Middle Bear – Dendrochronology Lesson

**Tree ring lesson plan**

How tree rings tell the story of Sky Islands

**GOALS:**

Students will understand why tree rings grow annually in the Sky Islands, what physical factors affect them and how species of tree differ, and what we can learn about the climate and fire history of these forests.

**LEARNING OBJECTIVES:**

* Name at least 5 ways scientists use tree rings to learn information
* Explain what causes rings to form, including why they appear in some trees but not others
* Count tree rings in a core or a cookie, identifying oldest and youngest
* Identify fire or insect scars in cookies, and determine age at the event
* Contrast the widths of rings and hypothesize factors that created the differences in ring widths

**NEXT GENERATION SCIENCE STANDARDS**

*5-LS1-1*. Support an argument that plants get the materials they need for growth chiefly from air and water.

*MS-LS4- 2*. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

*HS-LS1-2*. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

**Science and Engineering Practices:**

*Engaging in argument from evidence*

* (6-8) Construct a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).
* (9-12) Use appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

**Crosscutting Concepts:**

*Patterns*

* (6-8) Students recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They identify patterns in rates of change and other numerical relationships that provide information about natural and human designed systems. They use patterns to identify cause and effect relationships, and use graphs and charts to identify patterns in data.
* (9-12) Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.

**ARIZONA SCIENCE STANDARDS**

*Grade 6, Strand 4: Life Science, Concept 1: Structure and Function in Living Systems*

*PO 6. Relate the following structures of living organisms to their functions:*

Plants

* transpiration – stomata, roots, xylem, phloem
* absorption – roots, xylem, phloem
* response to stimulus (phototropism, hydrotropism, geotropism) – roots, xylem, phloem

**INSTRUCTIONAL PROCESS:**

**PREPARATION**

*Materials*

* Tree cookie outreach kit from Laboratory of Tree Ring Research
* Tree Corer
* Possibly straws for extension

*Setup*

* Find a place preferably with multiple species of tree visible nearby, especially if any are stumps or logs. \* Spread tree cookie examples on the ground.

**INTRODUCTION/ENGAGEMENT:**

*Essential questions*

* What do trees need to grow?
* What information can we learn from tree rings?
* How can we learn about past climate and fire history of the region from the way trees grow?

*Student misconceptions*

* The oldest wood is on the outside, by the bark.
* Trees grow upward from their base.
* All trees have rings, and all are annual rings.

*Learning structure*

* Discussion within a group of any size, often drawing alone or in pairs, followed by practice coring a tree by small groups or individuals with close supervision and assistance from an instructor.

**EXPLORATION**

*Step-by-step description*

* Display one of the tree ring cookies, and lead students through a series of hypotheses and drawings to understand how trees grow and why they have annual rings.
* Detail on “why trees have rings”: Ask why is has these rings. Most students know trees add rings every year, which is a reasonably good approximation at least for many pines in the Sky Islands. Then ask why students think the tree makes rings at all, instead of growing in a smooth monocolor. Show a palm as an example of a “tree” that produces no rings.
* Have students draw pictures on blank pages of their field journal to support their hypotheses about the way rings are made and the differences in the ways these trees grow. They should show these drawings to a partner or to a small group and explain their reasoning. One or more pairs should explain their hypothesis to the group, and the instructor should lead them toward the explanation that water and sugar are transported on the very outside, and the tree is always making new layers of wood just under the bark. So the newest wood is on the outside. Ask if this new information changes their hypotheses about tree growth and give them time to draw a new picture and discuss with their neighbor if time permits. Next provide the information that wood color changes based on the rate of growth: faster growth leads to less dense, lighter colored wood. Recalling that we started out knowing tree rings are annual alternations of fast and slow growth, see if students can hypothesize what causes these rings, based on drawings or discussion. Lead them toward understanding that alternating summer and winter creates alternations of fast and slow growth, or visible rings.
* Based on their new knowledge of how trees grow (adding wood to the outside, fast growth looking light), ask students to look at several examples of tree cookies and determine the approximate age of the tree when the cookie was cut. Ask them to find records of unusual events in the tree’s life. These might include particularly good or bad years for growth (marked by thick or thin light colored bands), fence nails being driven in (bits of metal), insect attacks (rounded holes), fire scars (blackened marks), or anything else unusual. Have students justify how they determined how they identified these events, and when they occurred, recording or even drawing them in their field journals.
* Show students tree cookies from several different trees, such as pine and aspen. Ask students to hypothesize reasons why the rings appear different, even drawing their hypotheses. Discuss differences in the structure of different species. Maybe include examples from mesquite or saguaro that do produce rings, but not annually. Have students hypothesize why these species show such different patterns and discuss their modes of growth and the seasons they experience.
* Finally core trees or logs if a corer is available. Have students guess how many rings they will see based on the thickness of the trunk, and all participate in turning the corer, and smelling the core. (Be sure to use a pine, as oak trees are hard enough to damage hand corers.

**APPLICATION**

*Why does it matter?*

* Tree ring science was founded by an astronomer who wondered whether the sunspots affected tree ring width. Although sunspots turn out not to affect tree growth rates, climate and other factors do.
* This is how we reconstruct historical climates and fire histories of a landscape to understand the changes we are causing to landscapes and to help forecast how they will change in the future.

*Extensions and/or follow-up activities*

* Inquiry projects for multi day programs could use tree coring as a method.
* Students can tour the Laboratory of Tree Ring Research’s exhibits in their new building on the main UA campus and learn about other ongoing research projects in the Sky Islands.
* Ask students why trees might grow lighter wood early in the season and darker wood later in the season. Suggesting they think of the xylem (water sap tubes) in a tree like a drinking straw. Make hypotheses about what are the benefits and costs of having larger diameter straws, making the analogy to tree xylem. Pass around straws of different widths to test these hypotheses.

(Ben's basic explanation of the difference is: "The basic argument is that large tubes (less dense wood) is more adaptive in the early season, when water is generally more available. Using more water allows more growth. But in the late season, water is less available, which means trees need to pull harder to transport it from the soil (more extreme water potentials). This increases the risk of catastrophic gas bubble formation in the xylem (embolism), destroying its water transport function. This risk can be reduced by reducing the size of the tubes and effectively making denser wood. The analogy is to suck on a straw - a bigger straw is easier to collapse. The net effect of this physical tradeoff is that it is generally adaptive for late-season wood is denser, making it appear to have rings. However different groups of plants (angiosperms vs gymnosperms) have evolved different kinds of xylem (gymnosperms have torus-margo structures that can act like emergency stoppers) that offer different solutions for embolism prevention and recovery, and this complicates the story.")

**ASSESSMENT**

*How will you determine if students “got it”?*

* Ask students to explain or draw the structure of how a tree grows, comparing and contrasting different species and locations.
* Ask students to determine how old a tree was at a particular fire or insect attack or particularly good year – do they begin counting at the middle?