“Solutions-Oriented Learning” Storyline

HS-Fire: Forest Management

Storyline introduction and overview:

The students will be introduced to a historical account of global climate change and the human events that may have impacted those changes. Fire has been used by humans throughout history to modify their environment, particularly forests, for human benefit. Over time, the management of forests has changed and the result is an increase in catastrophic wildfires. This storyline explores the use of fire as a forest management tool to improve the health of forests thereby decreasing the incidence of catastrophic fires and the role fire plays in climate change.

NGSS Learning Progression for Fire:

The high school storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Take a look at how the high school performance expectations fit in a continuum of learning for your students.

Placemaking: In August in the PNW, for the last 3 years, the air quality due to forest fires has been so unhealthy that outdoor school activities have been either cancelled or delayed.	**Anchoring phenomena:** Human activities impact our environment. HS Fire storyline phenomena, 1,700 Years of Global Temperature Change from Proxy Data	**Project Drawdown:** Indigenous Peoples’ LandTenure Forest Protection
Indigenous and other relevant cultural connections: In the PNW, Indigenous populations have used fire management to influence a variety of ecosystems, from forests to prairies, in order to create habitat and increase yields of beneficial plant and animal species.	**NGSS PEs (progress towards):** HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	

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Estimated time required to implement this storyline: 3 to 4 weeks

NGSS PEs:

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. LS2.C: Ecosystem Dynamics, Functioning, and Resilience Moreover, anthropogenic changes (induced by human activity) in the environment — including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change — can disrupt an ecosystem and threaten the survival of some species.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable.
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	PS1.B: Chemical Reactions Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy	Energy and Matter Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system

Learning Sessions

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Learning Session:	Materials List:
4	Soil samples with different amounts of organic matter Wood splints

1.	Grounding in Native Ways of Knowing:	Estimated time: Two 50 minute periods
	1. Discuss Land Tenure using What on Earth is 'land tenure'? Jigsaw Project Drawdown Solution #3' Indigenous Peoples' Land Tenure (view technical summary). Elicit inputs from students who may have Indigenous land tenure experiences. 2. Students research different land management practices from different Indigenous peoples. Students can do this worldwide (Traditional Land Use) or concentrate on the Indigenous peoples of North America or even just Washington state. Students with the same interests form a group and prepare a presentation for the class. 3. Explore examples of local Tribes' use of fire for propagation of specific food plants. Camas Prairie Restoration - USDA article that explores the use of prescribed burns to promote the growth of camas. Another source is Tribe's Huckleberry Harvest Brings Fire (or Something Like It) Back to the Forest - Oregon Public Broadcasting article about how fire has been used in managing huckleberry resources since time immemorial.	

2.	Examine phenomena: Human activities impact our environment.	Estimated time: 50 minutes
	Using HS Fire storyline phenomena, students are shown a current and a historical sketch/photo of the same area that show different management methods. Then, students are presented with the 1,700 Years of Global Temperature Change from Proxy Data that shows the Little Ice Age.	

3.	Pre Assessment:	Estimated time: 30 minutes
	HS-Fire: Forest Management Pre-Assessment **HS-Fire: Forest Management Assessment Rubric**	

4.	Guiding question: How does fire release stored carbon from our forests?	Estimated time: Part 1: 50 minutes

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		Part 2: three to four 50-minute periods

1. Two-Part Lab

- Part 1: Wood and CO2 lab: Students will identify the three elements of the fire triangle and observe CO2 released through combustion.
  Fire Triangle (replace candle with wood splint)
  CO2 Release (replace candle with wood splint)
  Using the answers generated in the above activity, students write a combustion chemical equation.

$$C_6H_{12}O_6 + 6O_2 \dashrightarrow 6CO_2 + 6H_20$$

  Students make the connection that the equation they wrote models the same event as the fire triangle. Students then use this model to label:
  - the form of energy that is stored (potential in the wood)
  - the form of energy that is released (thermal energy)
  - the form of energy that is needed for the reaction to start (thermal energy).
  - where the input of energy from the surrounding breaks bonds
  - where the forming of bonds releases energy to the surroundings.

- Part 2: Soil and CO2 lab- Students will quantify organic material in soil.The soil carbon lab is a simple lab designed to calculate the amount of organic carbon in a soil sample.
  - Place approximately 5g of soil into a porcelain crucible and weigh to the nearest .01g (this soil should be previously oven dried).
  - Heat the crucibles to a red color over a Bunsen burner. Stir occasionally to aid complete oxidation of the organic matter. Oxidation is complete when the soil becomes light tan, usually in 1-2 hours.
  - Cool the samples and reweigh. Determine the loss in weight and calculate percent organic matter.

Determination of Organic Matter Content by Dry Combustion

1. weight of soil and crucible before combustion	
2. weight of crucible	
3. weight of soil	

4. weight of soil and crucible after combustion	
5. weight lost (organic matter)	
6. organic matter, %	

- Pose the question: Why did the soil change color after burning?
- Possible extension: Lead a short discussion about carbon's role in soil.

5.	**Guiding question: How does fire severity influence the amount of carbon released from a forest?**	Estimated time: 50 minutes

1. Students discuss fire behavior by analyzing the Fire Behavior Triangle. Fire Behavior Triangle
2. Students construct a fire table to analyze how elements of the Fire Behavior Triangle influence fire behavior and the amount of carbon released. Fire behavior information and fire table instructions (See page 16, III Fire Intensity/Severity)
3. Students study the Forest Carbon Pools graphic (page 5, Figure 2). Then students develop a model (a poster, a 3D model, etc.) that shows their prediction of the changes in relative amounts of carbon in the various pools after a wildfire and give an explanation of their numbers.

6.	**Guiding question: How does carbon impact climate change?**	Estimated time: Two 50 minutes

	1. Students explain a. the difference between natural greenhouse effect and enhanced greenhouse effect b. the difference between climate change and global warming c. the natural and human causes of greenhouse gases using Mr. Geog Wagg's lesson in which they watch a video and study the graphics. 2. Students analyze the effects of carbon dioxide on temperature in the Greenhouse-gas-simulation. 3. Phenomenon: What DID cause the Little Ice Age? 1700 Years of Global Temperature Change from Proxy Data. a. How were Indigenous people in North America using fire in the forests prior to the arrival of the Europeans? What happened to the forests after the arrival of the Europeans? b. How specifically did human activity contribute to the change in climate? How is this evidence for the role that humans play in the current global warming trend? Students use the article America colonisation 'cooled Earth's climate' or the science journal article Earth system impacts of the European arrival and Great Dying in the Americas after 1492 to research this phenomenon. c. Students complete this investigation by researching how local tribes have used fire in the past. This is known as cultural burning.

7.	**Guiding question: What are prescribed burns and how are they used to decrease the severity of fire?**	Estimated time: 50 minutes
	1. Students access Prescription: Fire page. All students watch the video, "Controlled Burning Reduces Catastrophic Wildfire Risk," at the top of the page. 2. Students choose one of the three articles - What Trees Can Teach Us About Fire, In Need of Fire, or Controlled Burning 101- - they would like to read. After allotted time, students come back together as a group to discuss the guiding question, "What are prescribed burns and how are they used to decrease the severity of fire?" 3. As an optional extension to the previous discussion, use the information on page 32 (Washington) in The impediments of prescribed burns to discuss the pros and cons of prescribed burns.	

8.	**Guiding question: How are decisions made for forest management in Washington state?**	Estimated time: 50 minutes
	1. Invite an Elder or other expert in forest management from your community. Ask your guest to discuss the criteria that is considered in managing the fire risk in a forest. If possible, find someone with knowledge of or experience with using prescribed burns. 2. Students research House Bill 2928 and summarize their findings.	

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9.	**Guiding question: Is this property at risk of fire?**	Estimated time: Learn & Practice Protocol: 50 minutes Data Collection: one to three 50 minute sessions (plus travel)
	1. Students review the elements of the Fire Behavior Triangle, then use that information to do a fire danger assessment of a site. After collecting data on fuel load, weather patterns, and topography, students create and present a plan for increasing or maintaining resilience of the site against catastrophic wildfire. Wildland Fire Behavior This webpage provides a review of the three components of the fire behavior triangle. GLOBE Fire Fuel Protocol This resource helps students analyze the amount and type of fuels at their site. Starting on page 15, follow the Fire Fuel Protocols. The Biometry and Land Cover Samples are not necessary for this exercise. 2. Weather & atmosphere data resources and/or Fire Danger and Fire Weather Records and/or Weather and fire behavior links are additional resources.	

10.	**Possible next steps/off-ramps/actions**	
	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. CTE: ● Explore the skills necessary for seasonal firefighters to get a red card. ● During Learning Session 8 have students utilize a "belt weather kit" to analyze fire conditions. Discuss the conditions necessary for a "red flag" warning. ○ Video tutorial of *a "belt weather kit"* Service Learning: *Online Resource: South Sound Prairies - This page has information about volunteering for Prairie Appreciation Day in the South Puget Sound.*	

11.	**Post Assessment:**	Estimated time: 30 minutes

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	HS-Fire: Forest Management Post Assessment **HS-Fire: Forest Management Assessment Rubric**

Teacher Resources

OER Tracker - HS Fire: Forest Management

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