“Solutions-Oriented Learning” Storyline

MS Fire: Forest Management

Storyline introduction and overview:

Wildfires are a contributing factor to greenhouse gas emissions. Scientists estimate that wildfires emitted 8 billion tons of CO2 per year for the past 20 years. Wildfires have risks and benefits that humans are impacted by. In this storyline, students will learn about the risks and benefits of wildfires, the science behind how fire occurs and the conditions that make a fire catastrophic. Students will evaluate local/regional fires to determine how human activities contribute to wildfires. Students will research how forest management decisions are made to decrease the negative impacts of wildfires and to decrease the amount of CO2 that is emitted from those fires.

NGSS Learning Progression for this Storyline: The MS Forest Management and Fire storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Take a look at how the Middle School performance expectations fit in a continuum of learning for your students

Placemaking: Wildfires in Washington state burn over 284,000 acres annually based on data from a 10 year average. Forest management and other human actions affect the amount of acreage burned in our state. Wildfires are started in various ways however human activity accounts for 90% of the fires annually.	**Anchoring phenomena:** The smoke from forest fires can significantly impact human lives.	**Drawdown:** Indigenous People Land Tenure
Indigenous and other relevant cultural connections: Use the article 'Fire is Medicine': the tribes burning California forests to save them to highlight how indigenous people use fire as a forest management tool.	**NGSS PEs (progress towards):** 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. MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-PS1-4: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	

Estimated time required to implement this storyline: 3 weeks

“Solutions-Oriented Learning” Storyline

MS Fire: Forest Management

NGSS PEs:

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.
MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-PS1-4: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles to design an object, tool, process or system.	**ESS3.C**: Human Impacts on Earth Systems Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.	**Cause and Effect** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. **Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to predict and/or describe phenomena.	**PS1.A**: Structure and Properties of Matter Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to determine similarities and differences in findings.	**ESS3.B: Natural Hazards** Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	**Patterns** Graphs, charts, and images can be used to identify patterns in data. **Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Learning Sessions

“Solutions-Oriented Learning” Storyline

MS Fire: Forest Management

Learning Session:	Materials List:
4	Apple, matches

1.	**Grounding in Native Ways of Knowing:**	Estimated time: Two 50 minute periods

1. Play one or both of the following audio links: Karuk Tribe Calls On Governor Newsom To Allow Traditional Fire Management and Northwest Tribes Bringing Traditional Wildfires Back To Their Lands
2. Students read 'Fire is Medicine'. Assign a group of students to each of the following sections of the article in order to prepare a 2 minute presentation to the class. In the presentation, the prompt could be to explain what the sub-title of the assigned section means.

    a. Fire is medicine
    b. How US waged war on fire
    c. Putting fire on the ground
    d. How good fire is returning
    e. Accept some risks
    f. How are tribes leading the way
    g. Fire is in our DNA

2.	**Examining Phenomena: The smoke from forest fires can significantly impact human lives.**	Estimated time: 50 minutes

Ask students what experiences they have had with fire/smoke events.
Show a video or news article of a locally relevant fire/smoke event to your school district.

- Wildfire virtual field trip - video clip from 911 Okanogan fire
- News video from 2018 around the Puget Sound region
- Eagle Creek Fire

Ask the class: What is smoke? Where did the smoke come from? Elicit and record student responses to revisit later.
Students then draw a model of what they think smoke is made of, where did smoke come from and how did the smoke get here?

MS Fire: Forest Management

3.	**Pre Assessment:**	Estimated Time: 20 minutes
	MS-FIre: Forest Management Pre-Assessment **MS-Fire: Forest Management Assessment Rubric**	

4.	**Guiding question: What is fire?**	Estimated time: Two 50 minute periods

1. Teacher demonstration: Place an apple that has been cut long enough to turn brown in front of the class. Then light a match. Ask what this browning apple and a burning match have in common. Students write down possible answers and then share answers. The teacher guides their answers by asking if fire is a substance or a process.

2. Teacher explains: Fire is not, in fact, a substance but a process – a chemical reaction. It's the same chemical reaction that occurs when a cut apple left on the counter turns brown. That process is oxidation: combining oxygen with another substance. The defining difference between a fire and your sliced apple is speed: fire is an oxidation process that happens very fast, so that light, heat and sound are released. The sudden release of energy causes temperatures to rise. And it also results in smoke, the toxic waste of fire's leftovers.

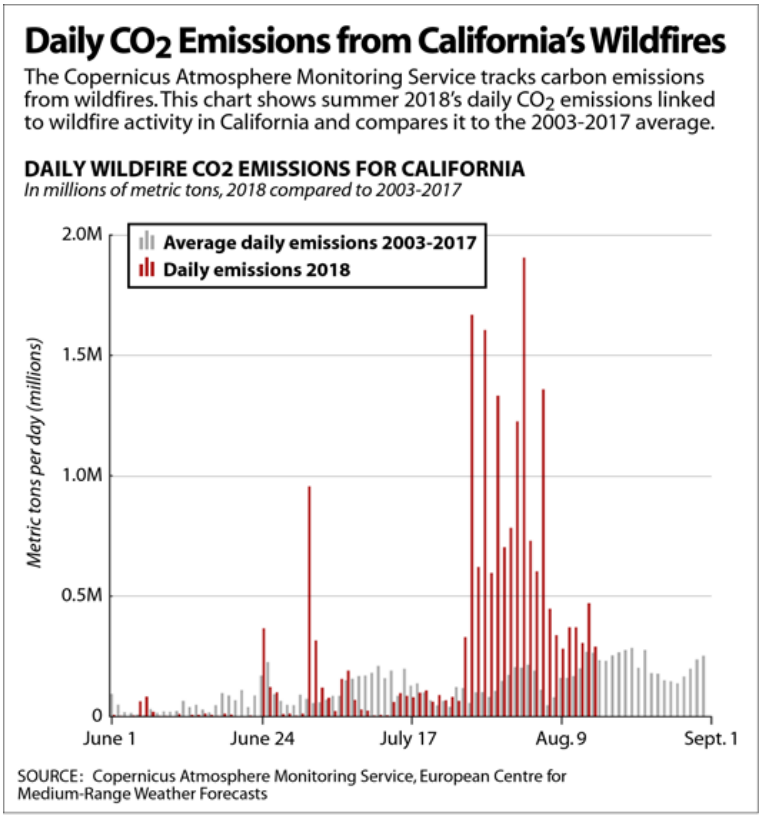
3. Show Fire Triangle. The fire triangle identifies the three needed components of fire. All three components must be present to have a fire. Fire will burn until one or more of the components are removed. Traditional fire extinguishing methods involve removing the fuel, heat, or oxygen.

4. Roleplay the oxidation (burning) reaction of wood.
   - Actors: Students make a label and attach the label to their front
     i. Three O_2 molecules (two students/ molecule) = 6 students
     ii. One $C_3H_6O_3$ molecule = 12 students in a wood molecule (touch elbows to bond)
     iii. Three or more students who represent thermal energy
   - Read the following script out loud: 'When thermal energy enters the room, all molecules increase in kinetic energy. As the oxygen **molecules** crash into the **wood molecules** with tremendous force (kinetic energy), the atoms fly apart and rearrange themselves into new **molecules** - 3 CO_2 and 3 H_2O'. Some wood molecules can be partially broken to represent residue (visual part of smoke).
   - Students use the fire triangle to draw in the molecules in this process.Students draw arrows to show inputs and outputs. Students identify the energy source.

MS Fire: Forest Management

5.	**Guiding question: How do wildfires contribute to climate change?**	Estimated time: Two 50 minute periods

1. Use the Carbon Cycle Capture Game to simulate the role of fire in cycling carbon. End the game by removing the Fire and allowing the trees to capture all the CO2.
2. Watch Climate Science in a Nutshell:#4 Too Much Carbon Dioxide (2:44 minutes). The video describes the ways in which carbon dioxide and global temperatures are connected. And explain how excess amounts of carbon prevent heat from escaping the atmosphere, causing a greenhouse effect.
3. Students make a claim that addresses the question 'How do catastrophic fires contribute to climate change?' Students use the graph to provide evidence to support the claim.



6.	**Guiding question: How do wildfires occur? What is the difference between wildfires and prescribed burns?**	Estimated time: Two 50 minute periods

1. Wildfires 101 (about 3 minutes) is a good introduction to what a wildfire is and how wildfires occur as well as a review of the fire triangle. After watching the video, have students write a definition of a wildfire (revisit model to see what they can add)
2. Students watch Restoration in a Fire Forest: The Benefits of Burning to learn about

	prescribed fires. 3. Students create a Venn Diagram comparing and contrasting wildfires and prescribed fires. 4. Students build this foldable model: Geometry of Fire Model. At the bottom of this sheet are instructions for teaching fire behavior using their model. This activity reveals other factors involved in catastrophic wildfires (weather, topography, fuel type, etc)

7.	**Guiding question: How do human activities contribute to wildfires?**	Estimated time: Three 50 minutes periods minimum (up to six periods)
	1. As a precursor to the next activity, if there is a nearby forest, take students outside to observe the density of trees and bushes. Use Matchstick Lesson to model how fire suppression can lead to catastrophic wildfire. (Make predictions, collect data, etc.). The link above contains the lesson overview, lesson and resource pages. 2. Take a look at the history of fire management in Washington starting with the Yacolt Fire in 1902 (Yacolt Burn) to present day. Pose the question: Why did the Carlton fire have a much bigger impact than the Yacolt fire?" Carlton Complex Burn Read through the information on each fire and look at the pictures. Students can begin to generate a list of potential factors (human activities) which led to the difference in the fires. 3. Show the Living (Dangerously) in an Era of Megafires as a review of the above information and an introduction to the project below. (TED Talk - 15 minutes) 4. Students generate a list of the human activities that directly and indirectly contribute to wildfires.	

8.	**Guiding question: How are humans mitigating the effects of wildfire?**	Estimated time: Four 50 minute periods
	1. Students use Science of Wildfires to explore how wildfires are currently monitored. **2.** Students use the STEM lessons to show how technology is being used to monitor fires. **3.** Wildfire: Friend or Foe? (PDF version) is a classroom activity to help students understand positive and negative effects of wildfires and role play positions on fire management agencies and community members. One suggestion is to add a tribal representative as another role in this activity. Students can use their finalized fire model along with other information compiled throughout the storyline (learning sessions 1, 5, 6) to inform their solution. Students identify criteria and constraints within their recommendation for fire management (solution) along with risks/benefits (see Teacher resources at end of learning sessions). As part of this activity, students forecast what the impact might be on climate change if their recommendation is implemented.	

	Useful resources to help students research their role: Habitat restoration - contains information which highlights a butterfly which requires fire for survival. 'Fire is Medicine': the tribes burning California forests to save them. This reading was used at the beginning of the story line and can help in the Tribal member role in the activity.

8.	**Possible next steps/off-ramps/actions:**	
	• Students design a new U.S. Forest Service poster with an updated message. • Divide your class into groups and assign each group one government entity that is involved in wildfire management in the Pacific Northwest. Local fire districts, DNR at the state level, and the U.S. Forest Service are all involved in wildfire management. Each group will research the mission of their assigned government agency in terms of managing wildfires and present to the class. The National Interagency Fire Center is a good resource for agencies that work together to manage wildfires on the federal level. (Note: "Policy" tab will take students to links to different federal agencies and their mission/plan. • *Career connections:* TREX: Prescribed Fire Training Exchanges (TREX) are two-week programs in Washington - and across the country - that facilitate peer -to-peer learning for those interested in advancing their understanding of prescribed fire and fire-adapted landscapes. Fire and Fuel Manager: Fire and Fuel Manager maintain healthy growth of our wilderness and woodlands by controlling natural and artificial fires and using fire to promote ecological health.	

9.	**Post Assessment:**	Estimated Time: 20 minutes
	MS-Fire: Forest Management Post Assessment MS-Fire: Forest Management Assessment Rubric	

MS Fire: Forest Management OER Tracker

Pacific Education Institute would like to acknowledge and thank the writing team for their work. The team included Carmen Kardokus, Lourdes Flores, Jill Fetcho, Michelle Townshend, Traci Bowlby and Shelley Stromholt. In you have comments or questions please contact info@pacificeducationinstitute.org .

Except where otherwise noted, this work developed by Pacific Education Institute (PEI) for the Washington Office of Superintendent of Public Instruction, is available under a Creative

Commons Attribution 4.0 License. All logos and trademarks are the property of their respective owners.