Dendrochronology: The study of Tree Rings

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Activity Name: Dendrochronology – The study of tree rings

Ages: 9-15

Activity Energy: Medium

Length of time: 2 hours

Number of Participants: 10 – 30 (limited by availability of increment borers)

Indoor/Outdoor: Both

Concept: This lesson introduces students to the study of tree rings, and provides hands on experience with survey equipment used in the forestry industry.

Materials Required: An increment borer for at least every 6 students is recommended*, flexible measuring tapes**, clipboards, pencils, zip-lock bags and Dendrochronology Group Worksheet (see other files attached to this resource).

* It takes about 5-10 minutes for a student to take one core sample therefore the number of participants is limited by the number of corers available and by the students patience while they wait for one to become available.

** You can make your own measuring tape by sticking duct tape back to back; laying it beside a meter stick, and marking the centimeters on the tape. White duct tape works best for this purpose.

Introduction: Dendrochronology is the fascinating study of tree rings, and has many applications that help us understand tree growth, historic climate patterns, insect outbreaks, and wildfire patterns. Tree rings form due to annual patterns in weather such as precipitation and temperature. These fluctuations cause the tree's cells to grow at different rates, creating large cells during optimum growing conditions and small cells during poor growing conditions. The dark rings (tree rings) appear because the tracheid cells of the tree are smaller and the secondary cell walls thicker during periods of slow growth.

This lesson is a great opportunity to have your students collect and interpret information about their environment using real scientific methods and tools. The increment borer is a precision survey tool that was developed in Germany in 1855 (Grissino-Mayer, 2003), and is composed of three parts; the auger, the handle, and the extractor. Some knowledge of how to maintain and properly use an increment borer is recommended prior to use. There are different increment borers for different tree diameters and species. For the purposes of this lesson, we recommend sampling softwood trees between 15cm and 40cm in diameter. The corer you are using should be of an adequate length to sample just past the center of the tree. See tips for tree coring below for more information. Increment borers are expensive ($230/each), so it is unlikely you will want to purchase them solely for the delivery of one lesson. However, because they are a common tool used in forestry research, they can often be borrowed free of charge from forestry research centers, museums, or universities.

Methods:

1. Begin with a series of questions to introduce your students to the topic. How long can trees live? *The oldest known living tree as of 2015 was a 5,064 year old bristlecone pine living in California.* If you carve your initials in a tree trunk and come back in 10 years, will your initials be at the same height or will they have grown higher up the tree? *The initials would be at the same height. Trees add height like you would build a tower, by adding cells to the top. However, some plants such as grass and onion species have adapted to add cells at the base, and therefore grow like human hair with the oldest cells at the top. This is an adaptation to survive browsing by deer and other ungulates.* Do all species of tree grow at the same rate? *No, different trees grow more quickly than others.* What other factors affects the growth rate of trees? *Water, sun, nutrient, and oxygen availability greatly affect the growth rate of trees. For this reason, trunk diameter is not always a good indication of age.*

2. Describe how trees grow: Trees put on growth in two locations; called areas of meristematic growth. These are places on the tree where cells are actively dividing and are called apical meristems and lateral meristems. Apical meristems are located at the tips of branches and roots, and lateral meristems are located in the area of the trunk just below the bark. Therefore trees grow simultaneously taller and wider.

3. Place the students in groups, each with one increment borer and one group leader. Hand out the increment borers, measuring tapes, zip-lock bags (for putting the core samples), and the Dendrochronology Group Worksheet and explain the hands-on part of the lesson, including instruction on how to take a tree core sample. We have attached a paper to this resource describing in detail how to operate and care for an increment borer, which we recommend reading prior to operation.

4. Travel to the survey site and demonstrate how to extract a tree core. Have the students guess the age of the tree before you begin.

5. Working in groups, have the students collect core samples, measure the circumference of the trees, and put the core samples in the plastic bags.

6. Back in the classroom, have the students count the tree rings, estimate the age of the trees, and calculate the diameter of the trees.

7. Collect all the class data on the board for discussion. What were some difficulties in collecting the core samples? Is diameter a good indication of tree age? How old was the oldest tree? Which tree was the fastest growing? The slowest growing?

Instructions/Tips for Coring Trees

1. Practice on a couple trees before you teach the lesson to gain experience.

2. Step 1: Remove the auger and insert it through the midway hole on the handle, secure the clip.

3. Step 2: Position the tip of the auger at a 90 angle to the tree at approximately chest height. Choose a position on the tree that does not have thick bark, branch scars, or other damage. Coring through more than ¾inches of Douglas fir bark for example can lead easily to a jammed increment borer. Position the corer as best as you can to hit the center of the tree, this requires practice to achieve an exact tree age. The closer you can get to the center the more accurate your estimate of the trees age will be.

4. Step 3: Push the tip of the auger into the tree as you rotate the handle clockwise. Once the auger has bit you can turn without pushing and the auger will pull itself into the tree. Stop turning when you have reached the center of the tree. To estimate how far you have reached you can hold the extractor along the side of the tree in line with the auger as a guide.

5. Step 4: Insert the extractor into the auger with the holding tray faced down. **Do not** push the extractor with excessive force or it can bend; don't force it! Once the extractor has been inserted, rotate the handle counter clockwise 180 degrees. Slowly pull the extractor out, being careful not to drop the core sample. Sometime a partial core is removed and the extractor must be re-inserted to extract the remaining section. Make sure to keep all parts of the core and if comparing one core to another you must keep the sections in their proper order. Place the sample in a zip-lock bag, use a separate bag for each sample.

6. Step 6: Estimate the number of years it took for the tree to reach the height of where you took the core sample. In the case of a sample that does not include the tree center, you must also estimate the number of missing rings and add that number to the counted total.

(Years to core sample height) + (counted tree rings) + (estimate of missed rings) = tree age

For details on preventing jamming, dealing with a jam, and proper maintenance of the increment borer, we recommend you read Gissino-Mayer's 2003 "A Manual And Tutorial For The Proper Use Of An Increment Borer".

Tips for Teachers:

- Avoid coring hardwood trees or trees with very thick bark. If coring Douglas fir trees, choose a spot where there is a fissure in the bark.
- Younger or smaller students may have trouble starting the corers into the tree and may need assistance. Once the corer is started they may be able to take over.
- If possible, have an adult work with each of the groups of students to provide assistance.

Background facts and information:

- Oldest living tree as of 2015 was a 5,064 year old Bristlecone Pine in California.
- Oldest clonal organism might be a stand of aspen trees in the United States thought to be more than 80,000 years old!
- Dendrochronology definition: *The dating of past events through the study of tree ring growth*. By matching tree ring patterns from different trees, climate histories can be put together going back up to 10,000 years!

- Why tree rings form: Tree rings form because of the seasonal fluctuations in growing conditions. In spring when it is wet and warm, trees grow quickly and the cells produced during this time are large. Later in the summer when water availability has decrease the cells are smaller. The dark line or “Tree ring” is caused by this summer growth of densely packed cells. Trees growing in places where the growing conditions are consistent throughout the year do not have growth rings.

Literature Cited:

Brunstein, F.C., and D.K. Yamaguchi. 1992. The oldest known Rocky Mountain bristlecone pines (*Pinus aristata* Engelm.). *Arctic and Alpine Research* 24:253-256.

Grissino-Mayer, Hendri D. 2003. A Manual And Tutorial For The Proper Use Of An Increment Borer. Tree Ring Research, Vol. 59(2), 2003, pp. 63-79.

http://www.rmtrr.org/oldlist.htm