Dendrochronology- A Guided Tour Teacher's Guide

Dendrochronology- A Guided Tour is designed to be a student investigation into the environmental science of crossdating tree rings. There are five lessons, which can be completed in 5-10 class periods.

1. Reading the Landscape (1 sessions)
2. Natural History Jigsaw (2 sessions)
3. Understanding growth rings (2-3 sessions)
    a. Coniferous
    b. Ring porous
    c. Diffuse porous
4. Crossdating Background Information (1 session)
5. Crossdating Cores Activity (2-3 sessions)

Lessons can be worked through independently, in small groups, or as teacher directed lessons. Each lesson includes background information and interactive components. Ending each session with student sharing and class discussion is recommended.

Materials Needed

- Rulers
- Chromebooks/ phones for digital images
- Digital images https://storm-stories.netlify.app/
- Pencil
- Natural history handouts
- Student worksheet packets

Procedure

Lesson 1: Reading the Landscape

- Students can work individually or with partners.
- First, direct students to read the directions pages 1-2, and to follow the prompts to write down features they notice in the trees and landscape.
- Allow 3-5 minutes for students to discuss and write reflections.
- Then, pass out pages 3-4. Review the information by reading aloud, having students take turns reading aloud, or by directing the students to read to themselves. Discuss the tree and landscape features, and have students reexamine the photographs on pages 1-2, and write down new features they notice in the box at the bottom of page 4.
- Project the images from pages 1-2, and have students come forward and point out features they notice that might indicate past windstorm involvement.

V shapes in trunks

Leaning trunk ↓

Nurse Log - moss covered base
Visible roots
Leaning trunks

Lesson 2: Natural History

- Students can work individually or with partners.
- First, direct students to read the directions on page 5.
- Assign students or groups to an natural event and supply with a printed a digital copy of the corresponding source (or have students search for their own sources):

1. 1938 New England Hurricane
2. 5-year drought (1963-1967)
3. 1953 Worcester Tornado
4. 1981 spongy moth outbreak

- Direct students to follow the directions on page 5, and to fill out the appropriate row on the chart found on page 6 as they read their source.
- When students finish reading and filling out the chart, transition students to creating slides to share their information with the group.

- Give students time to share their slides with the whole group. Students should record the information about the events on their charts as they listen.
- When groups have shared and all charts are complete, remind students that the tornado, hurricane, drought, and spongy moth infestation are only four examples of natural events that might impact a forest. Brainstorm other events to wrap-up. Ideas include unusual low temperatures/ frost events, heat waves, volcanic activity, other windstorms such as derechos or microbursts, floods, ice storms, wildfires

Timeline of Events in MA That Could Impact Tree Ring Growth

Date	Event	Evidence in Tree Rings*	Sources
1930-1932	Eastern US Drought	Narrow rings, although the entire decade of 1930s is narrow in many species	Don Davis and for 1930-https://pubs.usgs.gov/wsp/0680/report.pdf
March 1936	Great NE Flood	Likely not evident in tree rings	Don Davis (HF), Road sign in Hadley rt 47
July 1936	Flash Drought & Heat Wave	Narrow ring	https://stateclimate.org/pdfs/journal-articles/2020_4-Hunt.pdf Shows up as dry year in drought reconstruction for greater Hudson River Valley of eastern NY State (Neil Pederson)
Sept. 21, 1938	Hurricane	Narrow, +/- white, dark	https://www.weather.gov/okx/1938HurricaneHome
1945	Spongy Moth Outbreak	Narrow, white	https://www.researchgate.net/figure/Historical-records-of-area-defoliated-by-the-gypsy-moth-in-five-New-England-states_fig1_227273741
1953	Worcester Tornado	Narrow	https://www.masshist.org/beehiveblog/2021/06/the-great-worcester-tornado-of-1953/

May, 1954	Suspected frost event following warm spring April	Discolored, Missing or deformed pores in earlywood	Temperature data confirms warm April and May temps into low 30s
1963-1967	5-year Drought		https://www.telegram.com/story/news/local/east-valley/2017/02/11/1960s-drought-still-holds-record-in-region/22455516007/
1981	Spongy Moth Outbreak-largest defoliation in MA history	Narrow, white	https://www.mass.gov/doc/spongy-moth-factsheet/download And https://www.researchgate.net/figure/Historical-records-of-area-defoliated-by-the-gypsy-moth-in-five-New-England-states_fig1_227273741
July-Sept. 2010	Mild Drought		https://www.mass.gov/doc/drought-status-history-0/download
June 2016-March 2017	Drought		https://www.mass.gov/doc/drought-status-history-0/download
2015 - 2018	Spongy Moth Outbreak caused by prolonged dry conditions	Narrow, white	https://www.mass.gov/doc/spongy-moth-factsheet/download
May-Nov 2020	Drought, reaching significant and critical levels		https://www.mass.gov/doc/drought-status-history-0/download
May 2022-Sept 2022	Drought, reaching significant and critical levels		https://www.mass.gov/doc/drought-status-history-0/download

Lesson 3: Types of Growth Rings

- Students can work individually or with partners.
- Review the key vocabulary at the top of page 7.
- Then, review the information on pages 7-8 by reading aloud, having students take turns reading aloud, or by directing the students to read to themselves.
- Discuss the paragraph on coniferous ring structure on the top of page 9.
- Direct students to read the prompt about coniferous rings and respond in writing in the appropriate box. Share responses. Students should have circled one light and adjoining dark band, and may respond with observations such as the earlywood is larger than the latewood, the wood has visible cells, or the bands are different sizes.
- Move on to read about and discuss ring porous growth ring structure when class is ready. Review the information on pages 9-10 by reading aloud, having students take turns reading aloud, or by directing the students to read to themselves.
- Direct students to read the prompt about ring porous ring structure on page 11 and respond in writing in the appropriate boxes. Share responses. Students should have circled one light porous band, and bracketed one darker band. There are approximately 4.5 years of growth shown on this image. The horizontal ray is darker than most of the earlywood, but lighter than the bulk of the latewood.
- Finally, review the information on page 12 by reading aloud, having students take turns reading aloud, or by directing the students to read to themselves.
- Direct students to read the prompt about diffuse porous rings and respond in writing in the appropriate box. Share responses. There are approximately 100 pores shown between the arrows in this image. Students may reflect that small pores might not be able to transport enough water to keep the plant healthy during droughts.

Lesson 4: Crossdating Rings

- Students can work individually or with partners.
- Review the key vocabulary at the top of page 13.
- Then, review the information on page 13 by reading aloud, having students take turns reading aloud, or by directing the students to read to themselves.
- Direct students to read the prompts about the 1981 growth ring on pages 14 and 15. Allow students time to measure and record results.
- Discuss results. The 1981 growth ring on page 14 is 10mm, while the 1982 ring is 20mm. The difference is 10mm. Additional observations may include that there is very little latewood, the earlywood looks normal, etc.

- The 1981 growth ring on page 15 is 7mm, while the 1982 ring is 20mm. The difference is 13mm. Additional observations may include that there is very little latewood, the earlywood looks more normal, etc.

Lesson 5 : Crossdating Cores Activity

- Students can work individually or with partners.
- Pass out pages 16-18. Students will need these 3 sheets for each core they examine, so be sure to have enough copies on hand.
- Help students open digital images of tree cores for investigation. https://storm-stories.netlify.app/
- Direct students to follow the directions on pages 16-18 to analyze the tree cores.
- When finished, students can share findings with each other, or open a new image and start the analysis process with the new sample.
- Allow for time at the end of each class to share and discuss findings.
- Sample 1 is coniferous and is considered the most straightforward, Samples 2 and 3 are ring porous and of medium difficulty, and sample 4 is diffuse porous and considered the most difficult.
- Sample 1 shows narrow 1981 ring with little latewood, wide rings in the 70s and 60s, 1953 ring shows little earlywood, pith begins around 1947
- Sample 2 shows narrow 1980 and 1981 ring with little latewood, wide rings in the 70s, narrower and darker rings during the 1965 drought, extremely narrow 1953 ring with little latewood, extremely narrow rings during the 30s, followed by wider rings in the 40s indicating growth release following the 1938 hurricane, pith begins around 1898
- Sample 3 shows narrow 1981 ring with little latewood, wide rings in the 70s, narrower rings during the 1965 drought, narrow rings in the early 1950s, followed by an extremely narrow 1953 ring with little latewood, followed by much wider rings showing growth release by the tornado, extremely narrow rings during the 30s, followed by wider rings in the 40s indicating growth release following the 1938 hurricane, pith begins around 1905
- Sample 4 shows narrow white colored 1981 ring with little latewood, narrower rings during the 1965 drought, Narrow rings in the early 1950s, followed by much wider rings starting in 1955 showing growth release by the tornado, pith begins around 1890
- Discuss findings at end of sessions, and remind students that trees tell stories with their growth rings that can be read together with knowledge of the physical appearance of tree and landscape and knowledge of natural history events.

Enrichment
The list includes ideas for further research or cross curricular enrichment.

- Nipmuc culture and history

The Nipmuc People were the original stewards of the land of Central Massachusetts where Slab City Forest is located.
https://collections.americanantiquarian.org/reclaimingheritage/resources/

- Using Increment bores to core trees

Contact Harvard Forest for more information, to schedule a program, or to borrow equipment.
https://harvardforest.fas.harvard.edu/schoolyard-lter-program

- Creative writing

Students examine a tree core and write journal entries or life stories from a tree's point of view. See appendix for an example.

- Core sample drawing

Display pictures of damaged trees from the June 1, 2011 Massachusetts tornado and have students predict and draw what they think a core from one of these trees would look like.

- Listen to RadioLab podcast for more information
  https://radiolab.org/podcast/fellowship-tree-rings

Appendix - Sample Life Story From a Tree's Point of View

I am a sweet birch, *Betula lenta* in Latin. At the height you took the core, my oldest, innermost ring was formed in 1890, when I grew well in a sunny area with everything I needed for photosynthesis.

The 1930s was a difficult decade for growth, as seen in my narrow growth rings. There was a severe drought during the years 1930-1932, and a very dry and hot 1936.

When a tornado passed through my forest on June 9, 1953, I was injured and lost the ability to photosynthesize as much as I would have liked. There was hope for recovery the following season in 1954. We had an early and warm spring. However, things changed drastically in May. Temperatures plummeted into the 30s on May 13, 1954. I believe that this is why my growth rings were so narrow in 1953 and 1954.

I lost many of my tree companions during the tornado. This loss was also a gain, because the canopy opened up and I suddenly had more sunlight and space to grow. This is evident in my wide 1955 and 1956 growth rings.

Another story that I have to share is of the spongy moth caterpillar. This caterpillar likes to devour my leaves, and some years there are so many spongy moth caterpillars that I struggle to make food and tree ring–building materials. Their population was especially high in 1944, 1945, and 1981 as you can see from my narrow growth rings during those years.

I have seen my surroundings change from farm field into forest. I have witnessed and survived many events. I wonder what I will experience and record in my tree rings next.

Sources

Books

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Tornadoes in Massachusetts since 1950 | burlingtonfreepress.com

May 2024 Tornadoes Report | National Centers for Environmental Information (NCEI) (noaa.gov)

www.https://extension.psu.edu/

https://www.mass.gov/doc/drought-status-history-0/download

https://www.nature.com/scitable/knowledge/library/water-uptake-and-transport-in-vascular-plants-103016037/#:~:text=Both%20sub%2Dzero%20temperatures%20and,in%20the%20water%20column%20increases.

Anatomy of a Tree (National Arbor Day Foundation)

https://botanicgardens.uw.edu/wp-content/uploads/sites/7/2018/12/Trees-and-Storms-pub08-24.pdf

https://harvardforest1.fas.harvard.edu/publications/pdfs/Spurr_Ecology_1956.pdf