Understanding Nonpoint Source Pollution Lesson Three:
"The Impact of Nonpoint Source Pollution"

Academic Question: What is the impact of nonpoint source pollution on waterways?

Objective(s):
- To understand the impact of nonpoint source pollution on surface water

Process (Activities):

1. Explore with students the different impacts of nonpoint sources pollution on:
   - Contaminated Drinking Water
   - Stream and River Pollution
   - Lake Pollution
   - Groundwater Pollution

   When bodies of water become contaminated with nonpoint source pollution there are many impacts on the life that depends on the source of water for drinking or habitat. Three main impacts are eutrophication, sedimentation, and bioaccumulation.

   Eutrophication is the natural process in which a body of water is enriched by nutrients such as phosphates and nitrates that are washed in through runoff. These nutrients provide nourishment for plants in the water, which in turn become food for fish and other aquatic life. The term, eutrophic, means well nourished. Eutrophication has come to mean, however, a condition in which a body of water receives an excess of nutrients from agricultural runoff or sewage and the natural process is accelerated. The excess plant growth can block sunlight from the bottom of the body of water, preventing photosynthesis, which is necessary to re-supply the oxygen in the water. As animals in the water die because of lack of oxygen, they decompose which removes additional oxygen from the water.

   Sedimentation is the process of depositing insoluble particles of soil and other solids (referred to as sediments) into a body of water. Sediments are generally carried by runoff. These sediments become suspended in water, cloud the water, and reduce photosynthesis. Some sediment settles to the bottom of the body of water, destroys feeding and spawning grounds, and clogs and fills lakes and rivers.

   Bioaccumulation is the process in which a nonbiodegradable or slowly degradable chemical is retained and accumulated in the body and moved through the biological food chain by being passed from one organism to another as the contaminated organism is preyed upon by another organism.

2. Investigate these impacts of nonpoint source pollution on water quality with your students. Eutrophication and sedimentation are best explored through onsite field water quality tests—particularly nitrate, phosphate and dissolved oxygen as eutrophication indicators, and conductivity and turbidity tests as sedimentation

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indicators. The Cyberways and Waterways website has excellent water quality background information, testing procedures, and field testing worksheets to help you and your students participate in a hands-on investigation of the consequences of nonpoint source pollution. Bioaccumulation is a rather difficult concept to explore. One of the best activities created to help students understand the process of bioaccumulation is Project Wild's Deadly Links game. This game simulates the bioaccumulation of pesticides in a food chain. (Project Wild is a national environmental and conservation curriculum project created by the Western Regional Environmental Education Council. You can learn more about Project Wild by contacting the Texas Parks and Wild education office.) Using macroinvertabrates to determine water quality is also an indirect exploration of bioaccumulation. These macroinvertabrates can be used to measure water quality in part because of their sensitivity to pollutants accumulating within their bodies.

3. The following activities (adapted from Texas Watch Water Monitoring Lessons) are also interesting in class experiment to conduct with your students:

Dissolved Oxygen Activities—Understanding the Impact of Eutrophication:

Activity 1: Available Oxygen Introduction Activity

1. Gather the following materials: Large milkshake straws, regular straws, and stirrer straws. Cut each straw into 3 sections, and cut enough straws so each student has 3 sizes of straws.
2. Tell students you are going to limit a very necessary ingredient for life, oxygen. They will be allowed to breathe whatever oxygen they can pull through the straw.
   a. Hand out the large straws. Ask students to breathe only through the straw in their mouth. Discuss what is like to breathe only through a straw.
   b. Have students jog in place.
   c. Hand out the medium sized straws. Ask students to breathe only through the straw in their mouth. Discuss what is like to breathe only through a straw after jogging in place
   d. Have students jog in place.
   e. Hand out the small straws and ask the students to only breathe through the small straws. Caution them to sit down if they get dizzy.
3. Discuss with students the difference between terrestrial life's access to oxygen and aquatic life's access to oxygen. Just like the straws restricted our access to large amount of oxygen amounts, aquatic life has restricted access to the oxygen dissolve into water.

Activity 2: Oxygen Biomonitoring

1. Gather the following materials for each student group: river or pond water, 2 clear glasses, heat source, pan, Saran Wrap, and goldfish. "Feeder Goldfish" can be obtained at pet stores very inexpensively. If unavailable, obtain other fish sensitive to low amounts of dissolved oxygen.
2. Prepare a sample of water low in D.O. by first boiling pond water for five minutes. Next carefully add this water to the clear glass. If the water splashes when being poured, it will introduce oxygen back into the sample. Cover with Saran Wrap by floating the wrap on the surface of the water as it cools. Fill another glass with untreated pond water.

3. Have students place a monitoring organism into each glass of pond water. Do Not Allow The Organism To Die. Ask the students to count gill movements for 2 minutes, before transferring fish back to an aquarium.
4. Graph the gill movement counts for each organism.
5. Discuss with the students what gill movement might represent in fish (intake of gases for breathing.)

Water Clarity and Turbidity Activities—Understanding One Impact of Sedimentation:

Activity 1: Introduction – Seeing is Believing

1. Gather the following materials for each group:
   - ✍ Blue, red, yellow, and or green food coloring
   - ✍ 6 equal sized cups or cans with nontransparent sides
   - ✍ 6 small black beads, 6 white beads
   - ✍ Syringe or bulb pipette, measuring cups
   - ✍ Water
2. Have students complete the following procedure for determining the impact of color on the clarity of water
   a. Fill 6 equal sized cups with the same amount of water.
   b. Place a black bead and a white bead at the bottom of each cup.
   c. Add a single color of food coloring to four of the containers. Count each drop of die. Record how many drops of die were added at the point that each of the beads was no longer visible. (The white bead and black bead will require different amount of die.)
   d. Repeat these steps by adding an equal amount of blue and red die (to create purple) to the fifth container.
   e. Repeat the steps by adding equal amounts of red, blue, green, and yellow (to create a brownish color) to the sixth cup.
   f. Using the syringe or bulb pipette, slowly remove water from each container until each bead is visible. Using the measuring cup, measure the different amounts of water that were removed at the point each bead became visible.
3. Discuss with students what inferred with their ability to see the beads? Would a bright light help? Why is it important that the cups be opaque (unable to transmit light)? What happened when the depth of water changed?

Activity 2: Secchi Disk in the Classroom

1. Gather the following materials:
   a. 5 gallon buckets
   b. 3 buckets
   c. 1 secchi disk
2. Prepare turbid or tea colored water in each bucket. Make sure the secchi disk can be seen in only in the bottom of one bucket. Diatomaceous earth, found in pool supply stores can be used to make a stabile turbid solution. It is very messy. Do this activity outside.
3. Laminate 3 secchi disk directions to place next to each bucket. Ask students to form three lines, one behind each bucket.

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4. Show them the disk and with a meter stick explain: Measuring clarity (transparency) with a secchi disk
5. Have students practice with the secchi disk
6. Ask students to list some of the causes of turbidity. Point out there is organic and nonorganic causes.

Conductivity Activities—Understanding One of the Impacts of Sedimentation:

Activity 1: Pollution and Impacts on Conductivity

This activity is a set up as a challenge for small groups students to create a unique set of conductivity jars for a second group will rank in order.

1. Gather the following materials- one set of each small group
   - ✍ Pollutants such as; motor oil, dish soap, vinegar, sediment, salt, fertilizer, and other such materials (crushed chalk, tums, etc.)
   - ✍ Jars
   - ✍ Droppers
   - ✍ Creek water
   - ✍ Conductivity testing equipment
2. Have groups label jars (A, B, C, D, E, F, etc.)
3. The group should first set aside jar A as the control jar. Fill jar A with pond water. Groups will then make different solutions with materials in each of the jars. It is extremely important that they keeping a log of exactly what materials were added to each jar and how much of that material was added. In two of the jars, add more than 1 type material to the creek water.
4. Once the groups have completed the making their solutions, they should privately determine and record the conductivity of each jet. If they are not pleased with the outcome, they are allowed to make one modification.
5. Have groups rotate tables, so they are working with unknown solutions. They should begin by first making a hypothesis of the order of the conductivity jars from high to low conductivity. Next, the group should test each jar's water conductivity, and compare to the creek water's conductivity with no additions (the control). Groups should compare their hypothesis to their results and determine how accurate their hypothesis was. The group should check their answers with those recorded on the log of the first group.
6. Once the groups have completed their testing, have the class rank all the jars in order of increasing conductivity. Discuss what material additions lower conductivity?
7. Look in logs and determine a pollutant or material impact on conductivity.

Product/ Application: Have students return to the nonpoint source pollution scenarios they created in lesson two. Ask students to continue the scenario by adding the consequences of the nonpoint source pollution entering the waterways. Students should indicate if the nonpoint source pollution will contribute to eutrophication, sedimentation, and/or bioaccumulation. (Students will need time to research these questions.) Finally students should carefully describe the water quality and habitat condition of the waterway once the consequences of the nonpoint source pollution are realized, create a sample of what the water might look like, and create a picture or image of the habitat.

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Assessment: Allow students to present their model and scenario to the class. Create an evaluation checklist with your students that they will use to measure a high quality, accurate, and creative scenario, water sample, and image of the habitat.

Resources:
EPA's Surf Your Watershed http://cfpub1.epa.gov/surf/locate/index.cfm and EPA's Enviromapper for watersheds (http://map2.epa.gov/enviromapper/). This interactive resource allows students to zoom in on their area of study, assess the water quality vulnerability, explore the different watershed tributaries, and much more. This web site can be used as a checkpoint for students to compare and contrast the boundaries of the watershed they traced to those mapped using the Enviromapper.

Storm Drain Dumping Lesson Plan
Grade Level: 5TH – 6TH
http://www.tnrcc.state.tx.us/exec/oppr/cc2000/storm_drain.html
Students will develop an awareness of what happens to water contaminated through neighborhood runoffs.

U.S. Environmental Protection Agency (EPA)
What is Nonpoint Source (NPS) Pollution? Questions and Answers
http://www.epa.gov/owow/nps/qa.html

U.S. Environmental Protection Agency (EPA)
Nonpoint Source Pollution: The Nation's Largest Water Quality Problem
http://www.epa.gov/OWOW/NPS/facts/point1.htm

USGS in Texas, Relations of the occurrence and magnitude of contaminants to selected environmental characteristics for watersheds in Texas:
http://txwww.cr.usgs.gov/project.asp?cc=4648&ac=19000

Time Frame: One to three 45 minute lessons
Grade Level: 6th- 10th

TEKS Correlation:
Science
Grade 6: 6.1, 6.2, 6.3, 6.4
Grade 7: 7.1, 7.2, 7.3, 7.4, 7.8, 7.12
Grade 8: 8.1, 8.2, 8.3, 8.4
Biology: (b)1, 12.D
Aquatic Science: (b)1, 4.B, 7B,C, 8.C,D
Environmental Science: (b)1, 5.A, B, C, E, F
Geology, Meteorology, and Oceanography: 10.C

Mathematics
Grade 6: 6.1, 6.8, 6.11, 6.12, 6.13
Grade 7: 7.3, 7.4, 7.9, 7.13, 7.14, 7.15
Grade 8: 8.5, 8.14, 8.15
Geometry: 6

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Technology Applications (Computer Literacy)
Grades 6-8: 2, 4, 5, 7, 8

English
Grade 6: 6.1, 6.2, 6.5, 6.13, 6.17, 6.20, 6.22, 6/24
Grade 7: 7.1, 7.2, 7.5, 7.13, 7.17, 7.20, 7.22, 7.24
Grade 8: 8.1, 8.2, 8.5, 8.7, 8.10, 8.13, 8.17, 8.18, 8.20, 8.22, 8.24
English I: 1, 4, 6, 8, 13, 15, 16, 21
English II: 1, 4, 6, 7, 8, 13, 15, 16, 21

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