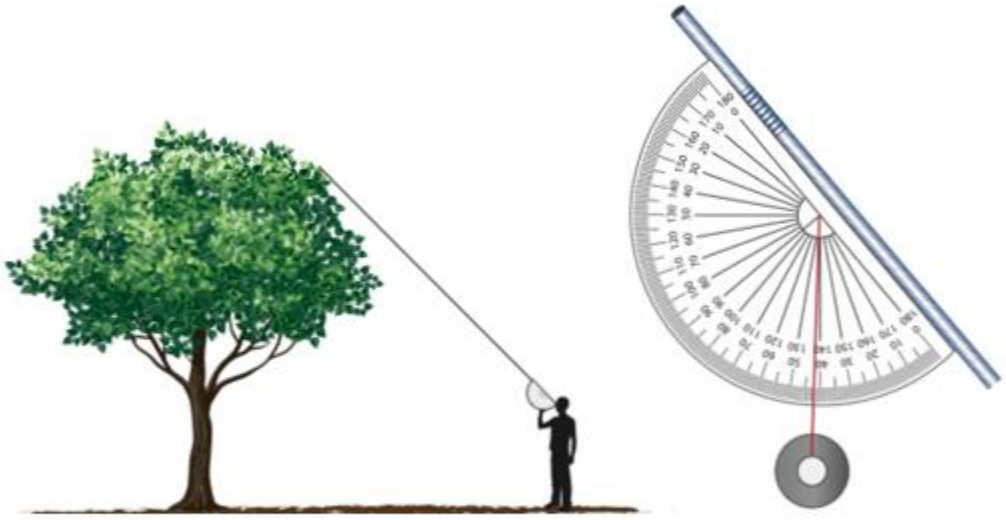
Record the diameter of a select number of trees in your area. After you have the diameters measured, move onto the next sections for finishing the rest of the data table!

Tree Name/Number	Diameter (inches)	Tree Height (feet)	Live Crown Ratio

Measuring the Tree Height

After you record the diameter for a handful of trees, it's now time to measure the height. We're going to make our own clinometer, which is a vertical angle gauge that measures the slope from your eye to the top of a tree. Ours is made from a straw attached to a protractor.

Position yourself so you can see the top of a tree without going uphill or downhill from the tree. You can choose any distance you want, but 50-100 feet from the tree will usually work for most trees, and your measurements will be most accurate if you're at the same elevation as the bast of the tree.

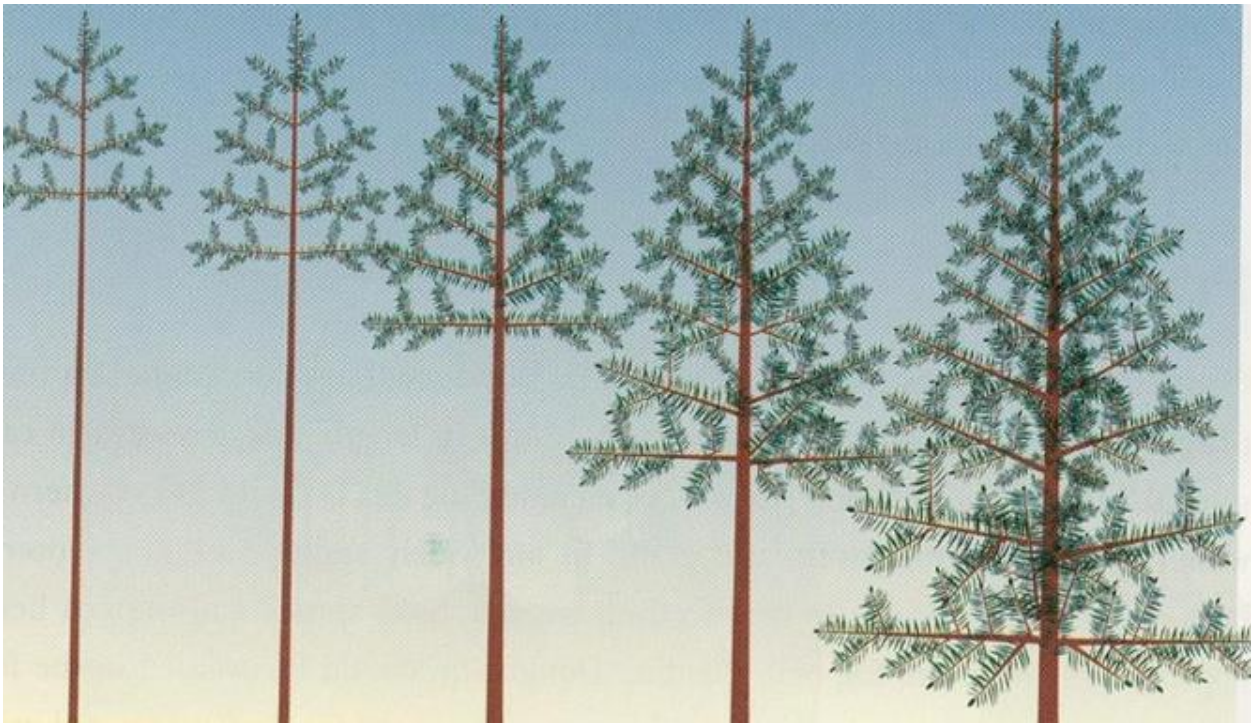


$$\text{height of tree} = \text{distance to tree} \cdot (\tan \theta)$$

Measuring the Live Crown Ratio

The *live crown* is the fraction of a tree's height that is green (green leaves, green needles). We don't include the bare trunk, bare branches, or dead leaves. You can figure this out by simply looking at it and estimating it.

Foresters use this information to estimate the health of the trees and the stand itself, as well as looking at the level of competition with neighboring trees. Usually, rangers estimate the live crown for every tree in their area. We'll just do this for the trees you did diameter and height measurements for.

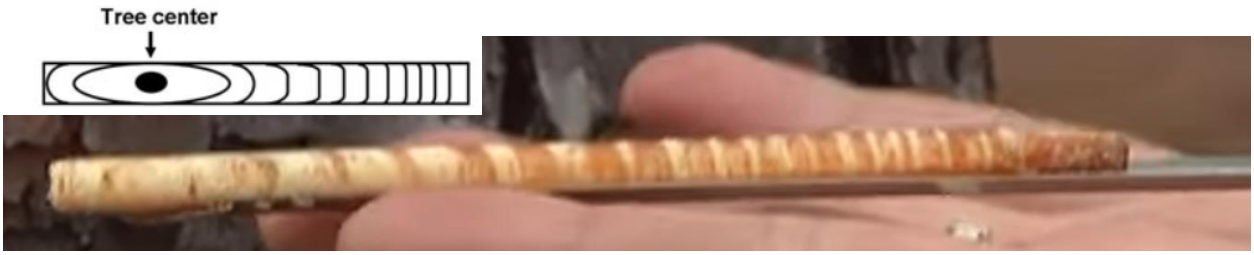


1/4 3/8 4/10 6/10 9/10

Measuring the Age of a Tree

You can determine the age of a tree by taking the ages of several dominant trees from different parts of your area and finding the average of these values.

To find the age of a tree, you'll need a special tool called an increment corer. It's a hollow drill that allowed you to extract a small, thin cylinder of wood (called the *increment core*) about pencil-size that shows annual rings which can be counted to figure out the age of the tree.



Notice near the left end that the pattern changes, which indicates that it's near the center of the tree. You always want to add a couple of years to your number, since the sample is usually taken at chest height and doesn't include the early growth near the base.

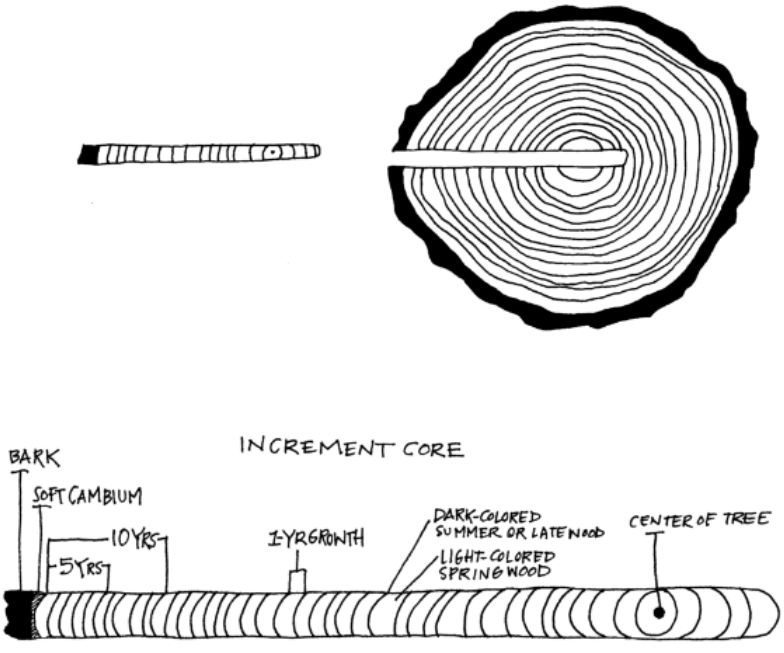
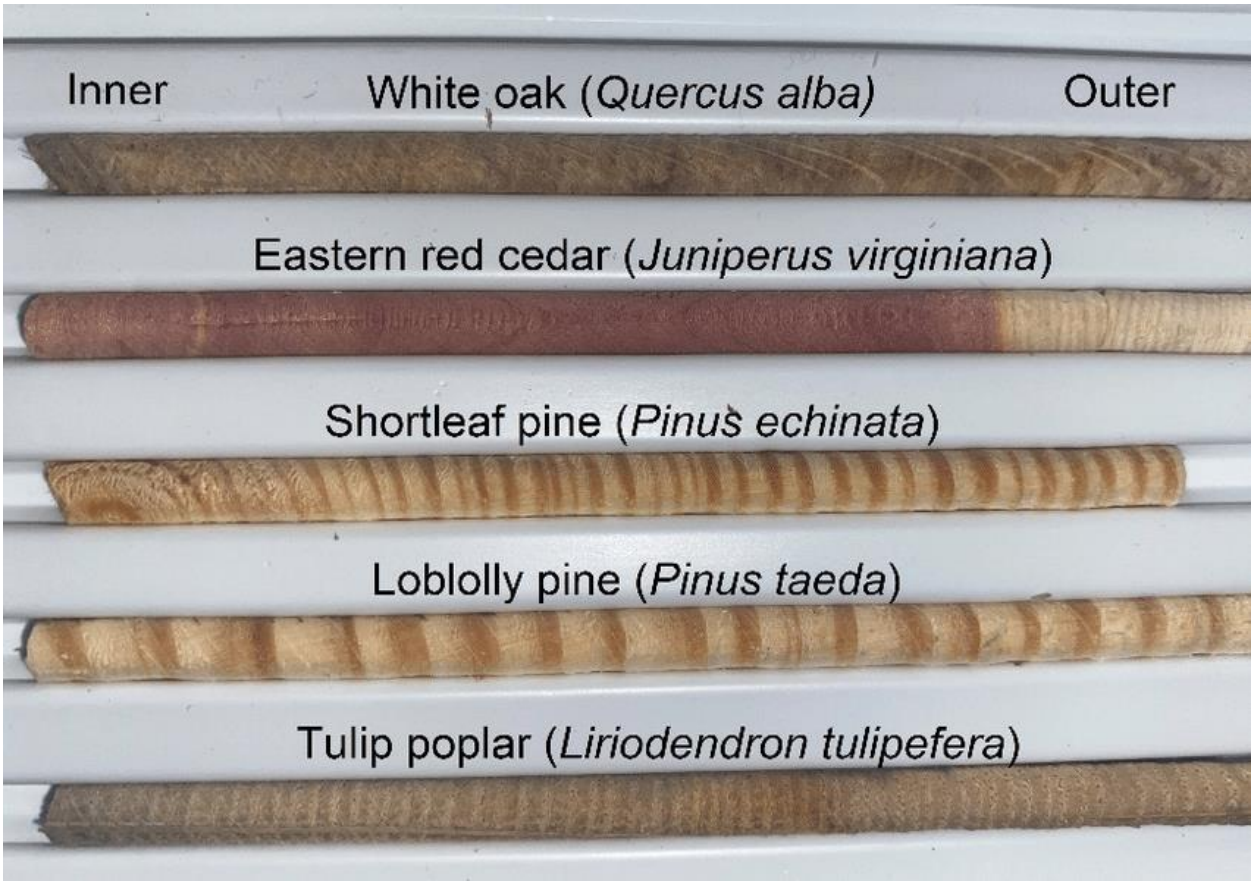


Figure 4.6. A cross-section of a tree that has been bored, showing the displaced core sample (Adapted from Fletcher et al. 1993).

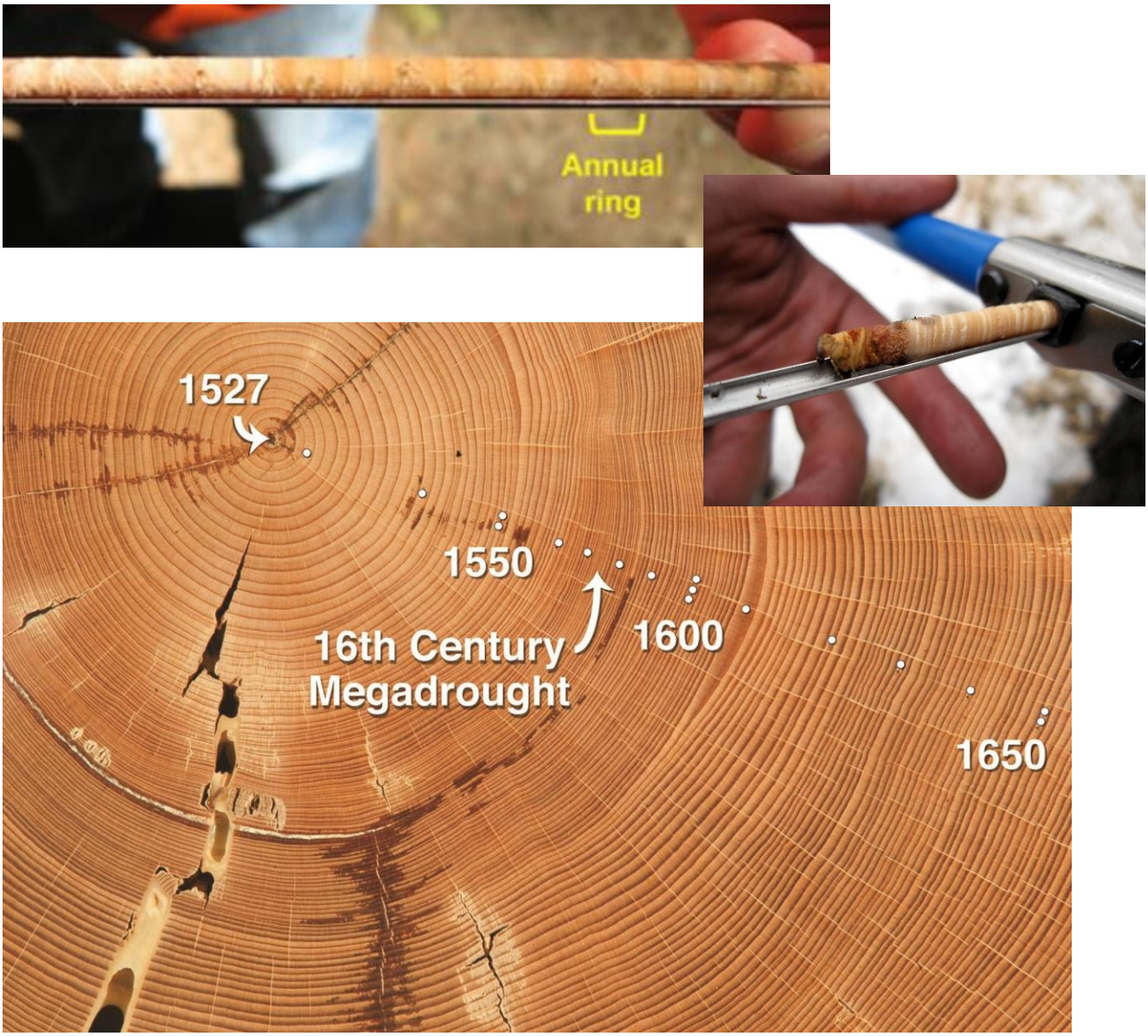
If your core was removed from the enter of three, you should see a round or oval shaped ring that marks the center. Start counting with this center ring outward to the end of the increment core, and add 4-5 years to account for the base growth not included in the sample taken 4 feet above the ground.

It's important to note that ring counts are not foolproof! There are many tropical trees and some hardwoods that have annual rings that are nearly impossible to count. Trees can also create false rings during years of unusual weather conditions (like a drought followed by high rain). Trees also can have missing rings in years of extreme drought or defoliation. In general, the older the tree, the more chances there are for odd things like this to occur, so remember that these core samples are only estimates of tree age at best.

Since most people don't have an increment borer, here are a couple of samples to look over:



What do you notice about the samples? How are they different? Which one was most difficult to read? Can you add numbers to each sample and order the trees oldest to youngest?



This Douglas-fir sample from the Southwest has annual tree rings dating back to the year 1527. The narrowing of the rings that formed from the 1560s through the 1590s indicates that the tree grew little during the 16th century megadrought. *Source: Univ of Arizona*

Source of images except where noted:
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