Tree's Dream

Accompanying Lesson: Environmental Services

GRADES 6-8

I. OVERVIEW

A. Title

Environmental Services – Students will make observations on a tree's ability to filter and clean water as well as protect and stabilize soil. They will complete an erosion assessment of their school and create action items to improve it. Finally students will develop a land management plan to improve erosion and reduce stormwater runoff at their school using i-Tree Design software.

B. Learner Objectives

1. Students will identify the environmental services provided by trees and forests.

2. Students will demonstrate how tree and other plants protect soil and clean water.

3. Students will complete an assessment of erosion issues around their school.

4. Students will create a management plan to improve erosion and reduce stormwater runoff.

NEXT GENERATION SCIENCE STANDARDS

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

MS-ESS3-3 Earth and Human Activity. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4 Engineering Design. Develop a model to generate data for interactive testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

C. Materials

Two 16" x 12" x 4" trays, soil for each tray, sod and an assortment of vegetation for one tray, filled watering can, two clear containers, map of school, computer or tablets for each small group

D. Time Considerations

Preparation: 1 hour

Activity: Three 60-minute periods

E. Getting Ready

Build two wooden 'soil trays' that are approximately 16" long x 12" wide x 4" deep. At one end of the each box cut a v-shaped notch about 1.5" deep and fit it with a spout of stiff paper so the water runoff is directed into a container. Make them water tight by lining with plastic material or aluminum foil. Alternative to building soil trays, you can use an aluminum foil roasting tray, planter box, or cake pan with the same dimensions.

Fill one tray with just bare soil and the other tray with soil, a piece of sod (with roots included), and an assortment of vegetation (leaves, pine straw, small tree sapling, sticks, etc.). Place trays on an outside table so that the spouts extend over the edge. Prop boards or a waterproof object under the opposite end of each tray so they have an identical slope. Fill your watering can with a nearby hose. Collect two identical clear jars, water bottles, or small bowls to collect runoff water from the spout of each soil tray.

Download *Teaching with i-Tree* – Project Learning Tree's free online curriculum that accompanies the free online i-Tree

Design software – developed by the U.S. Forest Service – to calculate the dollar value of the benefits provided by a tree or a set of trees. Become familiar with the use of the use of [i-Tree Design software](#).

F. Key Vocabulary

Sustainability - Avoidance of the depletion of natural resources in order to maintain an ecological balance.

Environmental scientist - A professional who works to regulate, control, and prevent air, land, and water pollution.

Habitat - An area that provides an animal or plant with adequate food, water, shelter, and living space in an adequate arrangements.

Biodiversity - The variety and complexity of species present and interacting in an ecosystem and the relative abundance of each.

Carbon sequestration - A natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.

Watershed - The land area that delivers runoff water and sediment to a major river or stream and its tributaries.

Erosion - The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff, but it is often intensified by some human practices.

Water quality - The chemical, physical, biological, and radiological characteristics of water.

Stormwater runoff - Rainfall that flows over the ground surface. It is created when rain falls on roads, driveways, parking lots, rooftops and other paved surfaces that do not allow water to soak into the ground.

Permeable - A material or surface that allows liquids or gases to pass through it.

Impermeable - A material or surface that does not allow liquids or gases to pass through it.

II. BACKGROUND

Forests and trees provide us with numerous benefits and will continue to do so as long as we manage them properly. Trees are a renewable natural resource that can be harvested to provide us with over 3,000 everyday products. In the "A Tree's Dream" video, it states that we plant 5 trees for every 1 tree that is harvested - indicating sustainable silviculture. Sustainable forest management is essential not only to meet our current demand for this natural resource but ensure forests for future generations. *Sustainability* is categorized into 3 pillars – environmental, social, and economic. When managing for a multiple-use forest (more than one purpose) the benefits should fall within all three pillars. Social forest benefits include: aesthetics, sound buffers, and places for recreation. Harvesting timber, manufacturing products, and the thousands of jobs associated with trees are a few of the economic benefits. This lesson focuses on the environmental services that trees and forests provide.

Forest ecosystems provide wildlife with the appropriate *habitat* in order to survive. There are four basic elements of wildlife habitat – food, water, cover, and places to raise young. Fruit and nut producing trees provide food for various wildlife species and any stream, pond, or body of water provides water to nourish their bodies. Dense and mature trees, shrubs, and woody vines help provide shelter from predators and weather events. Tree cavities, such as ones found in snags (dead trees left standing), and underground dens are a great examples of "places to raise young" for birds, mammals, and

reptiles. Within forest ecosystems, it is important to have a diversity of tree ages, types of trees, and densities of forests to provide a variety of habitat types and create *biodiversity*. Wildlife need dense mature forests to find shelter from predators and weather, but they also need young open forests to forage for nutritious new growth of herbaceous vegetation. Harvesting a stand of trees can help create an open landscape allowing sunlight to hit the forest floor which will assist with natural regeneration of tree seedlings, grasses, and other plants. Clearing an area of the forest also promotes the development of edge habitat. The "edge effect" is where two plant communities meet and animals have a richer habitat because they can use both communities. As the edge effect increases, the boundary habitat allows for greater biodiversity.

Trees take in and *sequester*, or hold onto, carbon dioxide and give off oxygen. Carbon dioxide is a natural greenhouse gas in the air that traps heat from the sun which keeps our planet warm enough for life. CO2 concentrations in the atmosphere have increased as humans have burned more fossil fuels and cleared more forests which has caused the earth's temperature to rise. Trees store carbon by making it part of their living tissue. Forests and wood products, like the lumber that goes into the construction of a home, hold onto or sequester carbon keeping it out of the atmosphere. Leaves also can absorb sulfur dioxide, nitrogen oxides, and other pollutants as well as settle out, trap, and hold small particles (dust, ash, smoke, etc.) that can damage the lungs. They absorb these pollutants through their stomata, or pores, successfully filtering them from the air. Trees that are planted in urban environments can contribute towards improving the air quality.

Forests have a large impact on protecting *watersheds* and keeping soil healthy. A watershed is the area of land around a body of water in which all water flows to one drainage point. A tree's leaves and branches intercept hard rain, softening its impact on soil. This helps keep the topsoil in place and reduces *erosion*, playing a vital role in the soil's composition. Leaf litter and other decomposing organic matter on the forest floor replenish nutrients back into the soil. A tree's roots also stabilize soil because they branch out in all directions, the width sometimes up to 4 times the tree's height, holding soil in place like hundreds of tiny hands. Stabilizing the soil in a watershed keeps sediment and run off out of the body of water. If sediment were to build up in the water, it would increase turbidity therefore limiting the amount of sunlight available for aquatic plants to photosynthesize, reduce the visibility for fish and other biotic organisms to find their food, increase water temperature, as well as decrease dissolved oxygen. Therefor forests play an important role in protecting the *water quality* in a watershed.

III. DOING THE ACTIVITY

DAY 1

A. ENGAGE – CAPTURES INTEREST, MAKES CONNECTIONS, AND PROVIDES AN OPPORTUNITY FOR STUDENTS TO EXPRESS WHAT THEY KNOW

1. Ask the students if they have heard of the career of an *environmental scientist*. Explore the career of environmental scientist by watching the "Career One Stop" video by the U.S. Department of Labor at: https://www.careeronestop. org/Toolkit/Careers/Occupations/occupation-profile.aspx?keyword=Environmental%20Scientists%20and%20 Specialists,%20Including%20Health&onetcode=19204100&location=UNITED%20STATES

2. After watching, ask the students, "What types of jobs or duties does an environmental scientist have? Do you think they do important work that is impactful?" Discuss answers.

3. Tell students that they are going to use some of the same skills that environmental scientist and natural resource professionals use when assessing the health of a forest ecosystem. Say, "We will be focusing on the environmental services that trees provide, specifically clean air and water, as well as soil protection and health."

B. EXPLORE – ACTIVITIES TO EXPLORE THE CONCEPT OR SKILL

4. Say, "Now we are going to watch a video about Tim the tree who has a big dream. Make sure to pay close attention to what Tim says about his homestead and life in the forest at the very beginning of the movie." Show the video, "A

Tree's Dream" at:

5. After watching the video, ask students the following questions and lead a discussion on each topic.

- "What did Tim say at the beginning of the video that he and his family did together in the forest?" (They made a home for wild animals; helped clean the air; provided people with recreation and jobs)

- "What animals did you see in the video and what specific habitats do they need to survive?"

- "What are some different careers that work with trees and forests?"

- "How do you think trees protect soil and keep it healthy?"

- "How do you think trees clean air and water?"

6. Explain to students the definition of a watershed. Do a quick demonstration so they can visualize this. Have students cup one of their hands and hold it out in front of them. Spray each student's hand with a water bottle and ask where the water collected (center of hand). "A watershed is the area of land around a body of water in which all water flows to one drainage point. So the watershed is not the actual stream, river, or lake but rather the land that is around it."

7. Say, "When we manage our waterways, we cannot just think about the body of water itself, we have to think about the impacts from the land around it." Ask, "Do you think a pond's water would be healthy or unhealthy if it had forestland surrounding it? What if instead of forestland is it was bare soil with no grass, trees, leaves, sticks, or anything on the ground?"

8. Show the students the two soil trays and point out the differences between them. Allow two students to volunteer to assist you with the demonstration. Have one student use a watering can and pour water across the top of the soil tray with nothing on it (bare ground) to represent a rain event. As they do this, collect the water out of the spout in a clear bottle or bowl. Ask the class to observe the water's speed of flow into the container, the amount of runoff, and appearance of runoff water. The water should be full of sediment from this soil tray and demonstrate erosion. Then have the other volunteer pour water over the soil tray with leaves, pine straw, grass, sticks, etc. (forest floor) and collect the water runoff. This water should be much clearer because the forest floor intercepted the rain. Allow each student to look at the two water containers up close and examine them.

9. Compare the two runoff samples. Discuss the following questions with the class.

- "Which water flowed faster?" (Bare ground – nothing to intercept it and slow it down)

- "Which container had less water?" (Forest floor – grass roots and leaves absorbed some of the water)

- "Which water came out clearer?" (Forest floor – forests can help filter out impurities and prevent erosion)

- "Which soil tray had more erosion?" (Bare ground – More runoff of soil and sediment into water)

- "If you were a fish, which pond would you rather live in?" (Forested area – most fish could not survive in a pond with only bare soil surrounding it)

10. Explain the negative affect erosion and sediment buildup can have on water quality and the organisms that

depend on that water. Show students pictures of healthy clear streams vs. unhealthy sediment filled streams.

- Sediment build up from construction site near the Chattahoochee River is Georgia: https://www.usgs. gov/media/images/sediment-laden-water-a-tributary-can-harm-water-quality-rivers

- Side by side comparison of water clarity: https://ucanr.edu/sites/calagjournal/ archive/?image=img5803p149.jpg

C. Explain – students develop explanations for the concept or skill they have experienced
11. Have students draw and label the two soils trays - bare ground and forest floor - on individual worksheets. Have them answer the following questions:

- What happened to the soil and runoff water on the bare ground demonstration?

- What happened when it rained on the forest floor?

- In what ways do trees roots and leaves help protect the soil?

- How does erosion and sediment build up affect water quality such as turbidity, temperature, DO, photosynthesis of plants, and aquatic organisms?

DAY 2

D. Elaborate & Evaluate – activities to apply learning to new situations and discuss/compare ideas with others & students review/reflect on their own learning and provide evidence for changes to their learning

12. Have students work in small groups to do an erosion investigation around the school. Have groups independently walk around the school grounds and establish areas of erosion. If you do not have any erosion at your school, show students pictures of erosion caused by different events take them to a nearby park. Have students complete a data sheet with their observations.

13. Data sheet - For each erosion example groups should record their observations of:

- Area it was found by drawing a simple school map and labeling each erosion site (In grassy field; Near parking lot or side walk; In high foot traffic area; etc.)

- How bad is the erosion (Mild – just a small area of soil exposed; Moderate – larger area of soil exposed and some evidence of water runoff; Severe – a lot of exposed soil and obvious gullies of water runoff)

- Why did this area erode? (Grass/vegetation died due to unhealthy soil or lack of water; Lots of water runoff from impermeable surfaces; High foot traffic has worn down and killed plants)

- How would you improve this erosion? (Amend the soil and plant grass; Plant a tree to intercept rain; Divert water runoff into a rock garden; Build a permeable pathway; etc.)

14. Back in the classroom, project a map of your school grounds using Google Earth or a screenshot of Google Maps. Lead a discussion on permeable vs. impermeable surfaces and how they can have an effect on erosion and water runoff. Have students determine if each item on the map (grass field, parking lot, building, outdoor classroom, side walk, etc.) is permeable or impermeable. Then have students estimate the percentage of permeable surfaces on their school grounds vs.

impermeable.

15. Have students discuss within their small groups how to reduce the percentage of impermeable surfaces as well as plant trees in designated areas to alleviate erosion issues. Groups should then develop an erosion mitigation plan for the school.

DAY 3
16. Lead a lesson structured around "Activity 3 – Land Manager Role Play" from Project Learning Tree's [Teaching with i-Tree](#) free online unit. Students will work in the same small groups to develop a management plan to help the school intercept stormwater and slow down erosion.

17. Explain how to use the [i-Tree Design](#) software with the students by creating a map of the school. Incorporate the currently existing trees that are planted on property and generate an estimated benefits report. Discuss and analyze the many ecosystem services that trees provide for the school.

18. Now allow groups to test their initial erosion mitigation plan using the i-Tree Design online program. Groups should work individually to "plant" additional trees on the map to help reduce stormwater runoff in areas of erosion around the school. If groups did not specify tree species in their initial plan then have students plant loblolly pines as a generic tree for this plan.

19. Once completed, have groups generate and save a final report of their estimated benefits. Each group should share a short presentation on the solutions they incorporated in their erosion mitigation plan and allow for constructive feedback on the effectiveness of their plan from the class.

DAY 4
20. Groups should individually discuss the positive and negative qualities of their initial plan and consider the feedback received from the previous day. They will then use the i-Tree Design program to make improvements to their initial erosion mitigation plan and develop a revised plan.

21. Students will use the [i-Tree Species](#) tool to select species of trees that are particularly good at "stream flow reduction" (stormwater management). Encourage students to pick native tree species that are hardy in your region that also incorporate other environmental factors they consider important for the school.

22. Once completed, have groups generate and save a final report of their estimated benefits. Now have each group present their improved erosion mitigation plan focusing on the changes that were made and why.

IV. ENRICH: EXERCISES THAT EXTEND OR ENRICH THE LEARNING EXPERIENCE

A. Option 1 – Pick a winning group on day 4 with the most effective erosion mitigation plan. Have this group present their findings to the school's executive staff. Encourage administration to fund this project or have the class lead a fundraiser to help plant trees on the school property.

B. Option 2 – Have students make a management plan to improve a specific issue (air quality, reduce energy costs, wind reduction) for their homes.

C. Option 3 – Take students to visit a local park or forest that has a body of water. Make observations about the riparian buffer and how it plays a role in the water quality. Have a park ranger or environmental scientist lead a lesson on sampling for water quality.

V. ADDITIONAL RESOURCES

1. Project Learning Tree – www.plt.org
Project Learning Tree (PLT) is an award-winning environmental education program designed for teachers and other educators, parents, and community leaders working with youth from preschool through grade 12.

2. Teaching with i-Tree - https://www.plt.org/curriculum/teaching-with-itree/
PLT's *Teaching with i-Tree* unit, designed for use with middle and high school students, includes three hands-on activities that engage students in discovering and analyzing the many ecosystem services that trees provide. Students use the free, online i-Tree Design software – developed by the U.S. Forest Service – to calculate the dollar value of the benefits provided by a tree or a set of trees.

3. GreenSchools Investigations - https://shop.plt.org/Shop/ProductDetails/greenschools-investigations
PLT's GreenSchools program inspires students to improve the environment at their school, at home, and in their community. Student-led Green Teams apply STEM (science, technology, engineering, math) to create greener and healthier schools—and save schools money!

4. Next Generation Science Standards - https://www.nextgenscience.org/standards/standards
Within the Next Generation Science Standards (NGSS), there are three distinct and equally important dimensions to learning science. These dimensions are combined to form each standard—or performance expectation—and each dimension works with the other two to help students build a cohesive understanding of science over time.