Polluted Waters

Skill: Language Arts, Science, Math, Social Studies

Objectives

Students will:

- Name and describe different kinds of pollution that can affect water quality as well as animals and plants that live in water.
- Identify major sources of aquatic pollution.
- Make inferences about the potential effect of a variety of aquatic pollutants on wildlife and habitats.
- Analyze the pollutants found in a hypothetical river.
- Graph the quantities of pollutants and make recommendations about possible sources and actions that could be taken to improve the habitat.

Background

All the water that has been available to our planet is on or in the earth right now. On the entire planet there are 326 million cubic miles of water. If the earth were a globe 28 inches in diameter, all of the water on the planet would fill less than one cup. Of that amount, only .03% is in river systems and freshwater lakes. This means that only slightly more than one drop would fill all the rivers and lakes. Waterways like rivers, lakes, and streams are a vital expression of the water cycle. All the rain and snow that falls on the land either seeps into the soil or runs off through waters to the sea. In addition, all along the way, water evaporates or is transpired by plants back into the atmosphere to form clouds and precipitation all over again.

With this picture of the scale and interconnectedness of our planet's freshwater resources in mind, it is apparent how fragile this vital substance is. Yet each day water is being stressed by pollution. Pollution is a complex topic. Most current books include four definitions:

Chemical Pollution: The introduction of excessive nutrients or toxic substances into an ecosystem, for example acid rain, fertilizers, pesticides.

Thermal Pollution: Varying temperatures above or below the normal, for example power plant turbine heated water, removal of shading trees.

Organic Pollution: Oversupplying an ecosystem with carbon and oxygen, depleting substances.

Vocabulary

- describe
- aquatic
- inferences
- analyze
- hypotheitical
- globe
- diameter
- evaporates
- transpired
- interconnectedness
- vital
- complex
- depleting
- fecal
- geysers
- economic
- catastrophic
- DDT

Materials

- 10 different colors of construction paper (2 sheets of each)
- 10 different colors of beads
- Writing or graph paper
- Scotch tape or glue
- Pollutant Information Sheets (one for each participant)
- Pollutant Graph (one for each team)
- 1 tablespoon measure

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert Whitson, Vice President, Dean and Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is issued by Oklahoma State University as authorized by the Dean of the Division if Agricultural Sciences and Natural Resources and has been prepared for both internal and external distributions through print and electronic media.

Polluted Waters

Biological Pollution: Adding undesirable organisms such as fecal bacteria; adding a substance that does not occur naturally in the ecosystem (such as pesticides, oil, brines); increasing the amount of a naturally occurring substance (such as sediments in runoff water); altering the composition of the ecosystem (such as introduction of aquatic plants via bird droppings, introduction of new species).

Because the effects of most pollution are long term, we must develop long term views about its effects on wildlife and its habitat.

Most of us view pollution as human caused. For example, the introduction of toxic substances is clearly human caused as is most organic pollution in lakes and rivers from sewage disposal from homes, towns, and big cities. Thermal pollution is dominantly human caused through power plants, industries, and forestry or urban development. Some dams also produce unnaturally cooled water with bottom discharge of water.

Surprisingly, these three forms of pollution -- chemical, thermal, and organic -- can also take place without human intervention. Natural pollution, too, affects wildlife and wildlife habitat. Some acid rain results from volcanic eruptions. Landslides and avalanches alter runoff patterns as well as sometimes kill plant and animal life. Overpopulation of water fowl can degrade water quality. Shifts in oceanic currents affect water temperature as well as weather patterns. Sometimes hot springs and geysers can heat water in lakes and streams. Understanding the cause and effects of pollution helps prepare us to be able to take constructive action now and in the future to protect and maintain a healthy environment.

The way we feel about pollution has to do with the attitudes and values we hold regarding the quality of life. Issues of economic importance often affect human reaction to pollution. One researcher called pollution the "chosen disease." Only in catastrophic circumstances like the disaster in Bophal, India are we able to see short-term effects of pollution. In the case of DDT, it took years before we could see the effects. For the most part, pollution is invisible; it often takes years to display its toxic destructiveness, since some pollutants enter water from a localized source, like a discharge pipe from a factory. This is called "point-source pollution." Other pollutants enter from less easily identified, diffused sources, for example when rain washes motor oil from streets and store parking lots into city drains, or when fertilizer and pesticides are washed to streams and lakes This is called a "nonpoint source pollution."

P.A.S.S.

4th Grade

- Read 1.1, 3.1b, 5.2cd
- Write 1.2, 2.1d

Science

- Process 2.1, 4.1,4, 5.4
- Life 3.1

Math

- Process 1.2, 2.1, 4.4, 5.1
- Content 5.1b
- Social Studies 2.1,2

5th Grade

- Read 1.1a, 3.1b, 5.2bd
- Write 1.2, 2.1

Science

- Process 2.1, 4.1,4, 5.4
- Life 2.2

Math

- Process 1.2, 2.1, 4.4, 5.1
- Content 5.1ab
- Social Studies 1.1, 7.1

6th Grade

- Read 1.1a, 3.1b, 5.2ad
- Write 1.2, 2.1d

Science

- Process 2.1,2, 4.1, 5.3
- Life 4.1

Math

- Process 1.3, 2.1, 4.1, 5.1,4
- Content 5.1,2
- Social Studies 1.2

Polluted Waters

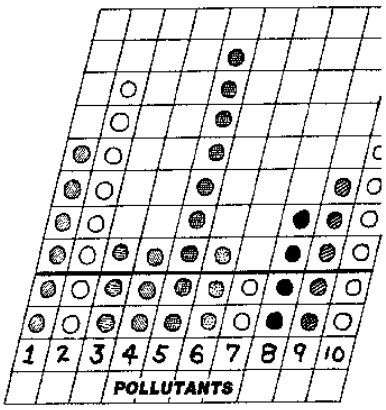
Procedure

- List the four major categories of pollution on the chalkboard and discuss each. They are: chemical, thermal, organic, and biological. Refer to the background for a description of each. NOTE: The first three are dominately caused by humans, although there are rare cases where natural processes can cause them. Biological pollution is typically natural, although there are cases where it is caused by humans.

  Pollutant Information Sheets.

- Review each kind of pollution with the students. Talk about how some of these can fit into more than one of the four kinds of pollution.
- Color code each kind of pollution with a different color of construction paper. Write a short description of the pollution on a piece of paper the same color to which it is coded. (Some teachers have simply copied the Pollutant Information Sheets, cut the descriptions apart, and pasted the appropriate paragraphs on each of the colored sheets).
- Post each sheet of colored paper with the corresponding description of the kind of pollution it represents in a row in a convenient place.
- Once all the kinds of pollution have been discussed, and the students understand that each kind of pollution will be represented in this activity by one color of paper or bead, tell the students that they are to divide into teams of three. These will be research teams; each team will analyze the pollution content of a hypothetical river.
- Distribute the colored beads. Provide one tablespoon of the beads to each research team. Also provide each team with a Pollutant Graph sheet.
- Have each team separate the colored beads into piles. Using the color key, they should identify each type of pollutant. Once this is done, they should count the number of each kind of pollutant they have identified and the whole array of pollutants. Arrange the pollutants in the same order as they are displayed in the color key that is posted in the classroom. This makes it easy to compare each team's findings.
- When they have the bar graphs completed and have compared the teams' results, tell them that any quantity above two units of each kind of pollutant is considered damaging to wildlife habitat. In their hypothetical rivers, what pollutants would be likely to cause the most damage to wildlife and wildlife habitat? Give examples and discuss the kinds of damage that could result.
- Optional: Invite the students to match the pollutants with the four categories of pollution listed at the beginning of the activity. Some seem to fit rather easily; others could fit in more than one category, depending on the source of the pollution. For example, is the thermal pollution human or naturally caused (power plant water effluent or thermal hot springs)?
- Optional (for advanced students): Note that all the pollutants came from the same river! Ask teams to explain why their results are so different.
- Alternative: Instead of beads use a hole punch to create colored tokens. Distribute 1/2 Tablespoon to each research team.

Polluted Waters



No. 2 Graph of pollutants

Discussion and Evaluation

Describe the effects that large quantities of the following things might have on aquatic environment. Consider short term and long term effects.

- Hot water
- Fertilizer
- Soil (silt)
- Heavy metals, etc.

Water is taken from a river, treated, used by people of a community, sent to a city sewage treatment plant, and then put back into the river. Is this aquatic pollution? Defend your response.

Class Extensions

1. List five things you can do - starting today - in your own life to reduce the number of pollutants you add to the environment.

2. Conduct a field trip to a local waterway and attempt to identify what kinds of pollution, if any, are affecting it.

3. Get information about current national and state laws protecting water quality in the United States. Write a short history of the U.S. Clean Water Act.

4. Why is DDT still being used, and where? Find out the current status of this pesticide use in the U.S. and other parts of the world.

Pollutant Information Sheet

Activity Sheet

1. SEDIMENTS: Light Tan

Particles of soil, sand, silt, clay, and minerals wash from land and paved areas into creeks and tributaries. In large quantities, these natural materials are considered a pollutant. Urban development, home building and other construction projects often contribute large amounts of sediment. Agricultural tillage and certain forest harvesting practices also contribute sediment to runoff. Sediments may fill stream channels and lakes that later require dredging. Sediments reduce fish populations by covering spawning areas and eliminating the habitat for macroinvertebrates on which fish feed.

2. PETROLEUM PRODUCTS: Purple

Oil and other petroleum products like gasoline and kerosene can find their way into water from boats, oil drilling rigs, oil refineries, automobile service stations, and streets. Oil spills kill aquatic life (fish, birds, shellfish, and vegetation). Birds are unable to fly when oil coats their feathers. Shellfish and small fish may be poisoned. If it is washed on a beach, the oil requires much labor to clean up. Fuel oil, gasoline, and kerosene may leak into groundwater through damaged or rusted underground storage tanks. Included are oily wastes from petroleum production and exploration.

3. ANIMAL WASTE: Red

Human wastes that are not properly treated at a waste treatment plant may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery (diarrhea), hepatitis, flu and common cold germs are examples of diseases caused by bacteria and viruses in contaminated water. Wastes from feed yards, poultry production and dairies, too, are a concern. People can come into contact with these microorganisms by drinking polluted water, swimming, fishing, or eating shellfish. Often unexpected flooding of barnyards or stock pens can release animal wastes to streams and lakes. Animal waste can also act as a fertilizer stimulating the growth of aquatic plants and algae.

4. ORGANIC WASTES: White

Domestic sewage treatment plants, food processing plants, paper mill plants, and leather tanning factories release organic wastes that bacteria consume. In consuming these wastes the bacteria require oxygen. If too much waste is released, the bacterial populations will use up the oxygen in the water causing fish to die from lack of oxygen.

5. ORGANIC COMPOUNDS: Pink

Detergents, pesticides, and many synthetic industrial chemicals are released to waterways. Many of these substances are toxic to fish and harmful to humans. They cause taste and odor problems and often cannot be treated effectively. Some are very poisonous at low concentrations.

Pollutant Information Sheet

Activity Sheet

6. INORGANIC CHEMICALS: Orange

Inorganic chemicals, mineral substances, and salts commonly dissolve into water. They often come from mining and manufacturing industries, oil field operations, agriculture, and natural sources. In high concentration these chemicals can interfere with natural stream purification: they kill fish and other aquatic life. They also corrode expensive water treatment equipment and increase the cost of boat maintenance.

7. FERTILIZER: Green

Plant nutrients from fertilizer, particularly nitrogen and phosphorous can cause large amounts of algae to grow and cover the water's surface. When the algae die they are consumed by bacteria which uses up the oxygen in the water. Once the dissolved oxygen is gone, fish kills occur. The process of over-fertilization is called eutrophication.

8. HEATED OR COOLED WATER: Dark Blue

Heat reduces the solubility of oxygen. Electric power plants return heated water to streams, lagoons, or reservoirs. Cutting trees along stream banks reduce shading and also warms the water. Because dissolved oxygen concentration are lower in warm water, heating tends to cause game fish to leave. Water temperatures that are much lower than normal can also cause habitat damage. Deep dams often let cold water from the bottom of the dam flow downstream.

9. ACID PRECIPITATION: Light Blue

Aquatic animals and plants are adjusted to a rather narrow range of PH. PH is a measure of the acidity of a solution. When water becomes too acid, fish and other organisms die. Water may become too acid from chemical pollution acid rain or acid mine drainage. Acid rain does not affect lakes where soils are alkaline and well-buffered.

10. PESTICIDES (INCLUDES INSECTICIDES, HERBICIDES, AND FUNGICIDES): Yellow

Agricultural chemicals designed to control growth of pests can be pollutants if they are washed into rivers or leached into groundwater. Irrigation return flow and natural runoff can take these toxic substances to rivers, streams, lakes and oceans. Infiltration and leaching can introduce this to groundwater.

Polluted Waters Graph Paper

1	2	3	4	5	6	7	8	9	10