ENVIROSCAPE WATERSHED MODEL PRESENTATION

AUTHOR:
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GRADE: 1-6

SUBJECTS: Science

DURATION: 30 – 60 minutes

MATERIALS:
- Enviroscape model and accessories
- Kool-aid or unsweetened drink mix- green and red
- Instant unsweetened tea
- Soy sauce or chocolate syrup
- Small pieces of paper
- Water
- Spray bottles
- Sponges
- Clay

LESSON OVERVIEW:
Through an Enviroscape model demonstration, students will learn how point and non-point source pollution moves through a watershed and what management strategies can be implemented to prevent or minimize negative effects on water resources.

OBJECTIVES:
Students will be able to:

1. Define watershed and name the watershed in which they live.
2. Differentiate between point and non-point source pollution.
3. Identify and differentiate between a storm drain and sewer.
4. Name three best management practices (BMPs) that prevent or reduce non-point source pollution.

BACKGROUND INFORMATION:
What happens to rain or snow after it falls? Where does precipitation go? Some gets evaporated back into the atmosphere. Of course, there are many other paths upon which precipitation can travel. To track these paths, it is helpful to learn about the watershed concept, and how water moves both over and through land.

A watershed, also called a drainage basin, is the land area that drains to a common body of water. The outer-most boundaries of the watershed have the highest elevation. In this analogy, water drains from high to low elevation and drains, and all of this water drains into the same body of water, similar to the way water drains in a bathtub. Watersheds are often named after the water body to which the water drains. You do not live in just one watershed either. For example, all of the water that falls on your property may run into Smith's Creek, which flows into Bob's Lake that is connected to the State River that runs into the Atlantic Ocean. In that scenario, your property is part of Smith's Creek watershed, Bob's Lake watershed, the State River drainage basin, and the Atlantic Ocean watershed. Water is always flowing into another water body.

Water enters a watershed in several different ways. One method is via infiltration. For example, rain falls in a forest or garden. It hits the ground and is absorbed like a sponge. It is naturally filtered as it travels through layers of soil and rock until it becomes part of the groundwater supply. It keeps moving and is cooled before it eventually discharges into surface water such as a lake, stream, or river, and continues to flow until it reaches the ocean. Back when there was very little development, this was the primary path of stormwater.

Another way water enters a watershed is through surface water run-off, or what is also referred to as stormwater. In urban and suburban there is a large amount of impervious surfaces such as paved roads which prevents water from naturally filtering back into the ground. Water that hits this road cannot pass through it, rather it flow across sidewalks, lawns, roads, and parking lots to permeable areas or directly into the nearest stream or lake. Along the way, stormwater water picks up sediment, heavy metals, nutrients, and toxins from the roads and treated lawns it runs over. All of these materials are different types of pollution, or substances, which in varying amounts, can cause damage to the environment.

Water also enters a watershed in a way similar to which it enters a watershed via surface water run-off. Specifically, it is related to the collection of stormwater and wastewater in some areas such as large, developing cities where there is a significant amount of impervious surfaces. At first, combined sewers were used in these areas in which both wastewater from homes and businesses and stormwater from storm drains were both collected and piped together to the waste-water treatment plant. As these areas continued to develop and the amount of impervious surfaces also grew, so too did the amount of stormwater. At certain times, such as during a heavy rain event, this increase in stormwater, combined with the amount of wastewater being carried to the wastewater treatment plant, causes combined sewer overflows (CSOs) to occur which leads to the discharge of raw or partially treated sewage into surface waters before it was able to be treated. This in turn can cause a multitude of other problems. Now, many of these areas are switching to separate sewers in which wastewater is kept separate from stormwater, though combined sewers still exist in some areas due to the huge expense to make the necessary upgrades. The wastewater from homes and businesses still flows to the waste-water treatment plant while the stormwater is piped directly into the nearest stream, lake or river. From here, it flows all the way to the ocean.

The increasing amount of storm water in many areas causes many problems for water quality. It travels over lawns, driveways, roads, and parking lots, picking up many pollutants, and eventually flows untreated right into our lakes and streams. The sheer amount of water alone can also cause flash floods and bank erosion which can be unsafe and lead to the degradation of habitat critical to aquatic wildlife.

Pollution is commonly divided into two types: point source and nonpoint source pollution. Point source pollution is contamination whose source can be pinpointed to a single thing, person, or property. Industrial pollution and CSOs are considered point source pollution because their source can be traced back to their exact source of origin. On the other hand, nonpoint source pollution results from sources whose exact origin cannot be easily determined. For example, fertilizer may be washed away in stormwater which may drain into surface water, but its source cannot be identified easily usually because it may have been washed into the water after a storm event.

Some examples of nonpoint source pollution are:

- Fertilizers/pesticides – Excess fertilizers and pesticides from lawns and fields can wash off or infiltrate into the ground. Excess fertilizers that wash into surface water such as ponds and lakes can lead to algal blooms or the growth of unwanted aquatic vegetation. Algal blooms can occur when there are excess nutrients present in water, and this can

cause detrimental effects to the health of the water body as well as human health. This in turn can lead to an increase in the natural aging of a lake, or cultural eutrophication. In addition, algae can block sunlight from reaching the plants and animals below, and can also deplete oxygen levels necessary for native wildlife to successfully survive, thus negatively impacting aquatic life in the lake.

- Bacteria – Bacteria from raw waste, either animal or human, can increase the spread of disease and make waters unsafe to drink and used for other purposes. Run-off can carry cow manure from farm fields or dog waste left on a sidewalk into our streams. *E. coli* is a type of bacteria that normally lives in the digestive tract of animals and humans. High levels of *E. coli* in water may indicate that some type of fecal contamination has occurred. While most *E. coli* strains are harmless, some can cause severe illness. This animal waste also increases the nutrients in the water, which can potentially cause an algal bloom or promote the increased growth of other unwanted aquatic vegetation.

- Soil – Bare soil can wash into streams cause habitat destruction and over time, makes the stream shallower and warmer as a result. Soil also carries nutrients, which can also cause excess growth of algae and other aquatic species.

- Thermal pollution - Sun-scorched paved surfaces such as concrete and asphalt transfers some of this heat to the water that falls onto it, similar to the way water in which a radiator cools down the engine of a car. This heated water flows directly to our stream and rivers and can impact the organisms that live there. Warm water does not hold as much oxygen as cold water and can lead to suffocation of aquatic plants and animals including fish. Such an unnatural increase in the temperature of the water can be harmful to the aquatic ecosystem.

There are some simple things that people can do to reduce or prevent stormwater pollution. These things, called best management practices (BMPs), are ways of reducing or preventing the impacts of pollution that can harm the environment. There are small things that you can do yourself in and around your home or school. You can also encourage your neighbors to do their part. Installing a rain garden is an example of a best management practice that reduces or prevents the effects of stormwater. A rain garden is a perennial garden consisting of native plants which catches stormwater, holding this water in place long enough to allow the plants and soil to filter out pollutants, and allow it to filter into the ground, thus recharging groundwater.

VOCABULARY:
Claim, communicate, decision making, defend, gradual change, human impact, investigation, model, observations, pollution, population, potential, timeline, transform, community, conservation, contribution, limitation, reshape, stormwater, groundwater, watershed or drainage basin, surface water, run-off, contaminants, sewer, combined sewers, combined sewer overflows, point source pollution, non-point source pollution, fertilizer, pesticide, bacteria, soil, thermal pollution, best management practices (BMPs), rain garden, algal bloom.

PROCEDURE:

Warm-Up (Anticipatory Set):

a) What is a model? Explain that the Enviroscape is a model that helps us visualize what happens to water in a watershed. Define watershed. Give them an analogy of a watershed as a large bathtub with hills, houses, roads and cities; any water poured into a bathtub flows toward the drain.

b) Ask the students to guess where all the water in your city goes. Name the watershed that you live in.

   i) Optional: Map out the course of water from your school/city to the ocean.

c) Stormwater

   i) Ask the students what happens to rain that falls in the forest (of course many things could happen, but the answer you are looking for is absorption into the ground).

   ii) Ask the students whether water can be absorbed into pavement, roads, and roofs like it is absorbed into the ground (no). Define impervious.

   iii) What happens to that water since it cannot be absorbed into the ground? Explain the difference between the sewer and a storm drain. The water goes to the storm drains and empties out untreated water into the nearest lake, river, or stream.

d) Have the students give their definitions of pollution. Tell the students that there are two types of pollution you will be talking about: point-source pollution and non-point source pollution. You can 'point' at where point source pollution is coming from, but you do not know exactly where non-point source pollution originates from. Give some brief examples of each.

Activity:

PART I:

   i) Show students where the factory is located in the model. Tell them that this factory is a bad factory and dumping pollutants into our stream.

      (1) Pour soy sauce or chocolate syrup into the factory.

      (2) Ask the students whether this is point source or non-point source pollution (point).

   ii) Move to the residential area. Ask the students what some people put on their lawns to make the grass greener (fertilizer). Tell them what a fertilizer is, how it works. Explain that although fertilizers are great for the health of lawns, it can be harmful to aquatic ecosystems. It can wash into our waterways if people use too much fertilizer, apply it at the wrong time, or don't apply it properly.

      (1) For younger students – explain that one plant (e.g. algae) that can take over the pond, (use the blanket analogy) preventing sunlight from penetrating into the water, and depleting oxygen levels, two things that other aquatic plants would normally depend on to survive.

(2) For older students – Discuss an algal bloom. Ask the students to guess what happens to the plants underneath the water when there is a blanket of algae on top. Touch on photosynthesis and respiration.

(3) Sprinkle green Kool-Aid on lawn areas. Ask the students whether fertilizer is point source or non-point source pollution (non-point).

iii) Who else in the watershed uses fertilizers (farmers)? Sprinkle the same Kool-Aid on the farmer's field.

iv) What else is on the farm besides the field (cows)? Animal waste can cause pollution in the water too. Ask the students why they wash their hands after going to the bathroom (to get rid of germs). Well those germs are in animal waste too (farm animals like cows as well as dogs and cats). When animal waste gets into the water, harmful germs also get in the water. If you drink or play in the contaminated water, you may get very sick. *E. coli* is a bacterium that lives in intestines/digestive tract. It's presence in water tells us that some type of waste is washing into the water, and this can make people very sick.

(1) Sprinkle unsweetened tea around the cows and down the residential street.

(2) Is animal waste point source or non point source pollution (non-point)?

v) Litter.

(1) Sprinkle drink mix or confetti on residential street.

(2) How can litter harm the environment?

(3) Point or non-point source pollution? (non-point)

vi) Car leakage. Cars contain harmful chemicals (oil, antifreeze, etc.) that can leak onto the street if the cars are not taken care of. These fluids can get washed into waterways as it becomes part of stormwater.

(1) Drip soy sauce behind cars.

(2) Point source or non-point source? (non-point)

vii) Soil that washes into water can also be a source of pollution. When you build a sand castle, what happens when you pour a bucket of water on top of it? It collapses and the sand washes away. At the construction site, all the grass and vegetation has been striped away. What do you think will happen to the soil now?

(1) How is soil harmful to the stream?

(a) Destruction of habitat. Imagine you are a crayfish. You are chilling out on the clean gravel river bottom, catching food, enjoying the simple life. It starts raining, but you aren't worried, it rains all of the time. Then, all of a sudden, the water gets cloudy with dirt; you can't see anything and your nice neat gravel bed you just cleaned out is buried in soil.

(b) For older students – Soil erosion can cause lake and streams to fill in prematurely. This can cause water temperature to rise and dissolved oxygen levels to decrease.

(2) Sprinkle Kool-Aid over the construction site.

(3) Point or non-point? (non-point)

viii) For older students – Thermal pollution. Have students guess at what thermal pollution is. What does the word thermal mean? Define thermal pollution.

(1) Have them imagine it is a hot summer day and they are walking to a park. They walk across hot pavement and finally reach the grass and the trees. Do you notice anything about the temperature when you reached the park? It is significantly cooler when you get to the grass.

(2) What happens when rain water hits the hot pavement? Water has the unique ability of being able to absorb heat. If the students are familiar with cars, give the example of water in a radiator cooling down the engine. After absorbing this heat, the rain water cannot be absorbed into the pavement (impervious), so it runs off into lakes and streams.

(3) Why is thermal pollution harmful?

(a) Warm water cannot hold as much oxygen. Animals suffocate. Also the warm water causes the aquatic organisms to respire faster, consuming the remaining oxygen faster.

(b) Many aquatic organisms have a particular range of temperature in which they can survive. People like to live within a certain temperature range, although people can dress appropriately for either very hot or very cold conditions. Fish and other organisms can't just take off their clothes and put on a bathing suit. If the water is too warm they may suffer from thermal shock.

(4) Sprinkle drink mix on roofs, roads, and parking lots.

(5) Point or non-point? (non-point)

ix) Now it rains. Spray the model with a spray bottle and let the drink mixes collect in the lake.

x) Ask the students whether they would want to swim in the dirty lake. Drain the lake and tell the students that you will be starting over and this time you will be focusing on ways to reduce the amount of pollution entering the lake.

PART II:

xi) Factory – soy sauce down the pipe

(1) Point or non-point? (Point)

(2) What do you do if you see someone polluting?

xii) Fertilizer – Kool-Aid on lawns

(1) Point or non-point? (non)

(2) Use fertilizer correctly. Fertilizer can be washed off lawns if it is over-applied. Some people might think that a little fertilizer is good for grass so a lot of fertilizer must be great, but in reality, the grass can only absorb so much fertilizer and the rest is washed away.

(3) Do not fertilize areas of lawn directly adjacent to waterways. This is called a buffer zone, and helps to keep fertilizer and pesticides from entering these sensitive aquatic environments.

(4) Plant rain gardens and vegetation. Explain rain garden. Plants with deep root systems are used in rain gardens to help trap and filter large amounts of stormwater, thus keeping the contaminated water from running into the storm drains. Uses sponges to represent vegetation or rain gardens. Put some sponges in the residential area. What happen?

xiii) Animal waste

(1) Point or non-point? (non)

(2) Look at the farm. What is so special about cow waste? Cow waste is a natural fertilizer. So the farm decides that he will scoop up the cow manure and use it on his field. Sprinkle tea on farm field but not in the cow pasture.

(a) The farmer also builds a retaining wall (clay) to keep fertilizer, crops, and top soil from washing away into the lake. Put trees/rain garden in front of wall.

(b) He might also build a fence or plant trees along river bank to keep cows from going directly into the river.

(3) What about animal waste in the neighborhood? What can you do to prevent animal waste from washing into the streams?

(a) Pick up your own animal's waste then properly dispose of it by throwing, burying, or flushing it..

(b) Ask neighbors to dispose of their animal waste properly.

xiv) Litter

(1) Point or non-point? (non)

(2) Don't litter. Ask others not to litter.

(3) Pick up litter.

xv) Car leakage

(1) Point or non-point? (non)

(2) Get vehicles tuned-up regularly to be sure there are no fluid leaks. People go to the doctor regularly to make sure everything is all right, so too should cars.

(3) Add vegetated areas adjacent to roadways.

xvi) Soil erosion

(1) Point or non-point? (non)

(2) Construct silt fences at construction site to prevent soil erosion.

(3) Build on already developed land instead of undeveloped land.

xvii) Thermal pollution

(1) Point or non-point? (non)

(2) Install rain gardens, green roofs, and green spaces.

xviii) Wetlands serve as natural filters and allow water to filter into the ground. Preserve wetland areas.

(1) Add sponges to lakeside.

Wrap-Up (Closure):
Discuss all the sources of pollution in your watershed. What were the major sources of pollution? Minor sources? Can you prevent all types of pollution? Why or why not?

ASSESSMENT OPTION:
Review the definition for watershed. Have students name the watershed in which they live. Ask students what they can do to prevent pollution in their neighborhood.

EXTENSIONS:
Research and explore other watersheds that are directly adjacent to the watershed in which you live. What kinds of potential pollution sources can you identify? What could you do to prevent pollution in nearby watersheds from being carried to yours?

RESOURCES:

Enviroscape Web Site:
http://www.enviroscapes.com

Using the Enviroscape Nonpoint Source/Runoff Model to Show Stream Restoration and Salmon Habitat Enhancement:
http://www.terendipity.com/enviroscape/shea.pdf

Enviroscape Environmental Resource Links:
http://www.enviroscapes.com/links.html

The World in Our Watershed:
http://www.watersheds.org/index.html

Home*A*Syst Assessment Guide:
http://web2.msue.msu.edu/bulletins/Bulletin/PDF/WQ51.pdf