"Solutions-Oriented Learning" Storyline
MS- Urban Forestry: Ecosystem Benefits of an Urban Forest

Storyline introduction and overview:

Urban forests provide many benefits to a community and can minimize the human impact on the environment. Students will explore the impacts an urban community has on the environment. Students will discover the role trees play in an urban community and how trees can affect the ecosystem, human wellbeing, and provide economic value. Students will explore Indigenous relationships with trees. During the course of this storyline, students will measure and monitor urban forest ecosystem benefits, perform a field investigation, and design a development to minimize negative environmental impacts.

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

Placemaking:	Anchoring phenomena:	Drawdown:
Students inventory the trees in their neighborhood or surrounding parks noting the type and placements of trees, and the other species that inhabit the same space.	What is a tree worth? Read the essay by Carly Ziter and, as a class, compose a list of the values of a tree.	Indigenous Peoples' Forest Tenure **Environmental Justice:** Tree Equity in America's Cities

Indigenous and other relevant cultural connections:	NGSS PEs (progress towards):
Trees have been part of the Indigenous peoples since time Immemorial. They have been honoring and respecting trees as they are important members of their communities. In this Storyline, we will learn through some storytelling and reading, how the trees have been part of the traditions and lives of Indigenous tribes.	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. MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

"Solutions-Oriented Learning" Storyline
MS- Urban Forestry: Ecosystem Benefits of an Urban Forest

Estimated time required to implement this storyline: three to four weeks

NGSS PEs:

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
MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

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). 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. **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)	**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 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	**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

MS- Urban Forestry: Ecosystem Benefits of an Urban Forest

	are engineered otherwise.	factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.
. **Asking Questions and Defining Problems** Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	**For MS-ETS1-1** **ETS1.A: Defining and Delimiting Engineering Problems** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	**Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies and 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.

Materials:

Learning Session	Materials
1.	Internet access to choose and read one or more of these stories: A story of the pine (Cherokee) : Seven dancing brothers 10. Origin Of The Pleiades And The Pine The Legend of the Cedar Tree - A Cherokee Legend Why Plants Have Human Characteristics – Spirit of Trees The first pine trees - A Micmac Legend
2.	Copies of the story What is One Tree Worth? Poster paper to summarize students' responses
3.	Copies of the pre-assessment MS-Urban Forestry Pre-Assessment
4.	N/A
5.	Padlet set up, one tablet or computer per student, video set up and videos Appreciate Urban Forestry & What is the Urban Forest Brain Pop Game set up and tablet or computer for each student, game in the internet: Carbon Cycle Game Copies of the infographic in the link or access to the link to show infographic: The Urban Forest and Ecosystem Services: Impacts on Urban Water, Heat, and Pollution Cycles at the Tree, Street, and City Scale Copies of the field investigation, one per student: Urban Forest Field Investigation

6.	Copies of the [Benefits of Urban Trees Foldable](#) for each student. Tape or glue
7.	Begonias for lab, scale, plastic sandwich bags, masking tape, light source(s), fan(s), spray bottle. Copies of [Transpiration Lab](#) Poster paper to display the outcome.
8.	Copies of [Carbon Storage Lab Investigation](#) for each student. Flexible tape measure that will fit around the circumference of the tree; **or** a diameter tape measure; **and/or** a long string, marker and push pin

Learning Sessions

1.	**Grounding Native Ways of Knowing: How have Indigenous peoples traditionally connected with and maintained relationships with trees - from the past to current day?**	Estimated time: 50 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 trees found in the communities
- Management and restoration of trees in the communities
- Trees as ecosystems and units

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

Indigenous peoples have unique relationships with trees. Many stories from different tribes tell about how people became trees that now protect people. Select one or two of the stories below to share with your students or find a more local story to your region. After the reading, allow some time for students to discuss the story with your guidance. Consider contacting a member of a local Tribe and invite them to tell a story about trees and guide the discussion.

- [Origin Of The Pleiades And The Pine](#), Cherokee
- [The Legend of the Cedar Tree - A Cherokee Legend](#)
- [Why Plants Have Human Characteristics – Spirit of Trees](#), Iroquoian Myth, Retold by Anne Pellowski
- [The first pine trees - A Micmac Legend](#)

Solutions Oriented Learning Storyline: MS- Urban Forestry: Ecosystem Benefits of an Urban Forest by [PEI](#) for [ClimeTime](#) [CC BY 4.0](#)

4

Below are some examples of tribal traditions and science connections to tree restoration and management for the teacher to gain background knowledge:

- Nisqually Indian Tribe and U.S. Fish & Wildlife plant 50,000 native trees to restore habitat.
- Sacred Tree Profile: White Pine's Medicine, Magic, Mythology, and Meanings
- Native American – Spirit of Trees

Other resources:
Return of the king: Western white pine conservation and restoration in a changing climate | Rocky Mountain Research Station This article presents the use and management of the white pine tree through the years.

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: What is a tree worth?**	Estimated time: 50 minutes
	Students read Carly Ziter's essay What is One Tree Worth? . As a class, make a list of all the values that trees bring to an urban community. Post the list to refer back to during the storyline.	

3.	**Pre-Assessment:**	Estimated time: 30 minutes
	MS-Urban Forestry: Ecosystem Benefits of an Urban Forest Pre-Assessment MS-Urban Forestry: Ecosystem Benefits of an Urban Forest Rubric	

MS- Urban Forestry: Ecosystem Benefits of an Urban Forest

4.	Guiding question: What does an urban community look like?	Estimated time: Two 50 minute periods

1. In groups, students brainstorm a list of characteristics of urban communities and rural communities. Students write a definition of an urban community and post for sharing with the whole class. Teacher guides a class discussion by pulling out common characteristics of an urban community and contrasting with a rural community.
2. In response to the question, "What did the land look like before it was an urban community?", students choose a location in Washington state and research historical records to explore what the land looked like before development. As part of their research, students include how Indigenous people cared for that specific area.
3. Students use Google Earth to look at their chosen urban community. Students make notes about the differences they observe between different parts of the community.
4. Post the question, "What are the problems associated with urban communities?"
   a. Students watch Nature Lab: Changing Cities, Changing Climates as an overall introduction to the role of plants in mitigating climate change and in preparation for a deeper dive into the science for learning session 5.

5.	Guiding question: What is an urban forest?	Estimated time: Two 50 minute periods

1. Students use Padlet or another online collaboration tool to gather their initial thoughts about an urban forest. Students watch two very short videos to help expand their initial thoughts about an urban forest. Appreciate Urban Forestry & What is the Urban Forest After watching the two videos, students can add to their initial ideas on the collab board to revise their thinking.
2. Students review the carbon cycle to understand how carbon plays a role in the urban forest. Carbon Cycle Game
3. Students review the inputs and outputs of a tree. Students will view Figure 1 infographic and identify the inputs and outputs of a tree. Students should be able to identify that CO_2 and water are inputs and O_2 and water are outputs. Review with students that light and heat energy are absorbed and reflected. The Urban Forest and Ecosystem Services: Impacts on Urban Water, Heat, and Pollution Cycles at the Tree, Street, and City Scale
4. Students complete a Urban Forest Field Investigation in the school yard or at home. They will define an urban forest, collect and record metadata and species data to identify the biodiversity of the area, and they will sketch the location of the urban forest and tree(s). Ask students to think about the infographic and add the inputs and outputs for the tree to their sketched model of an urban forest.

6.	Guiding question: What are the ecosystem benefits of an urban forest?	Estimated time: 50 minutes

Solutions Oriented Learning Storyline: MS- Urban Forestry: Ecosystem Benefits of an Urban Forest by PEI for ClimeTime CC BY 4.0

6

1. Teacher Prep: Read [FOA- Building Greener Cities: Nine Benefits of Urban Trees](#) a 2. Students watch FAO video [Benefits of Urban Trees](#) and fill out the note catching foldable: **Benefits of Urban Trees.** Each fold represents a benefit. Behind the fold, students write information about that benefit. 3. Students then complete their foldable by determining whether the trees are causing the benefits directly or whether the presence of the trees in the urban community correlates with improvements that are caused by some other improvement. Use [Thinking in Causation](#) to review these concepts. Students can use data in the video in #2 to justify their choice. This activity provides a good opportunity for class discussion as to the value of understanding the difference between the two relationships. 4. Students place the foldable in their science journal for future reference. 5. An additional video resource: [Ted-Ed: What happens if you cut down all the trees](#).	

7.	**Guiding question: How is an urban forest a solution to climate change?**	Estimated time: Two 50 minute periods
	Solution: Transpiration- The Cooling Effect 1. Students watch [Sweating Can be Cool](#) NASA Video. 2. Questions for discussion: ● Why does sweating help your body cool down? ● What is transpiration? ● How does transpiration provide a cooling effect? ● What is the ECOSTRESS mission and how can this data help look at the temperature of urban heat islands? ● Is the relationship between the rate of transpiration of a tree and the cooling effect of the environment around the tree causal or correlational? How do you know? 3. Using the foldable from the previous lesson, students answer the question: "How is the transpiration of an urban forest a solution to climate change? Solution: Carbon Sequestration: A tree can absorb 150 kg of CO_2 in one year. Sequestering of carbon consequently mitigates climate change. 1. Students will watch [Ted-Ed: What if there were 1 trillion more trees?](#) 2. Using the foldable from the previous lesson, students answer the question: "How is the carbon sequestration of an urban forest a solution to climate change?"	

8.	**Guiding question: How can we measure and monitor the ecosystem benefits of an urban forest?**	Estimated time: Three 50 minute period
	1. Students review the field investigation from lesson 5, students will continue to analyze the trees inventoried to solve how much carbon is stored in a tree? What does that	

Solutions Oriented Learning Storyline: MS- Urban Forestry: Ecosystem Benefits of an Urban Forest by [PEI](#) for [ClimeTime](#) [CC BY 4.0](#)

7

really mean? Watch Forest Carbon 101.
2. Students complete the Carbon Storage Lab Investigation and post results.
3. Students complete the Transpiration Lab and post results.

9.	**Guiding Question: How can we measure and monitor *other* benefits of an urban forest?**	Estimated time: One 50 minute period

	Measuring Health and Happiness benefits of an urban forest on people
	    1. Students will watch and listen to Big Yellow Taxi by Joni Mitchell.
	    2. Teacher will guide a small or whole group discussion using these questions:
	        ● What is the meaning of "paradise"?
	        ● Define paradise (A place where somebody finds comfort and beauty)
	        ● Can an urban forest be considered "paradise"?
	    3. Elicit a discussion as a whole group the implications of "paving paradise". Some possible answers could be:
	        ● Paved areas become unattractive and may become wasteful or polluted.
	        ● Trees and other plants cannot grow there.
	        ● Ground is impervious which leads to water runoff, urban heating, etc.
	    For each answer, students distinguish between causal and correlational relationships.
	    4. Students will create a Nature-based Learning Survey using their district approved system (Google, Microsoft, or other) and collect data from their peers to help measure how nature affects their learning and reduces stress.	

10.	**Guiding Question: What designs would provide the most ecosystem benefits of the urban forest?**	Estimated time: Four 50 minute periods

	1. Students brainstorm about the criteria and constraints of urban forest design and restoration. Post these ideas to aid in their brainstorming:
	        a. What is the cost of maintaining urban forests (water use)?
	        b. Do we need to have large forests to have ecosystem benefits?
	        c. What kind of trees should we plant?
	        d. Where should the trees be planted?
	        e. Should we plant trees in environments that do not naturally have trees (deserts)?
	    2. Students read Urban forests make megacities more sustainable.
	    3. Students read The Desert Dilemma.
	    4. Students read Streams & Habitat from the City of Redmond Stream Team to learn about how trees keep streams cool and prevent erosion.
	    5. Students choose one of the 50 careers listed in 50 Careers in Trees - Tree Foundation of Kern: About the Tree Foundation of Kern and research the role of that profession in restoring and maintaining urban forests. In groups of students who have each chosen a different career, design a new urban forest for a local area in which all	

	ecosystem benefits as well as constraints are considered. Focus on the questions: "What types of trees would be best for your local community?" to guide the design. Each design includes the ecosystem benefits addressed. 6. As an extension, the teacher organizes a classroom visit from a local urban forester regarding what the city is doing to maintain and restore urban forests.

11.	**Guiding Question: Design a solution to improve the environmental stability of your school grounds.**	Estimated time: 50 minutes
	Choose one ecosystem benefit to use to design one improvement that could be made to your school ground. Write your solution as a proposal to the principal ● using scientific knowledge ● describing your criteria ● describing the relationship between your solution and the improvement as causal or correlational and how you know ● describing one constraint your solution will pose.	

12.	**Post -Assessment:**	Estimated time: 30 minutes
	MS - Urban Forestry: Ecosystem Benefits of Urban Forests Post- Assessment MS-Urban Forestry: Ecosystem Benefits of an Urban Forest Rubric	

13.	**Possible next steps/off-ramps/actions:**	
	Salmon Extension 1. Students watch a 6 minute video about solving stormwater runoff. Solving Stormwater Video 2. Students read an article about designing our cities to function more like forests to reduce stormwater runoff. Puget Sound Cities Stormwater Salmon 3. Students watch a video called Talking About Trees on the website called Trees. This website includes a video that is local in Bellevue, WA. Trees 4. Explore the social-emotional benefits of urban forests in Human Dimensions of Urban Forestry and Urban Greening 5. Uses of the Oak by Indigenous people from the far west. Indigenous Uses, Management, and Restoration of Oaks of the Far Western United States	

Solutions Oriented Learning Storyline: MS- Urban Forestry: Ecosystem Benefits of an Urban Forest by PEI for ClimeTime CC BY 4.0

9

Teacher Resources

 OER Tracker