"My Space" in the Parking Lot Station

Teachers Note: The major theme of this station is comparable to the Riparian Buffer station on the north side of the fairgrounds, namely the importance of maintaining natural filtration strips and buffers. The "Going Going" and "Rainy Day Hike" lessons included in the on-line curriculum with permission from Virginia State Parks and Project WET, can be used as preparation for this station. Students and teachers may also wish to conduct self-designed experiments in the school parking lot before or after the field day.

Virginia Science SOLs

6.1, 6.5. 6.7, 6.9, LS.1, LS.12

Key Concepts

natural resource management, types of nonpoint source pollution, effects of thermal pollution, filtering capacity of natural vegetation and soils

Vocabulary

point and nonpoint source pollution, thermal pollution, impervious surface, stormwater, bio-retention/bio-swale areas

Setting

the parking lot adjacent to the horse facilities at Meadow Event Park, State Fair of Virginia

Summary

Student teams demonstrate the potential of a defined impervious surface to contribute polluted runoff to the surrounding natural system while making observations and taking measurements.

Learning Objectives

Students will:

1. understand the polluting potential of just one parking space and how to minimize those impacts.
2. gain experience in predicting water flow across an impervious surface.
3. compare air and water temperatures associated with different types of ground cover.
4. understand the importance of green space in preventing thermal pollution and a possible drop in dissolved oxygen in adjacent waterways.

Background Information

Over one-third of the nation's streams, lakes and estuaries are impaired by some form of water pollution. Pollutants can enter surface waters from readily identifiable **point** sources such as industrial discharge pipes and wastewater treatment plants and less noticeable **nonpoint** sources which may not seem significant on their own but have enormous cumulative impact. Typically, agricultural runoff from crop fields or feedlots is the most frequently used example of nonpoint pollution, but urban areas with a high percentage of **impervious surface** (i.e. rooftops, parking lots and sidewalks) must be considered when designing any successful pollution prevention plan.

Another type of pollution, which is not a substance but water that has been heated is thermal pollution. Defined as is the degradation of water quality by any process that changes ambient water temperature, common sources of **thermal pollution** are industrial cooling processes and urban runoff

Background, continued

during warm weather. **Stormwater** passes over hot parking lots, roads and sidewalks before being discharged through culverts and pipes into water bodies.

Elevated temperature typically decreases the level of dissolved oxygen (DO) in water. The decrease in levels of DO can harm aquatic animals such as fish, amphibians and macroinvertebrates. Thermal pollution may also increase the metabolic rate of aquatic animals, resulting in these organisms consuming more food in a shorter time than if their environment were not changed. An increased metabolic rate may result in food source shortages, causing a sharp decrease in a population. Changes in the environment may also result in a migration of organisms to another more suitable environment and in-migration of fishes that normally only live in warmer waters elsewhere. This leads to competition for fewer resources. The more adapted organisms moving in may have an advantage over organisms that are not used to the warmer temperature.

Heated water from industrial cooling processes can be controlled with cooling ponds and cooling towers which allow water temperature to return to a safe range before being returned to a body of water. Stormwater management to control heated runoff involves channeling the water into **bio-retention** systems (landscape elements designed to mimic the natural filtering capacity of wetlands and other vegetated riparian areas), infiltration basins, or **bio-swales** to return water temperature to a safe range before final discharge.

In addition to the ability to modify water temperature, vegetative strips act as big filters. Factors influencing the effectiveness of a particular bio-retention area include the sediment size and load it flowing over it, slope, type and density of vegetation, presence or absence of a surface litter layer and the frequency and force of storm events.

Materials

- 5 pollution kits (packets of sand, vermiculite, wood shavings, and crushed walnut shells) and adequate quantities of these substances to re-stock through the day
- 10 air thermometers and 5 water thermometers
- 5 filled one-gallon water jugs
- Catching container – such as a plastic dust pan with lip that makes it flush with the pavement
- 5 clip boards and pencils
- 5 parking lot data sheets that include the EPA Temperature – Dissolved Oxygen Graph (in journal)
- Measuring tapes (one per team if possible)

Procedure

1. Prior to the arrival of the first group of the day, determine a system of how the parking spaces will be assigned. Ten spaces will be needed each rotation for a total of 40 in the morning and 40 in the afternoon. Position small groups in every other parking space. Using the row closest to the bio-swale in the morning and the next row uphill in the afternoon is recommended.

2. To begin, ask students to identify the "watershed" of the parking lot. Are there high and low points? Do they see the point where runoff likely exits the parking lot? What do they estimate the percentage of impervious surface vs. porous surface (or green space) to be? Point out the bio-swale. Ask the students why they think it was included in the parking lot design?

3. Ask the students if they attended the State Fair last fall and if so, how did they get here? How do they think most families arrived? Private vehicles are our main source of transportation. Let's take a look at what happens in just one parking space in terms of the potential for both nonpoint pollution in general and thermal pollution specifically.

Procedure, continued

4. Explain to the group that they will be working in their teams of five to demonstrate the polluting potential of one parking space and what may be left behind by one vehicle. Teams will also be demonstrating how the impervious surface of the parking lot has the potential to warm rainwater or other liquids that may flow across it. By interpreting a graph developed by the U.S. Environmental Protection Agency, they will note the possible impact of thermal pollution on dissolved oxygen levels. Adult chaperones will need to accompany each group.

5. Explain to the students that before they are released to conduct their activities at their team's assigned parking space, they need to answer some general questions and receive more detailed instructions. Ask students what type of potential pollutants may be left behind from a family vehicle either intentionally or accidently? Answers may include: litter from the passengers, dust and soil particles that fall off the vehicle and the passenger's shoes, and oil, coolant, hot water and other fluids that may drip from the engine. Explain that each team has been given a container with small quantities of harmless substances that are meant to represent those pollutants. Review them with the students. (Substances may include sand or vermiculite to represent dust and soil particles. Wood shavings can blow from the barns or be on people's shoes.)

6. Instruct students to sprinkle a small quantity of each substance on their parking space to begin the activity. Draw their attention to their jug of water. Ask what they anticipate the water will be used to represent? Rainfall can occur any time of year, but when do they think the greatest threat of thermal pollution would be? Afternoon thunderstorms in the summer that developed after the parking lot surface warmed all day in the sun would pose a threat. What do the students think the potential for thermal pollution is today? (Answers will vary according to the weather that day.) Call the group's attention to the student data sheet and explain that we need to review it in its entirety, because they must complete their tasks in a certain order.

7. Tell the students that prior to pouring the water at the top (high point) of their parking space, they need to take both the water temperature inside the container and the air temperature above and at the surface of the pavement. Indicate on the student data sheet where this is to be recorded. Note that the water temperature of their sample needs to be taken again after it reaches the bottom of their parking spaces. The air temperature reading at the surface of the bio-swale near the bottom (or low point) of their parking space is also needed.

8. Draw the student's attention to the fact that after the water is poured, they will need to do two different tasks as a team. Thus, they will need to divide up and plan accordingly. Observations on what happens to any of the potential pollutants (the substances they scattered) as the water flows across them and eventually meets the bio-swale must be made. If the water moved even a portion of the pollution, the distance(s) should be measured and recorded. In addition, other team members need to try to capture some of the water with their collecting apparatus (i.e. dust pan as it reaches the edge of the pavement). Please note that actually collecting the runoff may be difficult. Tell the students that if they are unable to do this they can still get a water temperature reading by placing the water thermometer any where the water pools toward the bottom of the parking space.

9. Once they have entered all the information and answered the questions on their data sheets they should bring their runoff samples (if they have one) to the station leader for the Filterra Model demonstration. The station leader may need to use additional "polluted" water he/she prepared

Procedure, continued

in advance. The model demonstrates how vegetation and soil in its natural state filters out potential water pollutants. Instructions for use of the model will be provided to station leaders by the Hanover-Caroline Soil and Water Conservation District staff in advance of the field day.

10. If time is available, debriefing questions may include any or all of the following:
    - Did your team's water sample transport the pollutants potentially left by visitors? If so, what happened when the runoff reached the bio-swale (if it traveled that far?)
    - What variables may have affected this? (i.e. how quickly the water was poured)
    - How did the air temperature of the pavement and the vegetative strip compare?
    - How about the difference in the two water temperature readings?
    - How did you rate the threat of thermal pollution today?
    - What do you think would have happened to the water temperature if the sample had reached the bio-swale?
    - How can we help minimize the impact of paved parking lots in terms of water pollution?

Extension Activities

Ask students to locate large paved surfaces in the city/county and look for any controls that are in place to mitigate thermal pollution. Have students prepare a map with potential action projects that could be taken to better manage thermal pollution in their home city/county.

Parking Lot Student Data Sheet – Pollution Transport

1. Air Temperature

A. Air Temperature at Waist Height

____

Difference

B. Air Temperature at Parking Lot Surface

____

B – A = _____________

C. Air Temperature at Bio-Swale Surface

____

B – C = _____________

Was there a difference in air temperature between the surface of your parking space and the bio-swale?

If so, what do you think contributes to this difference in air temperature?

2. Water Temperature

Water Temperature in degrees Celsius

Water in one gallon jug

____

Water poured across pavement (over pollution samples and collected at the low point of parking space)

____

Difference in temperature

____

Maximum DO for temperature in ppm (use EPA graph)

____

____

Difference in ppm

____

Based on your results of your team's water temperature comparison, how would you rate the threat of thermal pollution (from this parking lot) today?

_______ High _______ Moderate _______ Low

3. Pollution Transport

Scatter the pollution samples on the pavement and then pour the water at the top of the parking space.

Did the water move the pollution samples? ________ Yes ________ No ________ Partially

If yes, or partially, measure and record how far the major portion of the substance(s) was transported.
_____________________ ft/in

If the substances were transported all the way to the bio-swale, what happened when the water reached the bio-swale?

In addition to temperature modification, what other benefits of the bio-swale (vegetative strip) do you think there may be in terms of the transportation of substances off the parking lot?

Max DO Levels to Temperature According to EPA Standards