“Solutions-Oriented Learning” Storyline

MS Wetlands: Ecosystem Services

Storyline introduction and overview:
Coastal wetlands bring many benefits to ecosystems including their ability to sequester carbon and mitigate fluctuations in sea levels. Students will understand the ecosystem benefits of coastal wetlands with a focus on the potential of estuaries for climate related planning.

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. Look at how the middle school performance expectations fit in a continuum of learning for your students.

Placemaking:	**Anchoring phenomenon:**	**Drawdown:**
Students explore critical wetlands near them. WA Wetlands of High Conservation Value Students can also locate and research a local estuary or saltmarsh. Use Google Earth or Maps Satellite & Street View. WDOE Modeled Wetlands Inventory shows classifications of wetlands. Research Resources: Google Earth Google Maps 2016 Modeled Wetlands Inventory- Washington Department of Ecology Map of Washington Wetlands	Wetlands are very diverse. Wetlands go by many names, such as swamps, peatlands, sloughs, marshes, muskegs, bogs, fens, potholes, and mires. They all provide many valuable services. Show students the poster below and have them list the types of wetlands. Have them describe what they all have in common and how they differ. USGS Wetlands: Water, Wildlife, Plants & People!	Drawdown: Coastal Wetland Restoration Agriculture, development, and natural disasters have degraded many coastal wetlands. Restoring mangrove forests, salt marshes, and seagrass beds to health revives carbon sequestration
Indigenous and other relevant cultural connections: Indigenous and other relevant	**NGSS Pes (progress towards):** **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	

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cultural connections: Billy Frank Jr. story of the Nisqually Delta Nisqually Story: Water from the Mountain Where the Salmon Run: The Life and Legacy of Billy Frank, Jr.	**MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Estimated time required to implement this storyline: 2 weeks

NGSS PEs:

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

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. - **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** Science disciplines share common rules of obtaining and evaluating empirical evidence.	**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.
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). ● Evaluate competing design solutions based on jointly developed and agreed upon design criteria.	**For MS-LS2-5** **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health.	**Stability and Change** Small changes in one part of a system might cause large changes in another part. - **Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World** The use 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

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	LS4.D: Biodiversity and Humans Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.(secondary) **ETS1.B: Developing Possible Solutions** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary)	differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. - **Connections to Nature of Science** **Science Addresses Questions About the Natural and Material World** Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.
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** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. **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.

Materials:

Learning Session	Materials
5	● Two long, shallow pans (baking pan or paint roller pan) ● Modeling clay ● Sponges and/or strips of carpet as wide as the pan ● Food coloring ● Jar of muddy water

	● Watering can or pitcher of clean water *Extended Learning Option- For each group of 4-5 students* ● Set of all materials above per team of students ● Measuring cups or canning jars with measuring marks
6	● 7 Dice *Extended Learning Option- For each group of 3-4 students* ● a set of organic and inorganic objects spread out evenly on a table: (such as rocks, sticks, plastic bags, leaves, seeds, feathers, sand, insects, Styrofoam cup, tree bark, newspaper, plastic container) ● 1 quart each of 2 different soil samples, one wetland, one sandy (samples should be dry and powdery) ● 2 vials with lids ● 1 ruler ● erasable crayons ● table salt ● small beaker of water ● colored pencils ● magnets

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 plants found in wetlands • Management of estuaries and wetlands • Wetland ecosystem changes Below are some stories connected with water, the land and wetlands that might be useful to connect students to native ways of knowing. Select one of these stories to share with students or find a more local story to your region. ● Nisqually Story: Water from the Mountain (Nisqually) ● Roger Fernandes "Salmon Boy" (Coast Salish) Suggested activity for teachers and students: 3-2-1 research process • Three new learnings about the Tribe most local to you	

	• Two questions that you still have about the Tribe most local to you • One action you can commit to begin a partnership with the Tribe most local to you Below are some examples of tribal science connections to wetlands. ● Western Washington ○ Squaxin Island Tribe Resolution 15- Skookum Watershed Fish and Wildlife/Riparian Habitat Acquisition and Protection Action Plan (Squaxin) ○ Squaxin Island Tribe, Capitol Land Trust and LOTT Acquire Wetland Property (Squaxin) ○ Floating Wetlands in an Urban Estuary (Duwamish) ○ Reservation Wetlands Ranked by Culturally Important Plants (Swinomish) ○ Wetland and Habitat Mitigation Bank (Lummi) ○ Water Quality (Puyallup Tribe of Indians) ○ Port of Tacoma's Restoration Project on Lower Wapato Creek to Move Forward (Puyallup Tribe of Indians) ○ Where the Salmon Run (Nisqually) ● Olympic Peninsula/Coast ○ Skokomish Estuary (Skokomish) ○ Skokomish Community Center Wetland Report (Skokomish) ○ Suquamish Tribe Wins Land Use Case (Suquamish) ○ Suquamish News: Tribe Purchases Kitsap Parks Property (Suquamish) ● Central and Eastern Washington ○ Restored Wetland Brings Wapato Back to Yakama Nation (Yakama) ○ Return of the Wapato (Yakama) 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 phenomenon: Wetlands are diverse ecosystems that provide important benefits to the**	Estimated time: 60 minutes

	environment and wetland inhabitants.	
	National Geographic slideshow of wetlands photos ● Show slideshow on full screen so students do not see the captions ● Elicit student thoughts on what they are seeing/what they know about what they see ● Ask students what all of photos have in common ● Explain that these are all photos of wetlands, and elicit student thoughts/ideas on how there could be such stark differences but they are all wetlands Introduce graphic organizer (or similar note taking tool) on wetlands ● Explain that you are beginning a unit on wetlands, which are very important and diverse ecosystems ● Make note of the sections of the graphic organizer and explain that in this unit students will also model some of the functions of a wetland and possibly visit a nearby wetland or engage with a community partner involved in wetlands WWT What are Wetlands? video ● Students do not need to take written notes yet, but using the graphic organizer as a guide, ask students to watch the video and make a mental note of what they learn and how they would categorize it based on the graphic organizer ● Students share takeaways from video	

3.	**Pre-Assessment**	Estimated time: 30 minutes
	Pre-Assessment: Wetlands-Ecosystem Services Pre-Assessment **Rubric**: Wetlands Ecosystem Services Rubric	

4.	**Guiding question: What are wetlands and where are they in Washington?**	Estimated time: 60 minutes
	From Swamps and Bogs to Marshes and Meadows Coastal Wetlands: Too Valuable to Lose ● Using these two resources, students work in pairs/groups to complete the top section of the graphic organizer (definition of wetlands) and "Types" section. May also add notes to other sections, but later lessons will focus more on those.	

	• Students share findings with class; teacher ensures students have correct definition and types US FWS National Wetlands Inventory Mapper Wetlands Mapper Instructions (video; tools review starts at 4:30) • Teachers prepare ahead of time by learning to use map and researching local wetlands (if interested/applicable, teachers can create, save, and print region-specific maps for student use) • Introduce mapper to students and either work as a class or in groups to identify local examples and types of wetlands. Depending on grade level and access to research tools, students may conduct more in-depth research on local wetlands and share findings with class. • Students add findings to “Examples” section of graphic organizer

5.	**Guiding question: Why are wetlands important?**	Estimated time: 60 minutes
	What are ecosystem services? • Tell students that one reason wetlands are so important is because they provide many ecosystem services. Elicit student ideas for what the term “ecosystem services” means. • Show the video (stop at 1:55). Ask students to share their understanding and examples of ecosystem services and answer questions/clarify misconceptions. • Ask students what ecosystem services they think wetlands might provide now that they know what wetlands are and what ecosystem services are. Why Wetlands are Nature's Super-Systems • Show the video • Students take notes in the “Importance” section of the graphic organizer while watching video. Students share their takeaways of wetlands ecosystem services; teacher answers questions/clarifies misconceptions. Wetland in a Pan Activity* In this activity, students will create a model of a wetland and demonstrate some of the ecosystem services wetlands provide. Materials: • Two long, shallow pans (baking pan or paint roller pan) • Modeling clay • Sponges and/or strips of carpet as wide as the pan • Food coloring • Jar of muddy water • Watering can or pitcher of clean water Setup: • Place a sloping layer of clay over about half of the pan to represent land.	

- In one pan, place sponges or carpet along the edge of clay to represent a wetland. Be sure the wetland material covers the width of the pan. Leave the other pan without a wetland for comparison.

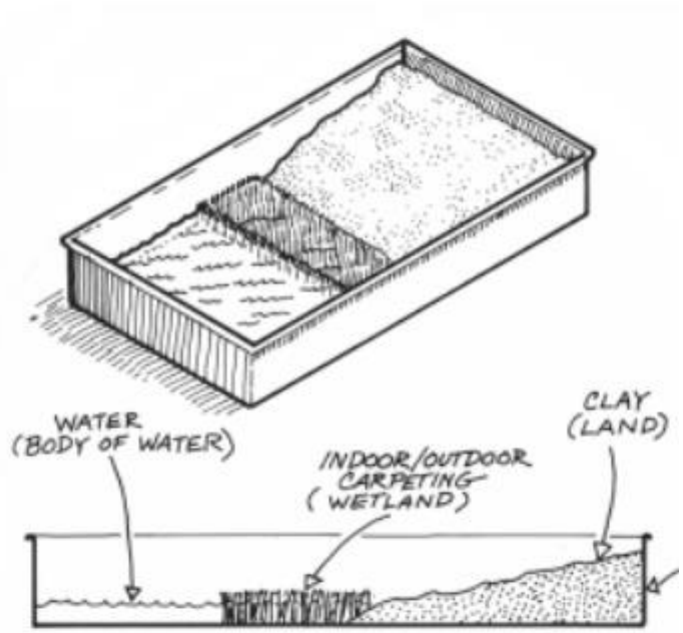
Activity:

- Review ecosystem services of wetlands. It is not possible to demonstrate carbon sequestration with this model, but flood prevention and water purification will be demonstrated.
- Begin by pouring clean water on the clay on both models to represent rainfall. The sponge/carpet should slow and capture some of the flow, resulting in less water getting through compared to the pan with no wetland. Ask for student observations and discuss why this is important. Prompt students to think about wetland removal and what might happen if the sponge/carpet were replaced with homes, development, etc.
- Add some food coloring to the pitcher of clear water, explaining that the food coloring represents pollutants we cannot necessarily see, such as chemical pollutants. Pour the water on the clay on both models. The sponge/carpet should capture some of the food coloring and water, resulting in lighter colored water coming through compared to the pan with no wetland. Discuss student observations.
- Pour muddy water on the clay on both models, explaining that the muddy water with dirt in it represents pollution we can see, such as farm animal waste. The sponge/carpet should capture some of the dirt in the water, resulting in clearer water coming through compared to the pan with no wetland. Discuss student observations.

This *Extended Learning Option* can be used to expand student learning to include quantitative measurements and the practices of scientific investigation:

Divide the students into teams and provide each team with materials to create its own wetlands model. Have each team use measuring cups (NOTE: Canning jars with measurement marks work well for this) to measure an amount of water and add it to the model with carpet; then measure the amount of water that collects in the body of water. Have them repeat the experiment without the carpet, again measuring the water that runs off. They should repeat each step five times. Have them chart the measurements and compare them.

*In an online setting, teachers may demonstrate this activity virtually for students. Alternatively, if students have access to the materials needed, they could complete the activity themselves either synchronously or asynchronously and provide pictures or videos.

	 Image source: WONDERFUL, WATERFUL WETLANDS Additional background information for teachers can be found at Wetland Functions and Values

6.	**Guiding question: What is “blue carbon” and how is it connected to wetlands?**	Estimated time: 60 -120 minutes
	Introduce how carbon cycles by having students play the Carbon Cycle Game. Provide students with Wetlands and Carbon Notetaking and CER template. Have students watch the video: “Blue Carbon - A Story From the Snohomish Estuary” and read the article As sea level rises, wetlands crank up their carbon storage (Science Daily) Students take notes on the note taking template. Have students construct an argument using the CER template addressing the prompt: *Extended Learning Option:* Have students investigate wetlands soil. WHAT'S IN WETLAND SOIL?	

7.	**Guiding question: How can human activities near wetlands ensure that preservation of wetlands services?**	Estimated Time: 2-4 days

	Students simulate a land use decision simulations using either Quagmire: A Simulation Game for Wetland Decision Making for grades 5-8 or A World in Our Backyard, Chapter VII: Protect your Wetlands Activity 2 (Page 116). Then, find a local wetland or coastal saltmarsh using any of these resources • WA Wetlands of High Conservation Value • National Wetlands Mapper • Google Earth • Google Maps • 2016 Modeled Wetlands Inventory- Washington Department of Ecology Map of Washington Wetlands After choosing a wetland, students study the map and research the area so they can propose actions the surrounding community could take to preserve or expand the wetland. Organize students in groups around different proposed plans, research how they might enact these plans and how they would monitor positive impacts and minimize negative effects. Each group plans and delivers a presentation to the class outlining their solution and its effects.

8.	**Possible next steps/off-ramps/actions:**	
	Design and take action to conserve coastal wetlands. Check out Our Wetlands, Our World **Taking Action** lesson on pgs.113-115 or design your own project using Pacific Education Institutes' FieldDesign Engineering Design for Field-Based Applications 6-12. Ideas for specific actions can be found at *At Home with Wetlands: A Landowner's Guide*. Explore rain gardens, a constructed wetland, using Pacific Education Institute ELA Performance Task: Rain Gardens or Lesson Plans - Rain Gardens Make career connections and explore how Washington State Department of Ecology supports the management and protection of wetlands, including rating systems, delineation, and mitigation. WDOE Wetlands Expand into the arts. Check out the Burke Museum's Drawing Wild Washington and Salish Seas Wetland Art and Poetry.	

9	**Post Assessment**	Estimated time: 30 minutes

	Post-Assessment: Wetlands-Ecosystem Services Post-Assessment **Rubric**: Wetlands Ecosystem Services Rubric

OER Tracker -MS Wetlands Ecosystem Benefits

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