"Solutions-Oriented Learning" Storyline

MS Regenerative Agriculture (Western WA)

Storyline introduction and overview:

Students will discover the carbon component in soils, the role carbon plays in soil health, and the role that regenerative agriculture practices play in soil health and climate change.

NGSS Learning Progression for this Storyline: The middle 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 middle school performance expectations fit in a continuum of learning for your students.

Placemaking:	Anchoring phenomena:	Drawdown:
Agriculture is fundamental to Washington's economy. 34% of all land in Washington is used for agriculture and it represents 12% of the overall economy. Agriculture is a principal source of economic stability for rural communities and the region as a whole. Climate change will impact the agricultural industry of Washington and so many farmers are learning and using regenerative agriculture practices to mitigate carbon emissions.	Observe soil burning. The teacher will burn various materials, then demonstrate burning a soil sample for students. Teacher will gather student sensemaking about why the soil burned.	Regenerative Agriculture Nutrient Management Conservation Agriculture Composting
Indigenous and other relevant cultural connections: Indigenous people of western Washington have used local land and water for agriculture purposes throughout history. There is a movement to learn and utilize Indigenous agricultural practices to create more sustainable and climate friendly ways to grow food.	**NGSS PEs (progress towards):** MS ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	

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Estimated time required to implement this storyline: 2 to 3 weeks

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NGSS PEs:

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**For MS - LS2-4** **LS2.C Ecosystem Dynamics, Functioning, and Resilience** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	**Stability and Change** Small changes in one part of a system might cause large changes in another part.
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.	**For MS-ESS3-3** **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;** Influence of Science, Engineering, and Technology on Society and the Natural World

Learning Session:	**Materials List**
2	Paper to burn Soil sample to burn Matches or Bunsen Burner Scale to measure the weight of the soil
4	Burned soil sample Scale to measure the weight of the soil Soil sample Microscope

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7	Claim, Evidence, Reasoning (CER) from learning session 5

Learning Sessions

1.	**Grounding Native Ways of Knowing:**	Estimated time: 30 minutes
	To connect to native ways of knowing, consider exploring the following ideas in connection with your local tribal nation by researching stories of the past and learn about current work and actions the Tribe is taking to mitigate, adapt to, and find solutions to a changing climate. ● Traditional food systems ● Management of agriculture ● Sustainable harvesting Show the Honorable Harvest - Robin Kimmerer (about 4 minutes). Post the following questions and show the video again ● What does ethical reciprocity between humans and the natural world look like? ● How can plants “teach us”? ● What are “sovereign beings”? ● What is a protocol? What is the protocol for harvesting food as presented by Ms. Kimmerer? Lead a class discussion focusing on the above questions. Invite a local tribe member to your class to speak to their stories of harvesting from the land. Contrast the indigenous ways of harvesting food to the modern ways of harvesting food. (Ms. Kimmerer is a Professor of Environmental and Forest Biology at the State University of New York College of Environmental Science and Forestry, a member of the Citizen Potawatomi Nation (an Indigenous people originally from the Great Lakes region), and a writer. Additional resources Below are some resources that relate to Indigenous people and agriculture in western Washington: ● Muckleshoot Tribe: Foods Still Matter: The Muckleshoot Food Sovereignty Project ● Coast Salish Tribe: Coast Salish Camas Cultivation ● The Indigenous Origins of Regenerative Agriculture ● Swinomish Tribe: Pacific Northwest Tribes Face Climate Change With Agricultural Ancient Practice ● Tulalip Tribe: Tulalip Preserves Huckleberry Resource ● OSPI: Stories from 1840 – Different Worldviews Additional resources on working with Indigenous students and tribes: To access information on how to reach out and build relationships with local tribes, visit the	

	OSPI Office of Native Education: Partnering with Tribes, and contact your district's tribal liaison/Title VI coordinator. To learn more about respecting and building upon Indigenous Peoples' Rights visit the Learning in Places website, a project led by Dr. Megan Bang then read Practice Brief #10: Teaching STEM In Ways that Respect and Build Upon Indigenous Peoples' Rights and Practice Brief #11: Implementing Meaningful STEM Education with Indigenous Students & Families published on the University of Washington's STEM Teaching Tools website.

2.	Examine phenomena: Observe soil burning*	Estimated time: 50 minutes
	1. Before introducing the phenomenon, introduce students to Washington Agriculture Snapshot and Washington Grown - Crops by County to give them some background. Discuss how agriculture (size of farms and crops grown) is different from east to west. As an example, point out that the amount of rainfall differs therefore the farming practices differ (irrigated vs dryland). End with making a list of all the things that are common for farms across the state - crops(most) need water and soil and sunlight. This unit focuses on soil and how different farming practices can impact the soil. 2. Students are familiar with the abiotic properties of soil but may not understand the biotic properties (carbon component) of soil. Pose the questions: **"Does soil burn? If yes, then what is burning in the soil?"** Students complete a quick write addressing the questions with reasoning. They will come back to these questions later in the unit. 3. Students are familiar with the abiotic properties of soil but may not understand the biotic properties (carbon component) of soil. Demonstrate burning paper and a small piece of wood. Then show the students the soil samples: unburned soil and burned soil. Point out that the soil samples weighed the same before the burning process. Pass the burned soil around the room so that students can feel it. An alternative to the soil burning demonstration is to watch the demonstration on Soil Science 3. Measuring Soil Moisture and Organic Content (the second demonstration) without sound (so that students can still ponder the above questions 4. Students revisit their answers to the question in step 2. Add the question: **"Is soil biotic or abiotic? Provide evidence to explain your thoughts."** ● Prepare the soil samples by weighing two 200 mls of soil. Place one sample in a crucible and burn off the organic matter (carbon). You can use a torch, Bunsen burner, or a BBQ. Take photos of the smoke emitted during the burning.	

3.	**Pre-Assessment:**	Estimated time: 20 minutes
	MS-Regenerative Ag (Western WA) Pre-Assessment **MS-Regenerative Ag (Western WA) Assessment Rubric**	

4.	**Guiding question: What is soil made of?**	Estimated time: Two 50 min periods
	1. The abiotic components: Students use the resource Soil Basics to answer: a. What is soil? b. What is the difference between soil and dirt? 2. The biotic components: Students read Biology Life in Soil. Show the burned soil sample (and photos) from Learning Session 2. Students compare the sample to the unburned soil and answer the questions: a. Why are the samples different weights? (The carbon has been burned off) b. Where did the carbon in the soil come from? (From soil microbes and dead plant and animal matter) c. Take the burned soil and try to add water to it. (It does not mix) Why not? Could they use the ability of soil to hold water to infer carbon content? Students draw in science notebook soil before and after adding water. 3. Students watch Humus Formation and observe the characteristics of humus (carbon) - the color especially. If possible, students go outside for the following activity: Carefully dig a plant out of the soil or even a weed and observe the soil that sticks to the roots. Inside these particles are millions of rhizosphere microbes. Using microscopes, students explore and sketch the microbes they observe. Students collect soil from different locations and compare the color of the soil. Discussion question: **Is the color an indication of how much carbon is present in the soil?**	

5.	**Guiding question: What are some ecosystem services that soil provides?**	Estimated time: Two 50 minutes
	1. Students will view Ecosystem Services in Agriculture and then read Soil and the Environment: Ecosystem Services I. 2. Students will "Mark the Texts" in their science notebooks by: a. Doing a 1st read paying attention to their first impressions as to what the main points are. b. Doing a 2nd read and "marking the text" in their science notebook by: 1. Numbering each paragraph/ stopping the video to record the time	

	in their science notebook. 2. Noting major points or forceful statements. 3. Including important words and phrases or points of confusion. 4. Writing any questions that come to mind. 3. Students will construct an argumentative statement that explores the question: **Does changing the amount of soil carbon affect the number of soil microbes that live in the soil?** a. **C**LAIM: A statement that answers the question. b. **E**VIDENCE: Data that supports the claim. c. **R**EASONING: Connects evidence to the claim. 4. Students participate in a Socratic discussion to explore their understanding about the ecosystem services of soil. AVID: Socratic Seminar, Pasco County SD, Socratic Seminar Sentence Frames, Puyallup SD, Science Sentence Frames (weebly.com)

6.	Guiding question: What is the role of soil in the carbon cycle?	Estimated time: Two 50 min periods
	1. **What is the carbon cycle and why is it important to ecosystems?** Students participate in the Carbon Cycle Role Play to model how carbon moves around in the environment. Have students complete pages 67-69 of the Science Coloring Book. 2. Introduce the term carbon sequestration (process by which carbon dioxide is removed from the atmosphere) and have students connect carbon sequestration to photosynthesis in the carbon cycle. If necessary, students read and watch What is Photosynthesis? to review photosynthesis. The 8-minute video discusses some common misconceptions in students' understanding of this process. 3. Using all the resources above, students construct their own carbon cycle incorporating the role of the soil microbes in storing and emitting carbon, and 2 different ways that carbon can enter the soil.	

7.	Guiding question: How do regenerative agricultural practices increase carbon in the soil? How is increasing soil carbon a benefit?	Estimated time: Three 50 min.periods
	1. Students explore the website of Kiss the Ground's A Closer Look: Regenerative Agricultural Practices to discover the differences between 'degenerative vs. regenerative practices'. 2. Students explore both sites: What is Regenerative Agriculture? - from Regeneration International and Can regenerative agriculture replace conventional farming? - from	

	European Institute of Innovation & Technology (EIT). Using the "Regenerative agriculture explained" infographic, students write down the practices of regenerative agriculture and write a couple of sentences describing how each practice increases soil carbon. **Students answer the question: "Why is increasing soil carbon a benefit to the ecosystem?"** 3. As examples of the impact of a regenerative practice, students watch the No-till vs till soil and ARS soil scientist Hal Collins on the significant impacts of carbon sequestration on soil health videos and discuss: **WHY is there a difference in soil quality in regenerative agriculture?** An extension of this activity is students perform the vertical column with a clod of soil from no-till and another clod of soil from tilled for a more direct experience. No-till and cover crop practices also improves water quality. The increased carbon in the no-tilled soil provides structure that resists erosion. Show Erosion and Soil video and Cover Crops article for more information. And it allows for percolation versus runoff. 4. Students revisit the CER from learning session 5 and revise their argument with additional evidence related to the changes (both physical and biological) that affect populations in an ecosystem.

8.	**Guiding question: What are the criteria and constraints of regenerative agriculture?**	Estimated time: 50 minutes
	1. Students analyze the infographic "Is regenerative farming a solution?" from the webpage, Can regenerative agriculture replace conventional farming?. 2. Students create a Venn diagram or a Box and T-chart to identify the criteria (benefits) and constraints (limitations) of the solution "Regenerative agriculture is a solution to improving soil quality.". This activity models the steps students will be taking for the project in learning session 9.	

9.	**Guiding question: How can regenerative agriculture practices provide a solution that impacts climate change?**	Estimated time: One-Two 50 minutes periods
	1. Students will use their resources and research from Lessons 1-8. 2. Students will make claims answering the guiding question: **What are two regenerative agriculture practices that could be used as solutions to increase the carbon content of soil?** a. Students generate at least 2 solutions to increase the carbon content of the soil on their piece of land, either from a local farm or their backyard.	

b. Students will describe why these regenerative farming actions will increase carbon content.
c. Students will also note the criteria (benefits) and constraints (limitations) of these practices.
d. In their Science Notebook they will make a graphic organizer with the headings:

Regenerative Ag Practice #1	
Criteria (benefits)	
Constraints (limitations)	
Regenerative Ag Practice #2	
Criteria (benefits)	
Constraints (limitations)	

10.	**Possible next steps/off-ramps/actions:**	

- Students explore career opportunities in Careers in Agriculture and Natural Resources
- Future of Agriculture resource focuses on new careers in agriculture
- Crop wheat from soil bottles and spread all three soils to dry thoroughly. Burn off the organics from the three dried soils. Quantify the % organic (Carbon) from each sample (this will take a substantial amount of time.)
- Soil is a living entity, and all living things contain organic and inorganic material. You can burn off organic (Carbon) from a variety of pre-dried tissues; carrots, potato, watermelon... and quantify it also. What is left after burning are inorganic materials (minerals)
- Spend some time talking about Washington state crops and where they are grown.

11.	**Post Assessment:**	Estimated time: 30 minutes
	MS-Regenerative Ag (Western WA) Pre-Assessment **MS-Regenerative Ag (Western WA) Assessment Rubric**	

Teacher Resources

MS-Regenerative Agriculture (Western WA) OER Tracker

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