Data Puzzles

Wildfire, Drought, and the Future of Forests - Teacher Guide

Setting the Stage

As part of a 2017 study, Dr. Camille Stevens-Rumann and her team of scientists sought to determine how a changing climate (drier) over the last several decades impacted post-fire tree regeneration. To answer this question, these scientists measured the regrowth (or lack thereof) of conifer seedlings (young, small trees) from 1485 burn sites across the US Rocky Mountains that were affected by fires during the 1985-2015 time period. The results of this study suggest that seedlings have a hard time regenerating (regrowing) in warm/dry conditions. In a future projected to be warmer and drier, we may see landscapes that were forested before a wildfire, transition to grasslands and shrublands after being burned if conifer seedlings are unable to grow back.

Photo Description: University of Colorado Boulder researcher Monika Rother squats next to a seedling (young tree less than 3 feet tall) at the site of the 2000 Walker Ranch fire in Boulder, CO. Photo from the University of Colorado Boulder.

Lesson Overview

In this Data Puzzle, students analyze and interpret post-fire conifer tree regeneration data from 1485 burn sites across the US Rocky Mountains to discover that conifer seedlings have a harder time growing back after a wildfire when climate conditions are warm and dry than when climate conditions are cool and wet.

Part 1 – (20 minutes) Eliciting Students' Ideas
Access students' prior knowledge about an opening scenario.

Part 2 – (40 minutes) Identifying Important Science Ideas
Students engage with a contemporary science investigation through an interactive reading in which students are tasked with 1) making connections between the science investigation and the opening scenario, and 2) identifying an investigative question.

Part 3 – (40 minutes) Supporting Ongoing Changes in Thinking
Students test/compare their current understandings of the investigative question against authentic data.

Part 4 – (40 minutes) Constructing Evidence-Based Explanations
Students finalize new understandings as they relate to the investigative question to create an explanatory model.

Data Puzzles

Instructional Overview	
Grade Level	Middle/High School
Instructional Time	~180 minutes
Building Toward	**Disciplinary Core Ideas:** ● ESS3.B: Natural Hazards **Science and Engineering Practices:** ● Analyzing and Interpreting Data ● Obtaining, Evaluating, and Communicating Information **Crosscutting Concepts:** ● Patterns ● Cause and Effect **Performance Expectations:** ● MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. ● HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
Driving Question	● *How do climate conditions impact the recovery of forests after a wildfire?*
What Students Will Do	● Analyze and interpret post-fire forest recovery datasets to identify conifer tree regeneration patterns ● Construct a model to explain the relationship between drought (cause) and post-fire tree regeneration (effect) in the northern Rocky Mountains
Materials	❏ Slide deck ❏ Student worksheet ❏ Answer Key ❏ Optional Succession rock--paper-scissors instructions
Material Preparation	❏ Print student worksheets ❏ Review presenter notes in Slide deck ❏ Review Answer Key ❏ Review the Succession rock--paper-scissors instructions ❏ Gather public record materials (e.g., butcher paper and markers, whiteboards, Google Doc, etc.)
Vocabulary	● Serotinous Cones - cones that open and release seeds only when a fire sweeps through and melts the resin (adhesive) keeping the cone closed. ● Succession - series of steps by which life comes back after a disturbance (e.g., wildfire) ● Seedling Presence - % of field sites where the same number (or more) conifer seedlings regrew after the wildfire

	• Seeding Absence - % of field sites where no seedlings grew back after the wildfire
Teacher Strategies	• Slow Reveal

Part 1 - Eliciting Students' Ideas

10 minutes

1. (Slide 4) Utilize the slide deck to introduce the Data Puzzle and explain that the purpose of the opening scenario is to identify times in the students' own lives where they may have experienced ideas/concepts similar to what they will explore later in the Data Puzzle.

2. Facilitate a whole-class discussion around the prompt, "*Wildfires are a natural part of ecosystems, forests in particular, across the United States. Imagine you were on a hike and happened across an area that had just experienced and looked like the image below. What would you expect this same area to look like if you came back in 5 years? 10 years? 20 years?*"

Teacher Tip: Listen for student resources (ideas, experiences, language) that you could connect with the concept of post-fire succession and factors (e.g., precipitation, temperature, drought, availability of seeds) that could impact whether or not a forest recovers after a wildfire.

3. (Slide 5) Have students discuss the factors that control whether or not a fire grows back after a wildfire and whether it matters if a forest grows back.

Create a public record of student responses to refer back to throughout the lesson to strengthen student connection to and allow students to track the revisions to their thinking throughout the lesson.	
Possible Teacher Prompts	*Possible Student Response*
• *What might forests look like 5 years? 10 years? 20 years? After a wildfire?*	• *5 years: maybe small trees/shrubs, some wildlife, still "open"; 10 years: bigger trees, less small plants 20 years: big trees looks/feels like a forest again*
• *What factors might control whether or not this forest grows back after a wildfire?*	• *Water, sunlight, soil conditions, nutrients, pollinators*
• *Does it matter if a forest grows back after a fire?*	• *Yes - forests are important for wildlife and resources, No - part of life, gives other living things a chance to grow*

4. (Slide 6) Introduce students to Dr. Camille Stevens-Rumann, the scientist featured in this Data Puzzle, who studied more than 1485 sites in the northern Rocky Mountains that were burned between 1985-2015 to observe and measure how life returns (or doesn't return) after a wildfire.

Part 2 - Identifying Important Science Ideas

30 minutes

1. (Slide 8) Show Why certain naturally occurring wildfires are necessary (4:20 minutes) to provide context for the puzzle plot.

2. (Slide 9) Students read the puzzle plot text included in the student worksheet either individually, in small groups, or as a whole class. While reading, students are asked to do the following tasks:
   a. Circle the investigative question the scientists are investigating.
   b. Identify similarities between the reading and the opening scenario.

3. Option to play succession rock-paper-scissors as a whole class following these directions (also linked in the student worksheet).

4. (Slide 10) Facilitate a whole-class discussion to help make connections between the reading and the opening scenario by utilizing the following prompt:
   a. *Do you think there are similarities between the post-fire succession patterns described in the reading and your predictions to how an area might grow back 5, 10, 20 years after being burned by a wildfire?*

> **Purposeful Conversation Pointer**
> The purpose of this whole class conversation is to relate the reading and opening scenario to each other **and** to the larger science ideas of successional patterns and how forests have adapted to live with fire. Referring back to student ideas from the opener will enhance students' understanding of the broader phenomenon and create coherence between each part of the lesson.

5. (Slide 11) Students summarize important science ideas presented in the Puzzle Plot by describing the different climate conditions that existed between the 1985-1999 (*cool/wet*) and 2000-2015 (*warm/dry*) time periods.

6. Students make a prediction for the investigative question, *How do climate conditions impact the recovery of forests after a wildfire?*, that they will test in Part 3 by analyzing real data.

Part 3 - Supporting Ongoing Changes in Thinking

50 minutes

1. (Slide 13-16) The datasets students will analyze were collected by the featured scientist, Dr. Stevens-Rumann and her team of fire ecologists. Use the images in the slide deck to introduce and define the presence and absence of seedling datasets.

2. (Slides 17-20) Use the prompts embedded in the slide deck to help orient students to the regrowth of seedling and absence of seedling data collected from 1485 burn sites in the northern Rocky Mountains. Remember, Dr. Davis and her team are comparing the regrowth of seedling and absence of seedling data (measures of post-fire forest recovery) at sites that burned and "recovered" during the cool/wet 1985-1999 time period to the sites that burned and "recovered" during the warm/dry 2000-2015 time period to see what role, if any, climate plays in post-fire forest recovery.

Data Sensemaking Spotlight - Describe Visual Patterns

In the "Slow Reveal" strategy, students look at one graph multiple times. Each time, more of the graph is revealed to the student. With each new reveal, students are given an opportunity to think differently about the data being presented. By trying to describe the pattern(s) you notice with words, you start building a vocabulary of common pattern types that you and others will recognize and be able to give meaning to. Things to look for in describing patterns include clumps of data values, gaps without data values, direction of data values, and comparing groups of data values.

Listen for…

- *On the top bar (1985-1999) more seedlings regrew than not at about 70%.*
- *On the bottom bar (2000-2015) it is closer to 50% regrowth or not.*
- *The top bar represents when it was wet/cool climate conditions, the bottom bar represents when it was warm/dry.*

3. (Slide 21) Students work in pairs to identify patterns in the datasets.

4. Students cite evidence from the graph to evaluate whether or not the data supported or refuted their initial prediction for the investigative question.

Part 4 - Constructing Evidence-Based Explanations

30 minutes

Final Model Construction

1. (Slides 23 - 25) Utilize the slide deck to describe what should be included in a scientific model and analyze an example of an explanatory model.

Note: If there is disagreement amongst students about what should be included in their explanatory models, consider creating a "Gotta Have Checklist", a whole-class public record in which students collaboratively identify the parts and conventions (signs/symbols connecting parts) that you just gotta have in your model.

2. (Slide 26) Students work in pairs to construct their explanatory models for the investigative question.

3. (Slide 27) Students share their explanatory models.
   a. Model sharing can be facilitated as a gallery walk, in small groups, or as a whole class.

Digging Deeper

4. (Slides 28 -29) Students consider and predict post-fire forest recovery patterns in a future that is projected to be warmer and drier in the northern Rocky Mountains. Then, students watch this video, "Restoration after the Rice Ridge Wildfire", to learn how scientists and forest managers collaborated to replant trees after a 2017 wildfire in the Lolo National Forest outside of Missoula, Montana.

Possible Teacher Prompts	*Possible Student Response*
• *Why do you think forest managers are planting different trees after a fire?*	• *To give the forest more fire resistance, increase biodiversity, improve forest resiliency*
• *Why do you think forest managers replant burn areas with seedlings rather than planting seeds?*	• *To create a faster recovery time for the forest, provide safety for wildlife, intentionally plant trees in "better locations"*

Additional Teacher Resources
Scientific Papers: • Evidence for declining forest resilience to wildfires under climate change. Ecology Letters. **Articles:** • Wildfire in Lodgepole Pine. National Park Service. • Q&A with fire ecologist Camille Stevens-Rumann. Colorado State University. • Climate change is transforming Western forests. And that could have big consequences far beyond wildfires. The Colorado Sun. • Wildfires Have Burned Colorado's Iconic Forests. Because Of Climate Change, Some Won't Grow Back The Same. Colorado Public Radio News. • As winter wildfires burn, will they forever alter Colorado's forests, water?. Water Education Colorado. **Videos** • Fires in the West may be changing the future of forests • NASA Sees 30 Years of Yellowstone Recovery from 1988 Fires **Data visualizations** • Landscape Change Monitoring System (LCMS) - Data Explorer   ○ LCMS overview video **Interactives** • Biomanbio succession game

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