**Modules in Ecology and Evolution Development**

**Dendrochronology Lesson**

**Field: Forest Science**

**Target Grades: 3**

1. Background

 a. Learning Goals

* Students will understand main controls on tree growth (e.g. light, nutrients, water, competition)
* Students will understand the principal of limiting factors (e.g. often one controlling factor limits tree growth)
* Students will identify that there are different limiting factors on tree growth in different habitats around the world (e.g. arid, semi-arid, temperate, tropical)
* Students will think about other influences on tree growth (e.g. insects, fire, humans, etc.)
* Students will learn how dendrochronologists (dendro = tree, chronos = time, logos = the science of) determine the age of tree and learn about forest history (dendrochronology often depends on rainfall as the limiting factor to reconstruct past climate)

b. Topic(s) of module

This module discusses important factors for tree growth and relates this to how and why different species of trees grow in different habitats through adaptation. This module then demonstrates how the field of dendrochronology helps scientists understand how old trees are, how trees grow and learn more about forests and forest history.

c. Importance and wider links

Knowing about the history of trees and forests is important because it can help scientists see back in time. For example, through dendrochronology, scientists know about past climate trends and that recent climate changes have no historical precedent. It helps scientists understand that humans are having a major impact on the world’s forested ecosystems through climate change and deforestation. Because trees and forests are important for many things to us (such as clean air, clean water, forest products, recreation, amenity, etc.), learning about the history of forests also helps scientists to better understand how to restore degraded forest ecosystems and conserve forests for future generations.

 d. References and further information

* Bergman, J. 2011. *“Build a tree” Dendrochronology Activity*. Windows to the Universe. Retrieved from: http://www.windows2universe.org/earth/climate/dendrochronology\_build\_tree.html
* Grissino-Mayer, H. 2016. *Principles of Dendrochronology*. The Science of Tree Rings. Retrieved from: <http://web.utk.edu/~grissino/principles.htm#2>
* National Park Service. *Dendrochronology.* WebRangers. Retrieved from: <https://www.nps.gov/webrangers/activities/dendrochronology/>

2. Materials

* If possible, have a poster-board that shows a tree, with different elements that can attach to the area around the tree (e.g. via Velcro, or tape), including for the sun, soil, water, another tree, insects, humans, and fire. This is to both explain (audio) and show (visual) the different elements that can impact the growth of trees. Alternatively, if you can be outside, have students look at different trees and think about how they may be different in age and what factors (as above) may be responsible for the tree’s growth.
* A tree cookie (or a few, to pass around to the students). Tree cookies are available from the UBC Beaty Biodiversity Museum (can be used if in the museum) or there are many examples of these online to print out. It is helpful to have tree cookies of different sizes that are similar in age to demonstrate how external factors control tree growth.
* One sample tree-cookie worksheet per student. This can be varied depending on the age of the students (e.g. for age 8 the tree might have 8 rings on it) or the one attached may be used – see last page for example
* Coloring implements (pens, pencils, etc.) or other materials (e.g. sand, glitter, etc.) to fill in the tree rings (if desired)

3. Procedure

 a. Pre-assessment

* Tell students that trees are living things and that, like people, they need certain things to survive. Ask (using the poster board) what things trees need to survive: sun, nutrients/soil, water. Briefly explain that these elements are not completely available in all habitats, which is why there are fewer trees in really dry locations or really cold locations.
* Ask students what they think happens to trees as they grow older (*they get bigger* - if you’re able to be outside looking at trees of different sizes that is ideal). Each year a tree grows, it adds another growth ring. The conditions (e.g. rainfall, sunlight, etc.) might be different every year, so not every growth ring is exactly the same. Dendrochronologists use these different growing patterns to tell what happened in a tree’s life. They depend on the ‘principal of limiting factors’, which means that a tree’s growth is usually limited by one factor, often moisture availability.
* Ask students to look at two tree cookies of different size and pick which one is older. If you have two that are different in size but similar in age, again ask what things trees need to survive and what other things (as below) might influence tree growth
* Ask (using the poster board) what other things might influence tree growth: insects/pathogens, fire, humans, competition with other trees

b. Participatory learning

* Pass around sample tree cookies. Ask students what they think influenced that tree’s growth
* Provide students with the sample worksheet of a tree cookie (or draw their own). Ask them to count the rings to determine how old the tree is and to identify the years when there might have been a lot of rainfall (*wide rings*) or very little rainfall (*narrow rings*).
* Students can color in this sample using similar colors for similar size rings (e.g. wide rings in blue, narrow rings in pink)

c. Post-test

* Come back to the group to ask the students how old the tree was and in which years there was a lot of/little rainfall

d. Summary

* Ask students how old they think the oldest known tree is (almost 5000 years old – a bristlecone pine tree in California called Methuselah). Tell students that trees this old help us understand things about the climate back in time.
* Learning about trees and our forests also help people to protect trees from changing climates and deforestation

3. Make it your own

 a. For older students

* Have them draw their own tree cookie depending on how old they are. Ask them to draw the rings of different widths and then describe the pattern they drew according to the elements trees need for growth
* Introduce the concept of cross-dating (e.g. using trees of different ages to extend the history of trees back in time). The *Lesson Plan Ten What Can We Learn from Old Trees?* by C. Judson (cited below) has a useful cross-dating activity for students. Cross-dating can also involve math and calculations, such as determining the date that each tree established by subtracting it’s age from the current year.

b. For younger students

* Simplify the module to only discuss sunlight, nutrients and water (not including other elements such as fire, disease, etc.)
* The ‘principal of limiting factors’ does not have to be made explicit

**My Tree Cookie**

**Name:**

**How old is this tree? \_\_\_\_\_\_**

**How old are you? \_\_\_\_\_\_\_**

**How old was the tree when you were born? \_\_\_\_\_\_\_**

**(hint: subtract your age from the tree’s age)**

**How old was the tree when it grew really fast? \_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**How old was the tree when it grew very slowly? \_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Why do you think the patterns of growth are different? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**