



## M18 & H17. History of Stand-replacing Fire

**Lesson Overview:** Students use information from 11 cross-dated increment cores to figure out the approximate age of a forest stand that originated after stand-replacing fire.

**Lesson Goals:** Understand how scientists can estimate the time when a stand-replacing fire occurred. Be able to assemble and interpret a *stand history diagram* and discuss evidence for a stand-replacement *fire regime*.

**Objectives:**

- Students can follow technical directions to record observations and contribute their information to a class diagram that shows the history of a forest stand.
- Students can describe the fire history shown by a stand history diagram that contains cohorts of trees.

**Subjects:** Reading, Writing, Speaking and Listening, Math, Science

**Duration:** one 30- 40-minute session

**Group size:** Whole class 

**Setting:** Classroom

**Vocabulary:** *fire regime, stand history diagram*

ABOUT STUDENT PRESENTATIONS: If you did **Activity M11 or H14**, this would be a great time for the presentation **on a species with serotinous cones, such as lodgepole pine.**

Middle School Standards:		6th	7th	8th
CCSS	Writing	2, 7, 8, 10	2, 7, 8, 10	2, 7, 8, 10
	Speaking/Listening	1,2,4,6	1,2,4,6	1,2,4,6
	Language	1, 4, 6	1, 4, 6	1, 4, 6
	Writing Science/Tech	3,4,7,9,10	3,4,7,9,10	3,4,7,9,10
NGSS	Interdependent Relationships in Ecosystems	LS2.A		
	Cycle of Matter and Energy Transfer in Ecosystems	LS2.C		
	Weather and Climate	ESS2.D		
	Natural Hazards	ESS3.B		
EEEEGL	Strand 1	A,B,C,E,F,G		
	Strand 2.2	A		

High School Standards:		9th	10th	11th	12th
<b>Common Core ELA</b>	Writing	2, 7, 10		2, 7, 10	
	Speaking/Listening	1, 2, 4, 6		1, 2, 4, 6	
	Language	1, 4, 6		1, 4, 6	
	Writing Science/Tech	7, 8, 9, 10		7, 8, 9, 10	
<b>NGSS</b>	Interdependent Relationships in Ecosystems	LS2.A			
	Ecosystem Dynamics, Functioning, and Resilience	LS2.C			
	Weather and Climate	ESS2.D			
	Natural Hazards	ESS3.B			
	Human Impacts of Earth Systems	ESS3.C			
	Global Climate Change	ESS3.D			
<b>EEEEGL</b>	Strand 1	C,E,F,G			

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**Teacher Background:** In this activity, students continue to build their skill in using trees' annual rings to figure out a forest's fire history. They use increment cores collected for the following study:

Heyerdahl, Emily K.; Loehman, Rachel A.; Falk, Donald A. 2014. Mixed-severity fire in lodgepole pine dominated forests: are historical regimes sustainable on Oregon's Pumice Plateau, USA? Canadian journal of forest research. 44(6): 593-603.

Each team determines the years of the earliest and final annual rings on a photo of an increment core. Then the class compiles the information from 11 cores into a stand history diagram. This is a vivid quantitative way to depict the history of a forest. Stand history diagrams will be used in the next two activities; by the end of **Activity M20 & H19**, students will be able to use a stand history diagram to describe the historical fire regime of a forest.

Scientists use dendrochronology to learn about the historical pattern of stand-replacing fire by analyzing the ages of all of the mature trees in a stand. If most of the trees originated within a few years of each other, they are generally considered a cohort. However, not all cohorts are initiated by fire. To figure out what disturbance allowed so many trees to establish in such a short time, scientists look for additional evidence: For example, cut stumps suggest logging; the presence of large numbers of old logs (without scorched wood) suggests windthrow; the presence of scorched wood and charcoal in the soil suggests fire.

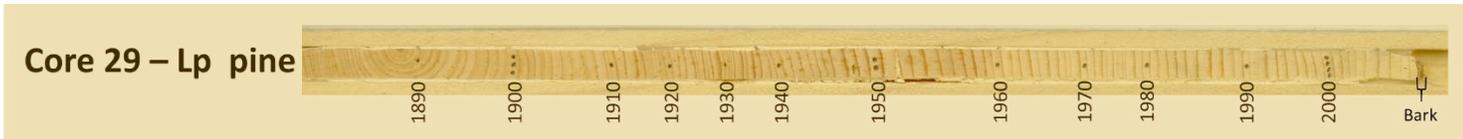
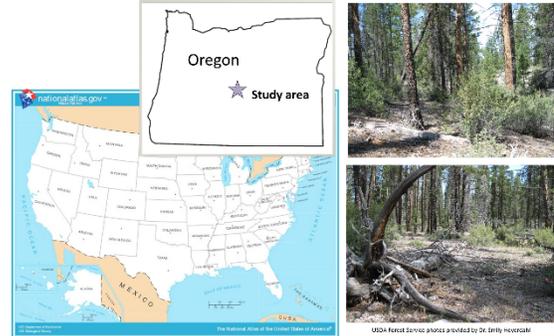
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**Materials and preparation:**

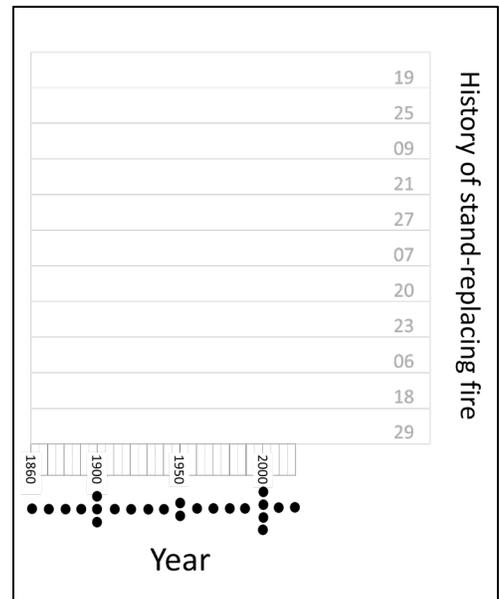
1. Project **PotholesStudyArea.pptx**, which shows a map and photos of the area where the increment cores and tree cookies used in FireWorks were collected.
2. Find in the trunk: 11 photos of increment cores. (These are about 20-40 cm long and quite narrow. An example is shown below.) They may be in the same case as the photo posters of fire-scarred tree cookies. The core photos can also be printed from **IncrementCorePhotos.pptx**.

**Tree cookies, increment cores, and fire history data are from research on the Deschutes National Forest, central Oregon:**

Heyerdahl, Emily K.; Loehman, Rachel A.; Falk, Donald A. 2014. Mixed-severity fire in lodgepole pine dominated forests: are historical regimes sustainable on Oregon's Pumice Plateau, USA? *Canadian Journal of Forest Research*. 44(6): 593-603.



3. Find in the trunk and display the background poster for the stand-replacing stand history diagram, shown on right. It is also available for download from **FireHistBackground\_stand-replacing.pptx** (right-hand side). Students will attach their timelines (next step) to this background poster. We suggest laying the background poster on a large table or on the floor for assembly. Have tape available for attaching the students' timelines that represent individual cores.



4. Prepare timelines for students to use in constructing the stand history diagram by doing one of the following:
  - **OPTION 1.** Use 11 of the laminated timeline strips provided in the trunk (shown below – they are actually about half a meter long). Provide 1/team. These can also be printed from the left-hand side of **FireHistBackground\_stand-replacing.pptx**. If you use this option, each team will also need a copy of the half-page **Handout M18 & H17-1. Record tree history on a timeline** and a dry-erase marker, preferably the same color for every team. To clean the strips after they are used, you will also need a cloth, an eraser, and cleaning fluid.

Timeline (1860-2000)				Tree number	Species	No. fire scars	Av. fire interval (years)
[Timeline grid with years 1860, 1900, 1950, 2000 marked]						0	X

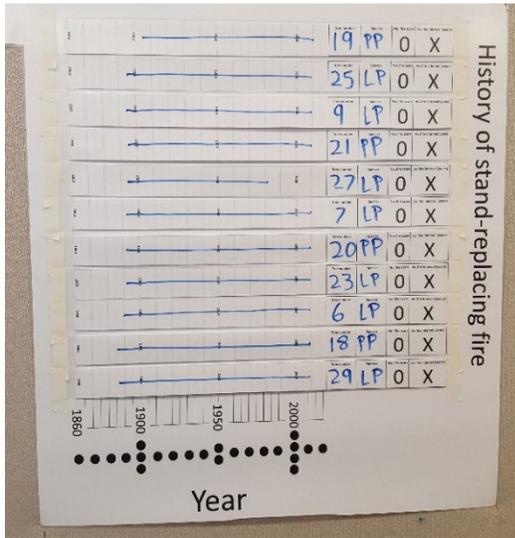
- OPTION 2. Make 11 copies (1/team) of *FireHistTemplate\_stand-replacing.pptx*, one for each team. Each team will also need scissors and tape.

5. Make 1 copy/student of **Handout M18 & H17-2. You find an older cohort!**

**Procedure:**

1. Explain: In the last activity, we learned how fire historians use dendrochronology to learn how many fires have occurred in past centuries and how severe the fires were. In this activity, we'll use dendrochronology to figure out the history of STAND-REPLACING FIRE in a forest in central Oregon. Refer to the projection of *PotholesStudyArea.pptx*.
2. Explain: Once we figure out the historical fire regimes for forests in this particular area – that is, the frequency, severity, and spatial uniformity of past fires - we'll be able to understand fire regimes of the ecosystem(s) that we've been studying. We can use what we learn to address one of the most important questions about today's forests, the question that we asked at the start of the last activity: "Are our forests OK, or are today's wildfires destroying them?"
3. Hand out to each team: a photo of an increment core, plus EITHER (1) a dry-erase marker, a blank timeline, and a half-page handout with instructions (**Handout M18 & H17-1. Record tree history on a timeline**) or (2) a copy of *FireHistTemplate\_stand-replacing.pptx*.
4. Have the students place the rings so they can read the print from left to right. Have them examine their cores as you explain:
  - a) Dendrochronologists have already dated each of these increment cores. They used small dots to mark the ring at the start of every decade. They also marked the earliest ring on the core – usually the pith – with a short black line. Find this line near the left end of your core.
  - b) The most recent ring is at the right end of your core. Find this ring. Ignore any bark that lies outside (to the right of) the annual rings.
  - c) Count rings to the left of the earliest dot to figure out the earliest year shown on your core. Count rings to the right of the most recent dot to figure out the most recent year.
  - d) Transfer that information to your timeline, as instructed on your half-page handout, and place the timeline on the class's stand history diagram background.

- Have students follow the instructions on the handout and add their completed timeline to the background. When all are completed, it should look something like this. Data are on the right.



Species	Tree number	Earliest date	Final date
Lodgepole pine	6	1890	2009
Lodgepole pine	7	1902	2009
Lodgepole pine	9	1895	2009
Ponderosa pine	18	1887	2009
Ponderosa pine	19	1906	2009
Ponderosa pine	20	1893	2009
Ponderosa pine	21	1895	2009
Lodgepole pine	23	1893	2009
Lodgepole pine	25	1896	2009
Lodgepole pine	27	1894	1982
Lodgepole pine	29	1887	2009

- Review/Ask: What is a cohort? Give an example. **A cohort is a group of living things that are all about the same age. Our class is a cohort.**
- Explain: Dendrochronologists figure that a lot of trees that all got established in a short time constitute a cohort. Scientists decide what “a short time” is depending on the location and growing conditions. In the study we’re using, the scientists decided on about 20 years to define a cohort. Do the trees in our increment cores form a cohort? **Yes, because all of the trees became established within a 20-year period (between 1887 and 1906).**
- Ask: How might a fire have gotten this cohort started? **The cohort could have become established after the overstory trees were killed by a stand-replacing fire, perhaps a crown fire. That would have made excellent conditions for young pines to germinate and start growing. What other events could have started the cohort? Possibilities include a pine beetle epidemic, logging, or a severe wind storm....** How could we be certain that fire was the cause? **Find other clues, like fire-scarred trees or charcoal in the soil or a nearby bog.**
- Summarize: Remember the name for the pattern of fire frequency and severity over a long time: a fire regime. Our increment cores suggest that the forest we’re studying had a STAND-REPLACING fire regime. How certain can we be about that? **We should probably be cautious about that conclusion, since we only have 11 samples and only 1 cohort. It would be better if we could go deeper into the past and get more samples.**
- DON'T TAKE THE STAND HISTORY DIAGRAM OR THE STUDY AREA PROJECTION DOWN YET. YOU'LL NEED THEM BOTH FOR THE NEXT 2 ACTIVITIES.**

**Assessment:**

1. Explain: Now we'll get a little more practice at discovering a history of stand-replacing fire.
2. Give each student a copy of **Handout M18 & H17-2. You find an older cohort!** and have them complete the assignment.

**Evaluation:**

	<b>Excellent</b>	<b>Good</b>	<b>Poor</b>
<b>Format</b>	Used correct business letter format	Used letter format	Did not use letter format
<b>Writing</b>	Writing is clear. Used full sentences. Used topic sentences for paragraphs.	Writing is clear. Used full sentences.	Writing is unclear or sentences are incomplete.
<b>Content:</b>			
Identified period when old cohort began growing	approximately 1770-1785	approximately 1770-1785	One or both dates inaccurate by more than 5 years.
Identified possible cause for beginning of old cohort	Old cohort could have started after fire, but we don't have charcoal evidence for a fire around 1770. Other possible explanations include wind storm and beetle epidemic.	Old cohort could have started after fire (or other cause). Did not discuss lack of evidence for fire.	Did not suggest a reasonable cause for beginning of old cohort.
Identified year of death for old cohort	Most of the trees died around 1877, although two of them died earlier.	Most of the trees died around 1877.	Date inaccurate by more than 5 years.
Gave explanation for death of old cohort	Fire was probably the cause, since so many of the logs in this cohort were black and charred.	Fire was probably the cause, since so many of the logs in this cohort were black and charred.	Did not identify a cause or did not explain evidence.
Connected death of old cohort to beginning of more recent (1887-1906) cohort	Old cohort was killed by stand-replacing fire around 1877, which is about 10 years before the earliest date in the cohort that we described in class. The fire that killed the trees in the old cohort may have cleared the way for establishment of the new cohort between 1887 and 1906.	Explained that old cohort died just before the more recent cohort began growing but did not explain the possible connection between the two.	Did not identify a reasonable explanation for the relationship between the two cohorts.

## Handout M18 & H17-1. Record tree history on a timeline

Using a dry-erase marker, record the fire history of your tree core on your timeline:

1. Record your tree's number and species in the correct boxes at the right end of the timeline. Use "PP" for ponderosa pine and "LP" for lodgepole pine. Make the print large so people can see it from across the room.
2. Find the tiny pencil-marked dots on your increment core. Find the left-most dot and its year (written below the dot). Count the rings to the left to figure out your core's earliest year, but don't count rings to the left of the pith (marked with a vertical line).
  - On your timeline, draw a vertical bar to show that year.
3. Find the right-most dot on your increment core and its year. Count the rings to the right to figure out your core's final year.
  - On your timeline, draw a vertical bar to show that year.
4. Draw a dark horizontal line to connect the 2 vertical bars.



Attach your core's timeline to the poster that has information from all increment cores:

5. Find your core's number on the poster.
6. Attach your timeline to the poster right on top of your core's number and the box it is in. Carefully line up the edges of your timeline with edges of the box.

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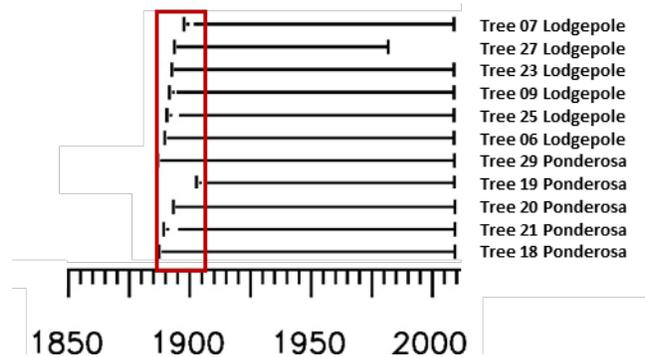
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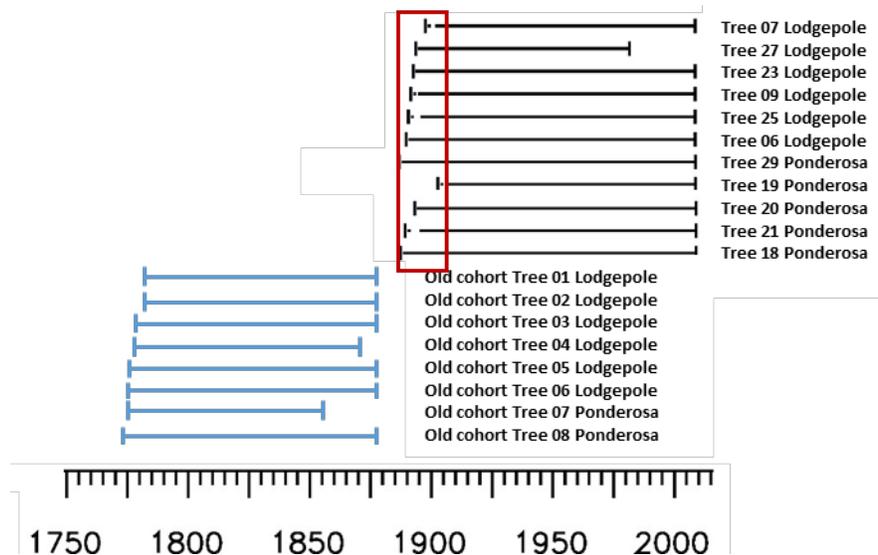
## Handout M18 & H17-2. You find an older cohort!

Name: \_\_\_\_\_

At right is a copy of the stand history diagram that you completed in class. The trees are in a different order, but their timelines are the same. A red outline shows the cohort of trees that you identified in class.



Suppose you go back to the place in central Oregon where those 11 cores were collected and find 8 fallen logs buried in the ground. These were not sampled in the earlier study, so they provide new information. The logs look very old. Their bark is all gone, but they are not rotten. Many of them have black char on the outside of the wood. You collect increment cores from all of them. You return to the lab and cross-date them to find the years of their earliest and most recent annual rings. Then you add your new data to the class's stand history diagram. Now it looks like this:



You have found evidence that there was a cohort of trees that started back in the 1700s! Call it the "old cohort." Write a letter to the scientists who did the original research. In the letter, explain:

- When your "old cohort" started growing (give a range of dates)
- What may have caused the old cohort to start growing (do you have any evidence for that?)
- When the old cohort died
- What probably caused so many trees in the old cohort to die at one time (do you have any evidence for that?)
- How your discovery might explain what caused the 1887-1906 cohort of trees (the ones in the gray shaded box) to start growing.