REYS: Restoration Ecology for Young Stewards

How Do Trees Affect Erosion – an experiment

The objective of this lesson is to provide students with a good example of the scientific method, while teaching them how trees help to prevent erosion. This lesson was developed by Cara Ianni, email her with questions: cara@stillysnofish.org

Time: 2-3 hours for grades 4-6 (can be split into 2 sessions), or two consecutive class periods for secondary levels. (For secondary levels, students may need to skip most of the writing during the first class period and concentrate more on finishing the active part of the experiment, using the second class to write up their procedure and results).

Preparation:

- Using the pushpin, poke holes into the plastic 16-ounce "deli cup." Poke holes from the inside of the cup towards the outside (or the water will not flow through), and the holes should be about 1 cm apart through the entire bottom of the cup. This is referred to as a "perforated cup" below.

Materials:

- Student worksheets
- Overhead of Pleistocene Ice Sheet extent (see: http://pubs.usgs.gov/gip/continents/)
- Pushpin
- 5 gallon bucket for clean-up (optional, but recommended)
- **Materials needs per student group:**
  - eight sticks of "EZ shape modeling clay" (see: http://www.kjpcrafts.com/ezshapemodelingclay.html), with 4 sticks pushed together to form a square
  - two 9"x13"foil baking trays, at least 2.75" inches deep
  - two cups of playground/sandbox grade sand (or Whitney Farms white sand)
  - two cups of generic-brand potting soil (coarse)
  - one 1-ounce plastic cup, available at restaurant supply stores (e.g. Cash & Carry)
  - one 16-ounce plastic "deli cup", available at restaurant supply stores
  - a wide-mouthed container, filled with at least 6 cups of water
  - 100 toothpicks, **4" long**, available at restaurant supply stores (optional: "party toothpicks, with the frilly tops, look more like trees and make nice touch)
  - Old floppy disc, or some small, flat surface, like a 6" ruler.
  - Strainer with fine metal mesh

Begin by explaining to students that they are going to be "doing science", that they will be performing an experiment that addresses the testable question: "How do trees affect erosion?" Define erosion (when water or wind wears away earth materials) and ask for examples. Have students record the testable question and the definition on their worksheet.

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Explain to students that one way to answer that question using science would be to find several streams that are similar, cut down the trees on half of the streams, and then measure the difference in how much the streambanks erode. Tell students that instead, we will be using a model for our experiment. Ask students to define a model and give example Explain that scientist have a saying that, "All models are wrong, but some models are useful," and tell how their example models, and the model that we are using today, are congruent with this saying.

The next steps will be to build the models used for the experiment, and depending on the grade level, you may choose to give all or most of the instructions below, or separate them into smaller parts (essential for younger grades). First you will go over the layers of the model and the reasons behind the layers, and them you will give specific instructions on how to build the model.

Tell students that we will be creating a model of the layers of earth materials that are present where we live (Puget Sound area). Show students that the bottom layer of the model will be clay, which will represent a lower layer of bedrock or clay, both of which, like the clay we are using in the model, are impervious to water.

Next, explain to students that the next layer we will add on top pf the clay will be a layer of sand, which is supposed to represent a layer of different sized-rocks all jumbled up together. Ask students how they think all of these rocks ended up on top of the clay layer. To focus the students, tell them that the rocky layer is a result from something that happened about 15,000 years ago, and ask them what they thing was here 15,000 years ago. Explain that 15,000 was the last ice age that North America has experienced, and that a glacier about ½ mile tall covered about half the continent, including Puget Sound (show overhead). Explain how the glaciers, when growing from the north, scraped away the dirt, trees, etc in its path, leaving only the bedrock behind. Also, when it melted, it formed rivers that moved rocks and sand of all sizes and dumped them on top of the bedrock – hence the layer of rocks called "glacial til."

Explain to student that the top layer of the model will be soil. Ask students how they they the soil got there (how is soil made), and if time, go over some simplified cycle of decomposition: live plants → dead plants → decomposers (worms, fungi, etc) → nutrient rich soil → used by live plants.

IMPORTANT: All materials MUST BE DRY to begin with, or the moisture will create friction and you will not get the anticipated results.

After explaining the parts of the model, give students the detailed instruction on how to build the model and model the process in front of the class. See the diagram. Place the clay in the corner of the foil pan, and smooth the edges so the clay (for the most part) is flush with the sides of the pan. Next, using the 1-ounce plastic cup, add 6 ounce of sand on top of the clay. Use the floppy disc of other small, flat item, to flatten the sand into an even layer on top of the clay. Some sand will likely fall off the side of the clay, into the foil pan – tell students that this is OK and to just leave the spilled sand there instead of putting it back on top of the clay. Repeat the process with a top layer of **8 ounces** of potting soil. At this stage, **each small group of students will build two identical models.**

Return to the testable question, and inform students that we will be using toothpicks to model trees. Ask students, "In order to answer our question, should we add toothpicks (trees) to one model or both?" You, or a student, should then explain that, for good science, we should add toothpicks to only one model, because that is the only way to tell the difference in erosion that only the "trees" had an effect on. Segue into variables – go over the manipulated, responding and controlled variable and have student record these on their worksheets.

Have student groups add all 100 toothpicks to only one model. Toothpicks should be spread somewhat evenly (make sure the get the outside edges!), about 1 cm apart, throughout the layered model. Have students stick the toothpicks upright, through the soils and clay, firmly into the clay.

Explain to students that we will be "raining" in our models with water through a perforated cup, to determine the effect of trees on erosion. Ask students what we need to control about the water in order to do good science (amount, rate & height), and add these controlled variables to the worksheet. Next, students should record their predictions.

Demonstrate the "raining process" for the class, before each group performs to process. Hold the perforated cup about 4" above the soil (will be just above the toothpicks on the "tree" model). The cup should be held motionless over the middle of the layered model. Using the one ounce cup (be sure it is clean), add 20 ounce of water into the perforated cup. **Water must be added quickly (~ 2 ounces/second) and the 1 oz cups must be full** to ensure a full 20 ounces is added (so don't go so quickly that the 1 oz cups are not full). This process will be repeated for both models – have one student hold the perforated cup, while another does the water scooping.

Have students walk around the room and look at other group's results to get an idea of what the average or general result is.

For those wishing to quantify the results (highly recommended for all grades), have students drain **just the water and the washed away soil/sand it contains**, into the metal strainer, using it like a sieve. Do this over the sink (which may clog) or bucket, and it's best to model the process. Keep the soil and sand that remained on top of the clay there – do not let it fall into the sieve. Drain out the water. Do this for both models, and record the amount of soil erosion (in ounces) for each groups set of models in a data table. (You can use the 1oz scoops to measure the amount of soil.) Calculate the average amount of erosion for both model types, to be used in the bar graph and in the conclusion.

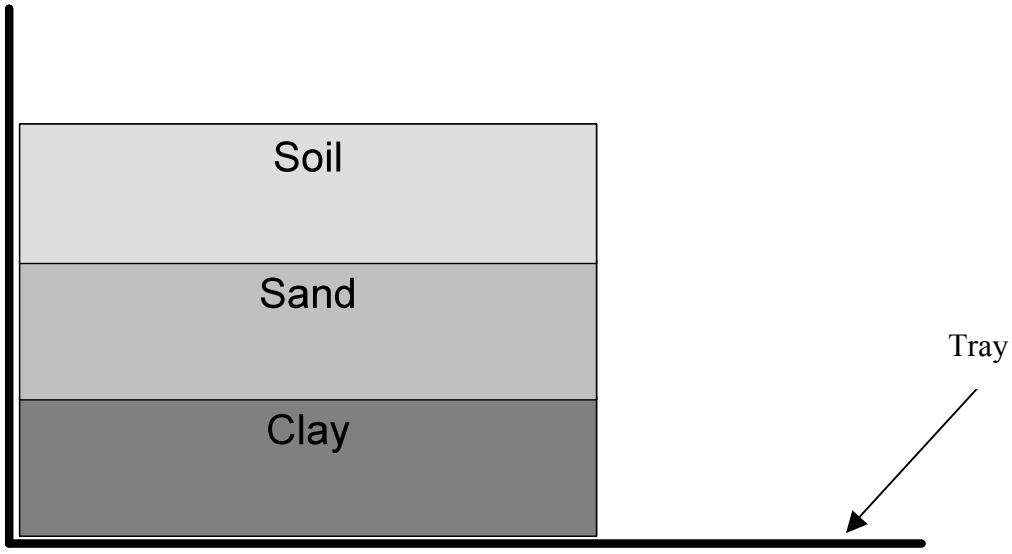
Clean up the models before completing the worksheet. Have students remove toothpicks and save for reuse. It is recommended that you wash the soils and sand into a bucket, which can be flushed down the toilet or used for gardening. **Save the clay and trays for reuse.**

Discuss the results as a class. Explain some of the mechanisms behind the pattern they observed of reduced erosion where there were toothpicks: 1) Trees interact with the water by slowing it down, 2) Trees interact with the soil by physically blocking its movement. You also discuss how, in reality, trees absorb water, thereby reducing the amount erosion. Connect this with

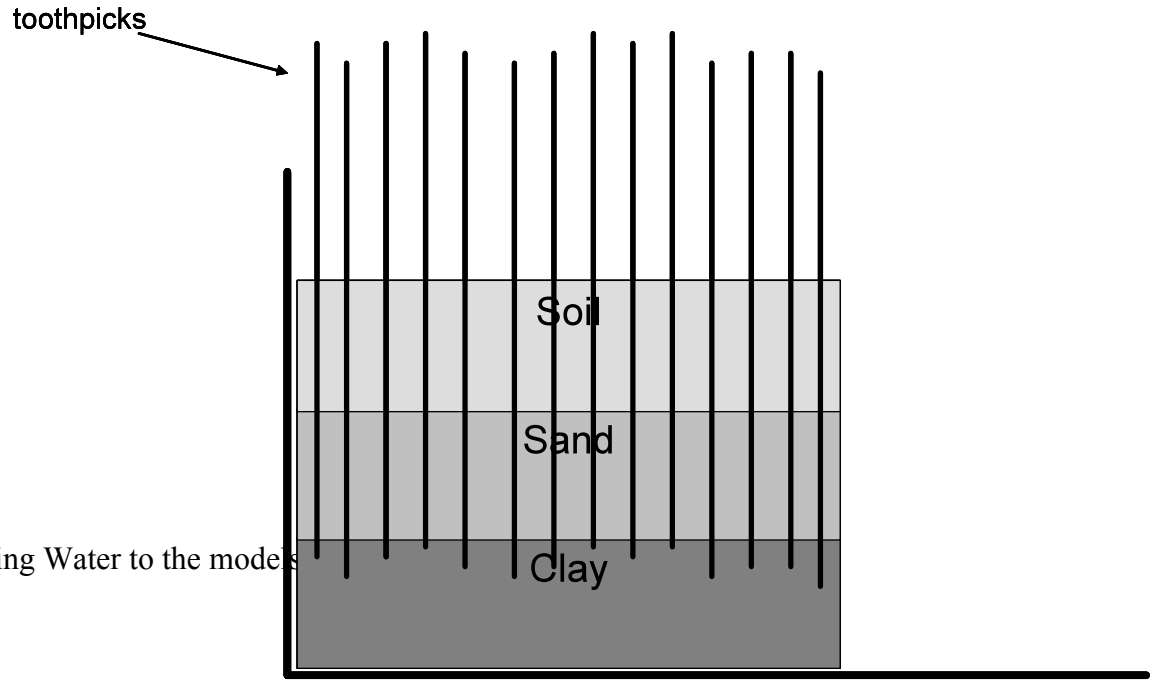
salmon and stream habitats – review the effects of high turbidity discussed at lesson #2's watershed tour fieldtrip.
Students should complete their worksheet, including writing down a detailed step-by-step recipe of the procedure follow, a material list, a diagram of the set-up (not the results!) both models, their conclusion, and for those who quantified the results, a data table and bar graph displaying the results.

Diagram of set-up:

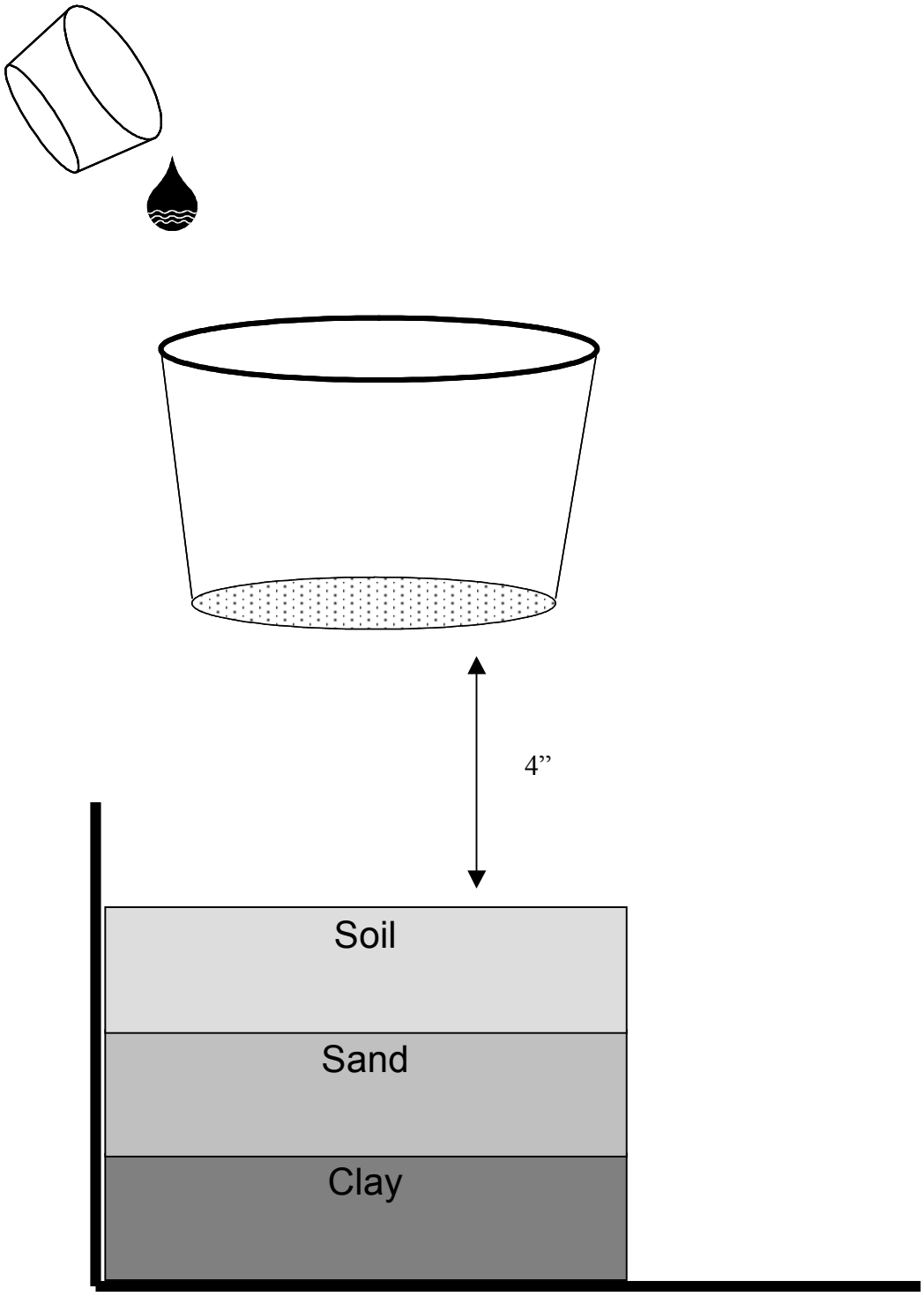
Model without toothpicks:



Model with toothpicks



Adding Water to the models


4”
Soil
Sand
Clay