Water Pollution: What Can We Do?

Student Activity Sheet

Name_____ Date_____ Class_____

Fresh water is a very limited and vital resource to all who occupy the planet Earth. Of all the earth's water, 97.4% is salt and 2.6% is fresh (includes surface water, groundwater, and rain or atmospheric water). Out of this 2.6% fresh water, 76% of the total amount is locked up in the polar ice caps or glaciers (equal to 2.0% of all water in the world), 24% is available for our use (equal to 0.6% of all water in the world).

About 66% of our body's weight is water and we must constantly replace water lost from our bodies. Humans must drink water to survive, yet twenty-five million people die each year from drinking polluted water. With the increase in population, agriculture, and industry, the small amount of fresh water available for consumption is certainly worth keeping clean.

Pollutants and other contaminants get into our water supply in many different ways. Water pollution is classified into two main categories: point and nonpoint sources of pollution. ***Point sources*** originate from a specific point or place, such as a discharge pipe from a factory or sewage treatment plant. ***Nonpoint sources*** originate over a widespread area and is thus difficult to determine exactly where the pollution comes from. Anything that destroys our water quality can be considered a pollutant, even some things most people don't commonly think of as pollutants. Fertilizers running off of large areas of farm land can cause severe pollution problems.

The effect of pollutants depends on the concentration of the contaminant, the volume of water in the receiving water body, and the flow rate of the water (speed of travel). Thus, contaminants entering a river may travel much farther and become more widespread than those entering a lake with a limited ***outflow***.

Objectives:

- Discover that fresh water is a very limited and vital resource.

- Learn about the current sources of water pollution and ways that these sources of pollution are being controlled.
- Discuss water quality issues and how they effect each of us.
- Actively participate in a visual representation of a body of water that receives various sources of pollution.

Materials:

Clear glass jar
Character story cards
One large apple (Teacher supplied)
Sharp slicing knife (Teacher supplied)
Labeled canisters filled with materials which represent different pollutants (Teacher supplied)

Procedures:

1. Your teacher will first demonstrate how much fresh water there is on Earth using the apple as a model of the Earth.
2. Twelve students will receive a small black canister from your teacher. This canister will be labeled. The same students will also receive a name card of one of the characters in the story to wear around your neck.
3. All the students should form a circle with the glass jar on a table in the center of the circle.
4. Listen carefully as your teacher reads the story about a lake and how the lake gradually became polluted. The glass jar represents the lake in the story. Answer any questions your teacher asks you.
5. If you are one of the characters in the story, you will need to empty the contents of your container into the lake (glass jar) when the teacher mentions your name.
6. When the story is completed, answer the discussion questions.

Discussion Questions:

1. Were all the pollutants human-made and harmful?

2. Which do you feel is worse, point or nonpoint pollution? Why?

3. Who is responsible for cleaning up the lake? Why?

4. How would the pollution effects be different if the lake was a river?

5. What other issues in the environment do you feel are important?

6. What can you do as a individual or as a class to prevent our limited freshwater supply from pollution?

Vocabulary

Pollutants: Any substance that causes an undesirable change in the character (physical, chemical, and biological) of the natural environment and is brought about by human activities.

Point source: A source of pollution which originates from a specific point on the landscape such as a discharge pipe or a sewage treatment plant.

Nonpoint source: A source of pollution which originates from a large or widespread area and whose source, therefore, can not be traced.

Outflow: Water which leaves a some containment. This may be natural, such as a pond or lake, or may be humanmade, such as a pipe.

Teacher Strategies

Preparation:

1. You will have to fill and label the containers with the materials that represent pollutants. The contents of the containers can be changed to whatever you feel is appropriate or have at the time. Included is a list of characters and possible canister contents:

trees	leaves
1st home owner	liquid (any kind)
2nd home owner	sludgey coffee
3rd home owner	sugar
beach goers	pop tops from soda cans, popcorn
1st farmer	soil
2nd farmer	liquid plant fertilizer
shopping mall lot	pencil shavings
electric company	vinegar
chemical plant	yeast
sewage treatment plant	chocolate fudge sauce
gas station	vegetable oil

   You may also chose to have give 12 students the empty containers labeled with their characters name and ask that they fill the container with whatever pollutant their character might be most likely to dump into the lake. You will also want to fill the glass container up with water before the activity. This container represents the lake in the story that you will read to the class. Leave enough head room in the container so that all the pollutants will fit in.

Preactivity:

1. Before you begin the main activity, demonstrate the scarcity of fresh water with the apple. When you start the preactivity be certain you have a very sharp slicing knife. As the slices get small it is difficult to cut if your knife is not sharp. Hold the apple in front of you and tell the students that it represents all the water on the earth. Ask them to guess how much they think is salt water. Cut the apple in fourths, three of which are set aside.
2. Take the remaining fourth and cut it in half. Add that to the rest of the pile you have set aside. Tell the students that the large pile is all the water in the world that is salty (97.4%).

3. Ask them if they think the remaining 2.6% of the apple (water) is available for our use. What form of water is not available? Cut the remaining sliver in thirds. Discard 2/3 of it, as it represents the frozen water which cannot be used (polar ice caps and glaciers= 2.0%).
4. Of the remaining sliver take off the peel as it represents some polluted water. The remaining 0.6% is all the useable water on earth! Let students know that includes all rain water.
5. Discuss the limited amount of water on the planet. Does anything else besides humans depend upon this minute percentage of water for survival? What should we do with this sliver of useable fresh water?
6. Remind students that the apple is merely a representation to show the proportion of useable freshwater compared to the amount of water on Earth that is not useable.
7. A discussion of point and nonpoint pollution should be done before you begin the activity. Putting the vocabulary words on the board and leaving them there throughout is helpful.

Main Activity:

1. Ask the students: What is an issue? Emphasize that an issue is a problem caused by differing opinions based on different values that result in different ways of doing things.
2. Explain that this activity focuses on water quality or water pollution issues.
3. Pass out containers containing materials which represent different forms of point and nonpoint pollution. Make sure each container has a label that identifies it as a character in the story. Pass out corresponding cards which will be worn around the neck. Ask students to note which character they are representing.
4. Show students a large clear glass jar of clean water and tell them it represents a very clean lake. Ask them if they would boat on the lake? How about swim in it? If there was a treatment plant, would they drink the water from the lake? Why or why not?
5. Have the students form a circle and put the glass jar on a table or desk in the center. Explain that you will be telling them a story about a lake. As they hear their character mentioned, they should come up and pour the contents of their container into the lake. Tell the story of the lake, introducing each character one at a time. After a few characters pollute the lake, ask students if they would still boat, swim, or drink the water from the lake. Why or why not? Repeat this question several times throughout the story.
6. What happens to the organisms and plants living in the lake? At what point do they begin to be affected?
7. Draw on the board or hand out the discussion chart (included on next pages) to show what real life problem or source of pollution each character represents. Are they point or nonpoint

sources of pollution? What ways can each source be prevented or reduced? Write student responses on the board.

8. Have the students guess what they think is in the canisters at the end of the lesson.

Answers to Discussion Questions:

1. The two pollutants that were not human made were the natural pollutants from the trees and the soil sediment from the first farmer. Even though the soil sediment was natural it still caused problems to the lake by clouding it up. The trees were the only character to not harm the lake because it was not used for drinking water.
2. Both point and nonpoint are sources of pollution. Some may argue that point pollution may be better because one knows where the source of pollution priginates and actions can be taken to control it. Nonpoint pollution is somewhat a mystery and trying to correct it is much more difficult.
3. This is a good question for debate. Some say the owner of the business, farm, home, etc. Some conclude that many people contribute to the problem so we all should help with the clean up. (This usually leads to a great homework assignment.)
4. The effect of the contaminant, the volume of water in the receiving water body, and the rate of flow of the water through the water body. Thus contaminants entering a river may travel much farther and become more widespread than those entering a lake with limited flow.
5. Deforestation, world population, ozone depletion, ocean dumping, land fill uses, and recycling.
6. Respect the environment around you. Help reduce waste and pollution by conserving resources, education, and political involvement.

Approximate Time Required: 45-60 minutes

Target Audience: Science

Extensions:

<u>Grades 4-6</u>

1. After discussing who is responsible for cleaning up the lake, give students “pollution clean up tools” and see if they can get the water clean again. Clean up tools such as sponge, paper towels, baking soda (to neutralize the vinegar), sieve, coffee filters, spoon, and pH paper to

test for neutralization. You will obviously need a wide mouth jar or will have to pour the contents of the container out into a basin.

2. Students can take the Water Quality Issues Survey and complete the summary chart (included).
3. Students will see the effects of watering seeds with polluted water. Pre-soak four lima beans and plant in four separated containers labeled - tap water, salt water, soap water, and vinegar. Every other day spray seeds with its "water" and watch for the results.

Grades 9-12

1. Microbiological Contamination: Students may obtain water from various sources around the state which should include: (some may be teacher supplied)

   tap water
   local stream/river (moving)
   local stream/river (stagnant)
   ocean
   distilled.

   Materials per pair of students:

   1 prepared agar plate for each water source
   1 glass jar with lid for each water source
   1 sterile Q-tip or swab for each water source.

   Optional Materials for class:

   Microscope
   Slides — wire loops
   Bunsen Burners — Gram stain
   Methylene blue — Colony counter

   Procedures:

   1. Students are to collect water using boiled glass jar and metal lid which have not been touched on the inside after boiling. Water will be tested for bacterial contamination. Lid should be replaced on hot jar as soon as it comes out of boiling water and is shaken off. Lid should not be screwed on very tightly. Lids should remain in place at all times until the moment of water collection and the moment of plating.
   2. The teacher needs to purchase or prepare sterile agar plates for pairs of students. These agar plates may be glass or plastic. Each pair of students will need one agar plate for each water source. If four water sources are to be tested and 30 students are

in the class, 60 agar plates will be needed. Agar may be purchased in liquid form in bottles, or may be purchased in dry form. Instructions on how to sterilize bottled agar are included with purchase. Instructions for making agar medium and sterilizing it come with powdered form.

3. Plates should be prepared and refrigerated after cooling. Recommendation - pour plates before or after school. After school or the next morning, plates will have solidified and should be taped and turned upside down so that moisture doesn't collect on the agar surface then placed in the refrigerator.
4. When students are ready to plate the water, one Q-tip or swab shuld be given to the student with the instructions NOT to touch the cotton ends. They should be given sterile Q-tips or swabs only when they are ready to perform the actual plating.
5. Each student of the pair should have a task. Student 1 opens the jar, holds the lid without touching the inside and with the other hand, steadies the agar plate. Student 2 releases the tape holding the agar plate closed and lifts the agar lid without touching the inside. With the other hand, the Q-tip should be placed in the water and then gently rubbed along the agar surface. The lids should be immediately replaced on plate and jar. A grease pencil should be used to mark the outer agar plate with #1 to indicate the first water source on the lid and lower side. Plates 2-5 (or however many sources) should be plated and marked in the same fashion.
6. Plates should be incubated at 38°C overnight or left at room temperature. Students can examine plates for a few days observing developing colonies. They may try to identify bacterial types from slides made under teacher direction, perform tests on bacteria, E.coli for its life cycle, shape, absorption of stain etc. and answer the following questions:

   a. Where does E.coli come from? Why is it found in water supplies?

   b. What are some of the problems experienced by humans who drink water containing E.coli?

   c. The U.S. has very safe drinking water compared to other countries. When does the U.S. experience problems with its water supply?

   d. What diseases are spread by contaminated water supplies? In what countries is this a major problem?

   e. Did you have any bacteria growing on your plates? In which plate was the count the highest? In which was it lowest? Which water do you feel is safest to drink?

   f. Did your plates show any evidence of E.coli growth? How did you know?

THE STORY OF THE LAKE
Water Pollution: What Can We Do About It?

Note: After each paragraph when a substance is added to the jar of water, ask the following questions to your class:
Would you drink from the lake if it had a drinking water treatment plant?
Would you swim in the lake? Would you boat on the lake?
Note also that this is merely our version of this story; so feel free to modify it to fit your particular needs.

Once there was a large lake surrounded by acres of green forests and brushland. It was a clear lake, and the only pollution the lake received was natural, from **TREES**. This was not a problem since the lake was not being used for drinking water.

In a little while though, the **1st HOME OWNER** moved in. They had a septic system but did not use it wisely. The **1st HOME OWNER** used toxic household cleaners and dumped them down the drain. They ended up in the lake after passing through the septic system.

Not too long after that, a **2nd HOME OWNER** moved in, close by to the first one. They also had a septic system for their house. A few years went by and they did not keep their septic system maintained. The septic tank began to leak and the outflow also ended up in the lake.

At almost the same time, a **3rd HOME OWNER** moved in next to the second one. They had a large green lawn, that the homeowner was quite proud of. Unfortunately, the homeowner used too much fertilizer and watered the lawn too often. A lot of the fertilizer washed down and away from the grass roots and eventually also ended up in the lake.

Now that a small neighborhood was around the lake, people began to visit its beach. There weren't too many **BEACH GOERS,** but they did not pick up after themselves. They left litter on the shores and some of the litter ended up in the water of the lake too.

There was a lot of flat, stone free land around the lake, and two farmers moved into the area. The **1st FARMER** used poor erosion control on his cropland and sediments from the his fields made their way to the lake, clouding it up. The **2nd FARMER** that moved in made an orchard of apples, but they required the use of pesticides to keep insects from eating all the apples. The farmer used too much of the pesticides and it ended up in the soil, which, of course, ended up in the lake eventually.

As the area around the lake became more and more developed, a shopping mall was built near the neighborhood. The shopping mall had a large parking lot, and it was always filled with the cars of the people shopping there. Stormwater that fell on the **SHOPPING MALL LOT** was carried off, containing oils from the cars, litter, and salt from the roads. The stormwater drainage system was not well designed and the stormwater runoff made its way to the lake.

Along a river that fed the lake, an industrial area was built. The first building to go up was the electric company. The **ELECTRIC COMPANY** burned coal to power its generators. The smoke that came from the smokestacks stayed in the clouds and formed acid rain, which fell onto the river and the lake. The next two buildings that were built were a **CHEMICAL PLANT** and a **SEWAGE TREATMENT PLANT.**

The chemical plant discharged heavy metals and organic chemicals into the river and the sewage treatment plant discharged raw sewage into the river when the amount of sewage reaching the plant was too much. Both of these ended up in the lake.

The last thing to be built near our now developed lake was a **GAS STATION.** The gas station was very busy, but to save on costs they used cheap quality underground tanks to store their gasoline. In a few years, the tanks began to leak and the gasoline flowed through the soil, reached the groundwater and flowed to the lake.

How can we possibly clean this up?!

WATER QUALITY ISSUES SURVEY

Below you will find a list of belief statement with which you may agree or disagree. Following each is a response line ranging from "Strongly Disagree" to "Strongly Agree." Please circle the response which best reflects how you feel about the statement.

1. No development should occur along rivers.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

2. Only homes and farms should occur along river.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

3. Homes, farms, resorts, and shopping centers should be allowed to be built along rivers, but not industrial factories.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

4. Factories should be allowed along rivers because they need the water for their operations and their waste disposal.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

5. Factories that pollute should be closed even if it means that people will lose their jobs.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

6. There is too much hype about water pollution and conservation these days. We have plenty of fresh clean water and don't need to worry.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

7. People have the right to use as much water as they want.

   Strongly Disagree Disagree Neutral Agree Strongly Agree

8. It makes a difference when people conserve water by not leaving the tap running while doing dishes or brushing their teeth.

   Strongly Disagree Disagree Neutral Agree Strongly Agree