Exploring Tree Rings

Overview: *Many trees live long lives. Students discover they can learn about the history of a tree by examining its rings.*

Grade Level/Range: *9-12*

Objective: *Students will explore:*

- *the differences between herbaceous and woody plant growth*
- *how tree rings can be used to understand its growth and history*

Time: *1 hour*

Materials:

- *a copy of A Sand County Almanac by Aldo Leopold*
- *cross-sections of tree trunks and branches*

Background Information

Trees are essential workhorses in our environment, providing us with oxygen to breathe; foods such as apples, hazelnuts, and maple syrup to eat; and wood for our houses, paper products, and furniture. In nature, trees provide food and housing for birds, insects, and other animals. They filter water and absorb carbon. Their importance is evident, but how do trees actually work?

Parts of a Tree

Trees are the world's tallest freestanding organisms. They have an amazing design that allows them to soak up 1,400 liters of water every day (that's like drinking enough water every day to fill 700 big soda bottles), and to do it against gravity. The basic parts of the tree are the roots, trunk, and crown.

Roots

Roots take up water and nutrients from the ground. They also anchor the tree in the soil. Most mature tree roots extend at least twice as far (widthwise) underground as the canopy of the leaves above the ground. Although some trees may also have a taproot extending deep into the soil, it is the roots closest to the surface that absorb the majority of the water.

Trunk

The trunk is the "highway," or main distribution route, transporting water and nutrients from the roots and crown to the entire tree. The tree trunk and its main branches have five key parts:

- *Its outer bark protects the tree, holding moisture in and keeping excess moisture out, insulating it against temperature changes, and protecting it from insect damage. The outer bark is continually renewed from within the tree.*
- *The inner bark, called the phloem, transports food to the rest of the tree, lives a short while, and then becomes cork and part of the outer bark.*

- *The cambium cell layer is the part of the trunk that is actively growing. Every year, it makes new bark and new wood.*
- *Sapwood, the next layer of the trunk, is new wood and is the transport system for moving water up to the leaves.*
- *As the tree makes a newer ring of sapwood, the older sapwood becomes heartwood, the central layer that supports the tree. It is dead, but holds its strength as long as the outer layers are intact. It is super-strong, nearly as strong as steel.*

Xylem tissue, which transports water, is found within the wood of the tree (both the sapwood and heartwood). The xylem vessels are tiny, each only several microns in diameter. When they die, their cell walls are still intact and continue to serve as a water transport pipeline.

Crown
The crown includes the large and small branches growing from the trunk, well as their leaves.

Key Functions
Photosynthesis
To make food, trees need carbon dioxide, water, chlorophyll, and sunlight. Through photosynthesis, the leaves capture light energy from the sun and, in the presence of chlorophyll, convert it into sugars with carbon dioxide absorbed from the air and water taken up by the roots. The leaves release oxygen in the process.

Fluid Transportation
The network of xylem tissue found throughout the tree and phloem make up the tree's vascular system. Water is absorbed from the soil by the roots. It moves to the water-transporting xylem vessels, a network connecting the roots, trunk, and canopy. Most of the water movement happens in the newer rings of growth. The phloem tissue, located beneath the outer bark, carries the sugars made in the leaves downward and inward through the trunk, branches, and roots, or up into growing shoots.

Trees release water through pores in the leaf surfaces, a process called transpiration, to keep from overheating under the hot summer sun. Transpiration also creates pressure to drive water up the tree. As water transpires from the leaves, negative pressure pulls more water from the xylem into the leaf. The tension continues to pull water through the branches, trunk, roots, and ultimately the soil.

Dormancy
To survive the winter's stressful cold temperatures and wind gusts, trees in temperate climates rely on a key process called dormancy, a time when growth and development stop (except for the roots, which never really stop growing), and the tree conserves energy. Deciduous trees lose their leaves to conserve energy. Autumn's short days and long nights trigger the tree to get ready. Evergreen trees keep their leaves throughout the year. They possess a thick layer of waxy covering their leaves to help them conserve water year round. The long, narrow shape of the leaves of pine trees and other conifers also helps reduce water loss.

During winter months, dormant trees may sustain some injuries such as frost cracks, when the pressure of ice is stronger than the wood, but trees that are *otherwise healthy can heal from such injuries, similar to how we heal from a broken bone.*

Following the prolonged cold, the new leaf buds that were produced the season before can start to grow, slowly at first, until temperatures warm. As soon as they start growing, the buds make hormones called auxins that stimulate growth in the rest of the tree, leading to the gorgeous green canopies we see in summertime!

Tree Growth

As explained above, trees continuously grow taller and wider during the growing season. The growth occurs at rates that vary with the environmental conditions, which results in the development of tree rings. If you cut horizontally into a trunk or branch, you will discover alternating light and dark rings resulting from these different growth rates. The lighter sections indicate periods of rapid growth and thus larger cells; such periods normally occur during the spring and early summer. The darker rings indicate periods of slower growth and thus smaller cells; these normally occur during the late summer and fall. Although there can be exceptions, generally, one pair of light and dark rings represents one year of growth. Thinner rings can signal challenging weather conditions such as drought. Thicker rings can indicate especially favorable growing conditions.

Laying the Groundwork

Read Aldo Leopold's "February: The Good Oak" (from A Sand County Almanac). This classic essay links the tree rings of an oak felled on Leopold's Wisconsin farm to local historical events. Ask students, What was the estimated age of "the Good Oak" and how was that determined? What kinds of assumptions did Leopold make about growing conditions and environmental factors on the basis of the oak's age? Point out that in addition to commenting on environmental conditions, Leopold associated the rings with local history. Why do you think he chose those particular events to detail as he reflected on the life of the oak?

Exploration

- *Ask students to further research how tree rings develop. They may want to check out this video for additional background:*
  Tree Stories from BYU: https://www.youtube.com/watch?v=xmZO7aRgcW4

- *Give each student or group a branch or trunk cross-section to investigate. Ask students to count the rings to estimate the age of the branch, or the age of the tree if you have trunk samples. Have them record their estimate in a journal along with a sketch of what they see.*
  If you are not able to access cross-section samples, you could also have them explore the Gallery of Tree Rings (http://web.utk.edu/~grissino/treering-gallery1.htm) on The Science of Tree Rings Website.

- *Inform students that counting rings may not always be accurate. Slow and fast growth may not always indicate a year-long cycle. Explore the science more deeply. Analyzing tree rings and using them to understand the story of trees is called dendrochronology. The field was founded by A.E. Douglass. For more accurate dates, dendrochronologists also use a technique called cross-dating rather than simply counting the rings. Find out more about cross-dating and participate in online tutorials at http://tree.ltrr.arizona.edu/treerings.html.*

Making Connections

Ask the following to inspire further exploration of tree rings:

- *Why are some rings larger than others?*

- *Do you think one set of rings always represents one year? Can you think of any environmental factors that may interfere with normal growth [e.g., a cold, dry spring or mild, fire, a wet summer] and thus cause a tree to develop multiple pairs of light and dark rings in one year?*

- *-Do you think we can use tree rings to determine the age of a live tree? How? (Core samples)*

Branching Out

- *Check out Vanishing Acts: Trees Under Threat (https://www.mortonarb.org/files/VanishingActs-TeachersGuide-Grades9-12.pdf) from The Morton Arboretum to help students discover how the study of tree rings can have practical application to current events.*

- *Explore other tree measurements. Practice math skills by asking students to measure the circumference of a tree trunk and estimate the height of a tree. Check out these creative measuring methods from the Elms Environmental Education Center (http://elms.smcps.org/student-tutorials/great-trees/how-to-measure-the-height-of-a-tree).*

- *Trees can be come important members of a community. American Forests maintains a National Big Tree Program to honor impressive trees including a national register of champion trees. Search for trees in your state online (http://www.americanforests.org/explore-forests/americas-biggest-trees/). Are there any close by? Compare the trees in your schoolyard with the trees in the database. Do you have any trees that you think deserve attention in your area? Ask your class to look for exceptional tree specimens and create your own list of local beauties.*