Stayin' Alive

Ross Barnett Reservoir Watershed Unit

Grades 4 – 6

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Stayin' Alive

Ross Barnett Reservoir

"CONGRATULATIONS! You have just completed college and have been hired to work for the Ross Barnett Reservoir Initiative. However, before you can begin tackling the many issues that impact the drinking water for Hinds, Madison, and Rankin counties, you need to be fully trained in your area of specialization. Together with others in your area of specialization, you will conduct experiments and investigations into one of six major issues affecting the quality of the drinking water for these three counties. You will be the only specialist on your team with your special knowledge, so you need to work hard to learn your material. Your team is relying on you for this information!"

That is the start of the student WebQuest "Stayin' Alive" on the water quality issues facing users of the Ross Barnett Reservoir watershed area.

PURPOSE

As students work in STAYIN' ALIVE, they learn about the Ross Barnett Reservoir and watershed, teaching each other about their own specialty. They also learn about several issues surrounding use of the water in the reservoir, how human actions can affect the quality of that water, and steps that can be taken now to minimize the negative impact of human activities. Specifically, students will learn:

Essential Questions

- What is a watershed?
- What benefits do wetlands provide?
- What is nonpoint source pollution, and what can be done to control it?
- What actions are being taken to conserve watersheds?
- How is the water in the Ross Barnett Reservoir connected to the water we use when we eat, drink, bathe, wash clothes, water the yard, etc.?

OVERVIEW

Students learn about six issues (sedimentation, pesticides, fertilizers, bacterial growth, litter, and invasive species) that negatively impact the quality of water contained within the Ross Barnett reservoir. In addition, they learn about how people can reduce the effects of each of these issues and the relationship between everyday habits and the quality of the water in the reservoir.

The class structure is based on the ***Jigsaw*** model of instruction. For more information on this model, refer to page 12 of this packet.

Engineering Teams

Engineering Teams of 6 are formed, and members of each team follow a jigsaw method of cooperative learning. A different issue affecting the water quality of the Ross Barnett Reservoir is assigned to each team member, who then becomes a specialist on the issue. All specialists work together to identify and understand the implications of their specific issues. Each specialist will take an exam on the key elements of their issue. Once each member of the specialist group has passed their exam, the original

Engineering Teams are reconvened so that all specialists may instruct the other members of the team. Following this instruction, the entire team must take and pass a test on all of the issues presented.

Expert Specialist Groups

Each Specialist Group will complete their portion of the Stayin' Alive WebQuest. Upon completion of this WebQuest, each specialist will take a test on their area of expertise. Students will peer-teach and peer-tutor each other until all members of the group pass the test.

Explanation of specialist groups

- Sedimentation and storm water specialists – what are the sources of sediment, and how can we reduce and control it? Students in this group should prefer hands-on experimenting.
- Bacteria and disease specialists – what are the sources of bacteria and disease-causing agents, and how can we reduce and control these agents? Students in this group should prefer problem-solving simulations.
- Nutrient run-off and algae growth specialists – how do farming practices lead to decreased fish populations, and how can we address these issues? Students in this group should prefer hands-on experimenting, with the ability to wait days for results.
- Pesticide specialists – how do pesticides get into the water, and how can we educate people on the dangers of using them? Students in this group should prefer working with demonstrations and playing instructional games.
- Litter specialists – how can we get people to reduce their dumping of trash in and along the reservoir shoreline? Students in this group should be outgoing and enjoy writing and performing skits.
- Invasive species specialists – what are invasive species, why are they so harmful to the reservoir, and what can we do about them? Students in this group should prefer playing games and creating informative poster presentations.

Team Challenges

Once all members of an Engineering Team have passed the Reservoir Issues test, they are ready to select their challenge. This challenge is the culminating activity for the unit, and teams/individuals will present their solutions at Waterfest in the spring. A second challenge involving application of the scientific method will be given at Waterfest to all competing teams. Solutions will be judged by experts in their fields, and winning teams will receive a traveling trophy and a cash prize. The teacher of the winning team will also receive a cash prize. Teams will select from the following challenges:

- **Technical Team Problem**
  This problem requires the 6 team members to collaborate on a local water quality issue to devise a solution that is scientifically sound. Students will present to judges orally and in written format.

- **Media Team Problem**
  This problem requires the 6 team members to collaborate on a local water quality issue to devise a solution that is scientifically sound. Students will present to judges orally and in written format.

- **Scenario Writing**
  Team members or individuals will write a scenario regarding the Ross Barnett Reservoir that will inform and intrigue the reader. This scenario must have a futuristic orientation.

Mississippi Department of Education Competencies

1. Science Inquiry (grades 4 – 6)

a. Form a hypothesis, predict outcomes, and conduct a fair investigation that includes manipulating variables and using experimental controls. (DOK 3)
b. Distinguish between qualitative and quantitative observations and make inferences based on observations. (DOK 3)
c. Use precise measurement in conjunction with simple tools and technology to perform tests and collect data. (DOK 1)
d. Organize and interpret data in tables and graphs to construct explanations and draw conclusions. (DOK 2)
e. Interpret and describe patterns of data using drawings, diagrams, charts, tables, graphs, and maps. (DOK 2)
f. Evaluate the results or solutions to problems by considering how well a product or design met the challenge to solve a problem. (DOK 3)
g. Draw conclusions about important steps (e.g., making observations, asking questions, trying to solve a problem, etc.) that led to inventions and discoveries. (DOK 3)
h. Infer and describe alternate explanations and predictions. (DOK 3)

4. Earth Science

d. Describe how human activities have decreased the capacity of the environment to support some life forms. (DOK 2) (**4th Grade)**
d. Describe changes caused by humans on the environment and natural resources and cite evidence from research of ways to conserve natural resources in the United States, including (but not limited to) Mississippi. (DOK 3) **(5th Grade)**
g. Conclude that the supply of many Earth resources (e.g., fuels, metals, fresh water, farmland) is limited and critique a plan to extend the use of Earth's resources (e.g., recycling, reuse, renewal). (DOK 3) (**5th Grade)**
d. Summarize the causes and effects of pollution on people and the environment (e.g., air pollution, ground pollution, chemical pollution) and justify how and why pollution should be minimized. (DOK 1) **(6th grade)**
g. Research and cite evidence of current resources in Earth's systems. (DOK 3) **(6th Grade)**

- Resources such as fuels, metals, fresh water, wetlands, and farmlands
- Methods being used to extend the use of Earth's resources through recycling, reuse, and renewal
- Factors that contribute to and result from runoff (e.g., water cycle, groundwater, drainage basin (watershed)

Social Studies

3. Demonstrate the ability to use social studies tools. (C, H, G, E)

b. Demonstrate spatial and ecological perspectives to life situations (e.g., location of waste disposals in the state, wetlands, forest areas, etc.). **(4th grade)**
f. Evaluate land use with a variety of maps (e.g., farming, industrial, recreation, housing, etc.). **(5th, 6th grades)**
h. Interpret special purpose maps and their uses (e.g., climate, vegetation, population, topographic, etc.) **(5th, 6th grades)**

4. Identify the interdependence of economics (self, family, local, and state). (C, H, G, E)

a. Compare the *resources* and *scarcity* of resources in a local region to other regions in Mississippi (e.g., Delta's rich soil vs. coastal waters). **(4th grade)**

SET-UP

Timing

STAYIN' ALIVE will take approximately 3 weeks to complete, but the activities within the unit provide for a great deal of flexibility.

- Week 1 – students work in their Specialist Groups to learn about one of the issues confronting the Ross Barnett Reservoir. They research the issue, conduct experiments and explorations, and take an issue-specific test on the content.
- Week 2 – students return to their Engineering Teams where they teach the other members the key concepts of the issues. They take a comprehensive test over the key concepts of all six issues, then select and begin to research their challenge.
- Week 3 – each Engineering Team continues to work on their solutions to the challenge. Final solutions and presentations will be given, and the top teams will present their solutions at Waterfest in the spring. Winning teams will receive a cash prize and a traveling trophy, and the teacher of the winning team will also receive a cash prize.

Grouping Students

This unit involves cooperative learning.

- Jigsaw groups – Engineering teams
  On day 2, the class will be divided into groups, called Engineering Teams, of 6 students each. These teams function as the Jigsaw group. Students work together as well as individually to achieve their group's goals of learning about the issues facing the reservoir, passing exams, and crafting solutions to their chosen challenge.
- Expert groups – Specialists
  On day 3, students are grouped into their Specialists groups based on the issue they will master for their group. All Sedimentation specialists will form one group, all the Invasive Species specialists form one group, etc.

Materials

- Computer (more than one is best – one per Engineering team is ideal)
- Markers
- Poster board
- Construction and manila paper
- Print resources (from library)
- Supplies to complete each investigation (as detailed below)

Whole Class introductory activities

- Watershed Model – per group
  - 1 plastic shoebox-sized container
  - 1 kitchen sponge (yellow with green scrubber side) cut into 4 rectangular pieces
  - 1 water spray bottle
  - a multi-color assortment of water-based markers
- Watershed Model – teacher supplies
  - a stack of white cardstock paper (3 sheets per team)
  - 1 packet of colored drink mix like Koolaid or Hawaiian Punch
  - 1 spoon
  - optional - map or satellite image of the school and neighboring areas showing the watershed

- Who Polluted the River?
  - 1 clear container of water for every 10 - 15 students
  - 1 labeled black plastic film canister per student
  - Canister ingredients (all are safe for students to handle)
  - Oregano or Parsley Flakes
  - Soil (dry, clayish) or cocoa or cinnamon
  - Fishing line or dental floss
  - Baking Soda
  - Assorted Litter (confetti)
  - Cat Litter
  - Soapy Water
  - Blue-Green Kool-aid
  - Soy Sauce
  - Water,
  - Orange Kool-Aid
  - Toilet Paper/Tissues
  - Vinegar
  - Vegetable Oil

Sedimentation and storm water specialists

- Simply Sediments
  - Empty 1-liter bottle with cap
  - Sediments or dirt from yard
  - Water
- Three Types of Erosion
  - Large piece of white bulletin board paper
  - Dropper or pipette
  - Watch glass or shallow saucer
  - 2-3 tablespoons of soil
  - 5-10 cups of sand to create a hill
  - A blow dryer with cylindrical barrel
  - A trough for a wind chamber (You can also use guttering from a roof.)
  - Wooden matches, sticks, or coins
  - Large container with a spout filled with water (a watering can with a regular pour spout will work, or a ketchup squirt bottle)
  - A long board to create a slope
  - Long sheet of plastic to cover board and drain water off
  - Large container for collection of the runoff water
  - A small rectangular wood block
  - Plastic or rubber tubing
  - Soil
  - Water

Bacteria and disease specialists

- Water Treatment Plants
  - Glass jar
  - Food coloring
  - Celery stalk
- Let's Give Water a Treatment
  - Pond water
  - Rain water
  - Dirty water (mix dirt and water)
  - 4 clear plastic cups labeled A, B, C, D
  - Small can with holes in bottom
  - Paper towels
  - Sand
  - Microscopes
  - Bottle with eye dropper filled with bleach
  - Slides
  - Goggles for each student
  - Student sheet

Nutrient run-off and algae growth specialists

- Fertile Green – Nutrients and Water
  - 6 clear plastic containers
  - Measuring spoons
  - Water samples from a lake or pond
  - Plant fertilizer
  - Tap water
  - Dissolved oxygen kit (optional)
  - Digital camera (optional)
  - Electronic probe for measuring turbidity (optional)
- Water Treatment
  - 3 two-liter bottles
  - Cotton
  - Fine sand
  - Activated charcoal
  - Coarse sand
  - Fine gravel
  - Coarse gravel
  - Water
  - Dirty water
  - Alum
  - Tablespoons
  - Bleach
  - Goggles for each student

Pesticide specialists

- Seepy Sandwich
  - Food coloring to represent pesticides.
  - Slices of bread to represent the soil and rock.
  - A sprayer to produce rainwater.
  - A waterproof work area.
- Pesticides and the Food Chain
  - 75 – 100 corn kernels (2/3 yellow, 1/3 another color).
  - Pie pan or other shallow container
  - Stopwatch Tweezers (one per student)
  - Snack sized plastic bags (five per student)
  - Sandwich sized plastic bags (one per student)
  - Large sack (plastic grocery bag)
  - One die or number cube
  - "Mystery card" in a sealed envelope (mystery note at end of this document)

Litter specialists

- Every Litter Bit Hurts
  - paper sack
  - disposable cup
  - small glass bottle
  - plastic six-pack ring
  - String
  - snack bag
  - cigarette butt (place in clear baggie)
  - banana peel
  - Balloon
  - Straw
  - beverage can
  - writing materials are optional

Litter specialists (continued)

- How a Reservoir Works
  - Plastic box
  - Spray bottle
  - Pebbles
  - Soil
  - Sand
  - Leaves

Invasive Species specialists

- Effect of Invasive Species game
  - 4-cups
  - 2-plastic knives
  - 1-plastic spoon
  - 3-plastic forks
  - 1-large binder clip
  - 8 red pom-poms
  - 10 black pom-poms
  - 8 white pom-poms
  - 3x4 piece of felt
  - 20 bingo chips
- Rival For Survival game
  - Dice
  - Movable game pieces
  - Paper for keeping score
  - Game board (see appendix)
  - Game cards (see appendix)
  - ***These need to be prepared by the teacher in advance of the unit.
- Invader Species of the Great Lakes
  - Prepared game cards (cards provided)

Special Guest Options

Debra Veeder
Adopt-A-Stream Coordinator
Mississippi Wildlife Federation
855 S. Pear Orchard Rd., Suite 500
Ridgeland, MS 39057
Phone (601) 206-5703
Fax (601) 206-5705
dveeder@mswf.org
www.mswildlife.org

Presentation topics:

- Working watershed model
- Aquatic insects
- Chemical testing of water for students

OUTLINE OF INSTRUCTION

Day One: Introduction to unit

1. Show PowerPoint "Watersheds – Connecting Weather to the Environment".
2. Use the accompanying teachers guide as you show the PowerPoint. This PowerPoint is rather long, so splitting it across two days is an option.
3. Group students into Expert Teams and assign each member to one of the six Specialist areas.
4. Have each team create a sign or banner for their team.

Day Two: Introduction to unit continued

1. Lead the class in "Who Polluted the River" activity.
2. Re-group class into Specialist areas and review each area's WebQuest assignments.

Days Three - Five: Specialist Group work

1. Specialist groups begin mastering their areas of specialty.
2. Some assignments require longer than 3 days to complete (primarily to provide ample time for algae growth). These groups will need to meet during week two to complete those activities.

Days Six – Seven: Expert Teams Reconvene

1. Expert teams reconvene and each Specialist teaches the topic to other members of the team
2. Students prepare for the Water Quality test.

Day Eight: Exam Day

1. Play Conservation Jeopardy as a review.
2. Students complete "Deadly Waters" performance assessment and take the Water Quality test.
3. Students finishing early may complete a mini-challenge.

Days Nine – Fifteen: Challenges

1. Teams select one of three challenges to complete.
2. Teams work together to devise a solution to their chosen challenge.
    a. Devise solution
    b. Develop creative presentation of solution
3. When finished, students will compete in a school-level competition to determine the winning solution for each of the three challenges. Winning teams progress to the tri-county competition at the spring Waterfest.

UNIT TIMELINE

Day 1	Day 2	Day 3	Day 4	Day 5
• Organize teams; make team signs • Assign roles • Introduce Unit • Introductory PowerPoint	• Whole class demonstration – "Who Polluted the River?" • Specialist groups meet and view their WebQuest assignments	• Specialist groups meet to read about and begin mastering their areas of specialty	• Specialist groups continue to meet and work through WebQuest	• Members complete WebQuest assignments and submit final products to teacher
Day 6	**Day 7**	**Day 8**	**Day 9**	**Day 10**
• Expert Teams reconvene and specialists teach their topics to the other members of the team	• Teaching continues; study for Water Quality test • Test covers basic content all team members are required to know	• Take test • Students finishing early complete mini challenges	• Introduce challenges • Teams select which of the 3 challenges they will tackle	• Teams begin planning solutions to selected challenge
Day 11	**Day 12**	**Day 13**	**Day 14**	**Day 15**
• Teams continue to work on solutions to challenge	• Teams continue to work on solutions to challenge	• Teams continue to work on solutions to challenge • Begin presentation planning	• Teams continue to work on solutions to challenge • Work on presentations	• Teams continue to work on solutions to challenge • Finish presentations • Practice presentations – these will be presented at Waterfest before a panel of judges

DESCRIPTION OF JIGSAW MOVEMENT

Set Induction: The teacher asks the students, “How would you like to be the teacher for the next few weeks?”

Activities

1. The teacher explains that the class will be studying Watersheds and the Ross Barnett Reservoir and that the students will take on the role of teacher for the information on this topic.

2. In large group, the class reviews the concepts that will be covered.
    - Teacher presents the introductory PowerPoint.
    - Teacher leads class in exploring “What is a Watershed”.
    - Teacher leads class in exploring “Who Polluted the River?”

3. Discuss the different ***Jigsaw*** groups and the responsibilities for each.

4. ***Jigsaw*** groups are assigned, and topics are assigned to the groups.

5. Students go into groups to complete the activities in each category.

6. Presentations are completed and practiced. Students take a skills test at the end of their group study.

7. Students return to original ***Jigsaw*** groups to teach the topics that were researched – other group members take notes to be used for study. The group takes a test over all six topics.

RESOURCES AND REFERENCES

THE FARMER CARES FOR THE LAND http://food_fiber.okstate.edu/farmrcr1.pdf

Question and Answer game http://www.epa.gov/ogwdw/kids/flash/flash_qagame.html

Sediment and Storm water http://www.stormcenter.com/envirocast/2002-12-01/envirocast-feature.php

Cleaning surface water through filtration http://www.epa.gov/safewater/kids/wsb/pdfs/353.pdf

Sediment and erosion model http://www.epa.gov/safewater/kids/wsb/pdfs/353.pdf

Bacteria and Disease http://www.scorecard.org/env-releases/water/community.tcl
Scorecard for Mississippi watershed – tell students to enter their zip code, click on "get report"

Bacterial pollution http://www.epa.gov/safewater/kids/wsb/pdfs/353.pdf

Bacteria in water http://www.epa.gov/safewater/kids/wsb/pdfs/682.pdf

Wastewater treatment activity http://www.epa.gov/safewater/kids/wsb/pdfs/352.pdf

Growing algae http://www.epa.gov/safewater/kids/wsb/pdfs/353.pdf

Pesticide pollution http://www.epa.gov/safewater/kids/wsb/pdfs/353.pdf

Insect identification and water quality http://www.epa.gov/safewater/kids/wsb/pdfs/682.pdf

Every "Litter" Bit Hurts
http://www.litteritcostsyou.org/docs/lessons/Every%20Litter%20Bit%20Hurts.doc

Litter, Landfills, and Recycling http://www.keepaustinbeautiful.org/files/Litter%20Impact.doc

Litter and Debris in our Waterways
http://www.vaswcd.org/documents/Education/NRCW/Sec3.litterinwaterways.pdf

Invasive species – MSU Article http://www.wrri.msstate.edu/newsletter.asp

Alien Invasion in Mississippi http://www.dafvm.msstate.edu/landmarks/05/winter/12_15.pdf

Mississippi Landmarks magazine http://www.southernfocus.com/articles/landmarks.pdf

Rival for Survival game http://www.iisgcp.org/education/rival_lesson.pdf

Invasive Species game rough draft http://www.utoledo.edu/as/lec/pdfs/Invasive.pdf

Invader Species of the Great lakes http://www.iisgcp.org/education/invdr_spec_gl.pdf

Play the Watershed Game http://www.bellmuseum.org/distancelearning/watershed/watershed2.html

Water Filtration instructions (make your own) (need Adobe Flash)
http://www.epa.gov/safewater/kids/flash/flash_filtration.html

Water Treatment Procedure http://www.epa.gov/safewater/kids/watertreatmentplant/index.html

Source of EPA pdf files http://www.epa.gov/safewater/kids/teachers_4-8.html

Water Sourcebooks http://www.epa.gov/safewater/kids/wsb/index.html

Construct your own wetland in a bottle http://www.epa.gov/safewater/kids/wsb/pdfs/352.pdf

Demonstration of non-point source pollution http://www.epa.gov/safewater/kids/wsb/pdfs/353.pdf

History of Ross Barnett reservoir
http://www.mvk.usace.army.mil/offices/pp/projects/prws/background.htm

Educational information on Ross Barnett reservoir http://www.rezkeepers.com/education.html

Blue Centauri Text Analyzer (to determine readability levels)
http://bluecentauri.com/tools/writer/sample.php

Deadly Waters http://www.sc.audubon.org/PDFs/deadly_waters.pdf

Construct a Watershed Model

Adapted from "A MyScienceBox Lesson Plan" by Irene Salter (http://www.mysciencebox.org)

Summary

Simple materials are turned into models of wetlands and watersheds in this simple activity. Students follow the path of the water (and urban runoff) to a bay and develop an initial understanding of what watersheds are. Then some students add sponges to the borders of their bay to simulate wetlands and compare watersheds with wetlands to those without. Students extrapolate the role of watersheds as reservoirs in times of drought, as sponges in times of flood, and as filters for pollution. Finally, students compare watersheds with wetlands to those without after a "toxic chemical spill" (Koolaid drink mix) to see the effects of pollution throughout the watershed as well as to discover the role of wetlands in reducing the harm of severe pollutants to a bay.

Materials

Each team of 3 students needs:

- 1 plastic shoebox-sized container (great for organizing supply closets later on!)
- 1 kitchen sponge cut into 4 rectangular pieces (the yellow sponges with the green scrubbing material are cool because kids can observe a color change in the yellow "soil" portion of the sponge while the green material simulates plants living in the wetlands)
- 1 water spray bottle (available at most hardware stores near the cleaning supplies or at plant nurseries for watering and misting plants)
- a multi-color assortment of water-based markers

The teacher needs:

- a stack of white cardstock paper (each team will use 3 sheets)
- 1 packet of colored drink mix like Koolaid or Hawaiian Punch
- 1 spoon
- optional - map or satellite image of the school and neighboring areas showing the watershed

Everyone needs:

- a copy of the Watershed and Wetlands Questions
- a sink to clean sponges and dump dirty water
- a trash can

Procedure

- Group students into teams of 3 that later pair up into groups of 6

Part 1 – Building a watershed

1) Tell students to imagine that it is raining. Ask the students: "Where does raindrop go after it hits the school building? Where does it go from there? Where does it end up?" They should be able to trace it to a gutter. You may need to prompt them towards naming the rest of the route.
2) Discuss the idea of a watershed. It includes all the land that water flows over and through to get to a larger body of water. Help students imagine what this means in terms of a raindrop that falls in different places in your watershed. Use a map if you want. It is not important that all the kids completely understand the idea right now. The activity that follows should help consolidate the idea for kids that aren't getting it right away.
3) Tell the students that they will be building models of watersheds and observing what happens to their models when it "rains". Briefly demonstrate what they will be doing to make their watershed (see steps 5-8) so they can see a nearly finished product before setting the kids loose.
4) Split the class into groups of 3 and have 1 member of each group collect 3 sheets of cardstock and 1 watershed tub. The rest of the group should clear everything off the tables except for a pencil for each student (they may get wet).
5) Crumple the sheet of cardstock into a ball then slowly flatten it out again. You should have a piece of paper with many valleys and ridges. Pick one end to be the top; this end will have tall mountains. The other end will be near a bay.
6) First, add water to your watershed. Make students think about where to put these rivers. Will they be at the tops of ridges or in the valleys? Where might lakes form?
7) Next add natural areas – animals, trees, plants, rocks, sandy banks. Add urban and agricultural areas – houses, cars, schools, farms, gardens, factories, roads, cars. Make students think about where to put various things. Where would you find forests? Where would you find meadows? Where would animals want to live? Where might it be very rocky? Where would people want to build houses? How would they get to their houses? Where would they work and go to school? Where would their food come from? Would you want to build a farm at the top of a mountain? Allow 5-10 minutes for students to finish their watersheds. They should be very colorful.
8) Carefully fit the watershed into the plastic bin so that the mountainside is propped up on the narrow end of the bin (the mountain end) and the land slopes gradually towards the far end of the bin (the bay end), leaving a 2-3 inch gap between the end of the paper and the bay end. Wedge the paper snugly in place leaving as little gap as possible between the sides and the paper.
9) Take one of the markers and prop the mountain end of the bin up a little. This is to make sure that a bay forms on the bay end and does not run back under the land.
10) The 3 students should take turns spraying the paper using the fine mist setting. Spray for 3-5 minutes until there is a decent sized puddle in the bay end.
11) Give students the Watershed and Wetlands Questions handout and give students a few minutes to answer the first set of questions. The questions do not have to be used during class. You could use the questions to being a class discussion or use them as a homework assessment.
12) When students have finished writing their answers, begin a discussion of how this model represents a watershed and how different things affect the watershed. If you still have the diagram of your watershed on the board, you could add these ideas to your diagram. Now is the time to really consolidate the idea of a watershed. Some questions could include:
    - What path did the rain take through your watershed?
    - What effect do natural areas have on the watershed? Urban areas? Agricultural areas?
    - What is "runoff"? Is runoff different in natural versus urban versus agricultural areas? It is important to distinguish erosion from urban runoff. Also, it may be interesting to think about differences in urban versus agricultural runoff.
    - What affect does runoff have on the bay?
    - What is a watershed? How is this model similar to a real watershed? How is it different?

Part 2 – Adding Wetlands

13) Tell students that they will now build another watershed. This time, we will compare watersheds with wetlands to those without. Open a discussion of what students think wetlands are. Have they ever seen one? What does it look like? What kinds of plants and animals live there? If they don't know the term wetland, they will likely have heard of a marsh and can bring up a good mental picture.
14) Pair teams up with one another. One team will have a wetland represented by sponges at the border between the land and the bay; the other will do the activity exactly as before (in the third rendition, they will switch roles so that everyone has a wetland once).
15) Clean up the materials and allow groups to create a new watershed with a new sheet of cardstock paper. It should not take as much time this time nor is it necessary for the watersheds to be as elaborate.
16) Set up the bins as before, however, one team should add a tightly packed row of damp sponges to the border between the land and the bay. **THE SPONGES MUST BE DAMP**. They should not be sopping wet, nor should they be wrung out as much as possible. They should be somewhere in between so that some water could still be wrung out if you tried.
17) Place the watershed with wetlands directly beside the watershed without wetlands and prop up the mountain end with a marker.
18) Allow it to rain an equal amount on each watershed. The students should make an effort to squirt the 2 watersheds an equal number of times. As it rains, encourage them to notice any differences between the 2 watersheds.Stop when a decent sized bay had built up – about 3 minutes.
19) Give students a few minutes to answer the second set of questions. When students have finished writing their answers, begin a discussion of what the role of watersheds might be. Some questions you may want to consider include:
    - Were there any differences in how quickly each bay filled? What does that mean about what wetlands do in times of heavy rain? Introduce the idea of wetlands as sponges during wet times and reservoirs during dry times to even out the flow of water.
    - What happened to the color of the bottoms of the sponges? What does this represent? Introduce the idea of wetlands as filters for pollution.

Part 3 – Toxic Waste!

20) Have students hypothesize what might happen to a watershed if a truck carrying pesticides crashed along a highway near a creek. What parts of the watershed might be affected?
21) Students will now have a chance to test their ideas on their models. As before, there will be one team with a wetland and one without, however they should switch roles. A spoonful of pesticide will be added to each watershed before it rains.
22) Clean up the materials and allow groups to create a new watershed with a new sheet of cardstock paper. Set up the bins as before, placing the watershed with wetlands directly beside the watershed without wetlands and prop up the mountain end with a marker.
23) At this point, the teacher should go around and add a teaspoonful of drink mix to the middle of each watershed.
24) Allow it to rain an equal amount on each watershed. Notice any differences between the 2 watersheds. Stop when a decent sized bay had built up – about 3 minutes.
25) Give students a few minutes to answer the final set of questions. When students have finished writing their answers, begin a discussion about the differences between non-point source pollution (runoff) and a pesticide spill. This activity should clearly illustrate how a single event in one location can affect a very large area and affects all downstream water users including wildlife in the marsh and the bay. Students will observe that while a wetland can soak up some pollution, some will also leak through into the bay. Can it be cleaned up once it gets into the water? Emphasize that although a waste spill is far more dramatic, urban non-point source pollution accounts for the vast majority of the pollution in most watersheds.
26) Given what we've discovered about watersheds and wetlands, what can we do to help them thrive? Have students brainstorm ideas.
27) Clean up.

Watersheds and Wetlands Questions

Part 1 – Building a watershed

1. Describe the path that the rain took through your watershed.

2. What happened to the drawings that represented natural areas (creeks, trees, plants, animals, wildlife)? What does this represent in nature?

3. What happened to the drawings that represented urban areas (houses, schools, factories, roads, cars)? What does this represent in the real world?

4. What effect did the runoff from natural and urban areas have on the bay that formed at the bottom of the land area?

5. The models we are using are not perfect. What is wrong with our watershed models? How are they different from a watershed in the real world?

Part 2 – Adding wetlands

1. How quickly did the bay with a wetland fill up compared to the bay without wetlands?

2. How much water is the bay with a wetland compared to the bay without wetlands?

3. Look at the underside of the wetlands. What happened? What does this represent?

4. The models we are using are not perfect. What is wrong with our wetland models? How are they different from a wetland in the real world?

Part 3 – Toxic waste!

1. The drink mix represented pesticides. What other real world toxic wastes could affect a watershed.

2. Where did the toxic waste go in your watershed?

3. What parts of the watershed were affected? What parts were not affected?

4. Describe any differences between the watershed with wetlands and the watershed without wetlands.

Teacher Background – Construct a Watershed Model

The concept of the watershed forms the foundation of much environmental science. Formally, a "watershed" is the area of land that water flows over and through on its way to a larger body of water like a creek, river, lake, or bay. Practically, this means that a watershed is all the land that drains into a specific body of water. Every house, school, and neighborhood is part of a watershed. Studying ones own watershed allows students to apply scientific knowledge to their neighborhood and community and are easy ways for students to make connections between their actions (pollution, water conservation, habitat restoration, etc.) and the quality of the environment they live in.

Watersheds may be as large as several states (the Mississippi River watershed for example) or as small as a few city blocks. For instance, the San Francisco Bay watershed covers the entire western slope of the Sierra Nevada Mountains, the Central Valley of California, the Sacramento River Delta, and the many smaller creek systems that surround the San Francisco Bay itself. This area of land is approximately 40% of the entire state of California! One could also refer to the Codornices Creek watershed in Berkeley that my school is near. It's area encompasses a narrow strip of land 5 blocks wide and 3 miles long between the San Francisco Bay and the Berkeley hills. Both are equally valid watersheds to discuss since students can see their personal connection both to the Bay and to the neighborhood they live and go to school in.

A watershed begins in the tallest mountain areas where water falls as rain or snow. This water then trickles into rivulets, rivulets merge into creeks, and creeks merge into rivers on the water's way downhill. Eventually, these streams of water reach the larger body of water under study – a bay, a river, a lake, a creek. Much of this water will also seep into the ground as groundwater and may travel much more slowly through the soil and rock and perhaps underground aquifers to reach a body of water. Any land a water drop has traveled over or through to get to the body of water being studied belongs to that watershed. All this movement of water is part of the larger water cycle (see the Water Cycle Stories Lesson).

I found that my students had a difficult time understanding that a watershed meant *land* and did not just include the creeks, rivers, lakes and bays. Pointing out that a watershed is usually bordered by ridges helps. Using a 3-D map to illustrate separate valleys that have separate watersheds also helps.

At the edges of a watershed, particularly those with little human development, one will find wetlands. Broadly defined, "wetlands" are transitional areas between land and water habitats. More specifically, the wetlands are characterized by:

1) lots of water - the water table is at the surface or close to it most of the time
2) soil that is wet much of the time (although some wetlands are actually dry for more of the year than they are wet)
3) specialized plants that are adapted to live in wet soils with lots of groundwater

The many types of wetlands include marshes, swamps, bogs, meadows, mud flats, and other habitats where land and water meet.

In the not so distant past, up until even the 1970's, wetlands were often considered to be wasted space. The marshy land at the edges of bays seemed wasted on the weedy plants that grew there and seemed like perfect, flat strips of land that could be filled in with soil and concrete to build desirable waterfront housing, office, and industrial space. In a span of 150 years, the San Francisco Bay watershed lost 90% of its wetlands. And only now are we realizing their worth and importance to a healthy ecosystem.

Wetlands serve many essential roles in the environment. They are critical habitat for many specialized plants and animals that survive nowhere else. The plants that live in a wetland act as a filter to soak up pollution that runs off upstream. In fact, several communities such as Arcata, CA and Phoenix, AZ use wetlands as part of their urban water treatment facilities instead of the harsh chemical treatments that must otherwise occur. Wetlands also serve as a reservoir to even out fluctuating water levels, soaking up excess water during a wet times and releasing stored water during dry times. Finally, as the nation learned in the Hurricane Katrina disaster, wetlands can serve as a buffer against natural disasters such as hurricanes.

Who Polluted the River?

Materials:

- 1 clear container of water for every 10 - 15 students
- 1 labeled black plastic film canister per student
- Canister ingredients (all are safe for students to handle)
- Dry Ingredients: Fill canister halfway full with dry ingredients listed above
- Liquid Ingredients: Fill canister 2/3 full with liquid ingredients listed above

CANISTER LABEL	CANISTER INGREDIENT
Trees	Oregano or Parsley Flakes
Construction Site	Soil (dry, clayish) or cocoa or cinnamon
Person Fishing	Fishing line or dental floss
Farmers	Baking Soda
Gardeners	Baking Soda
Beach Party	Assorted Litter
Family Picnic	Assorted Litter
Barnyard	Cat Litter
Washing the Car	Soapy Water
Antifreeze	Water with Blue-Green Kool-aid
Mystery Liquid	Water and Soy Sauce
Homeowner	Water, Orange Kool-Aid and Toilet Paper/Tissues
Electricity Plant	Vinegar
Commuters	Vinegar and Vegetable Oil
Motorboat	Vinegar and Vegetable Oil

Procedure:

1 Prepare and label the canisters as described in the materials section, enough for each student to have one canister. For each 15 students, fill one clear container with water nearly to the top.

2 Distribute one canister to each student. Instruct them to keep the canister closed and upright. The students should also be told not to reveal the identities of their canisters at this point.

3 Explain that you will tell a story about the river (water body) and that each one of them will play a part in the story. When they hear the name of the character listed on their canister in the story, they should open their canister, and empty its contents into the container (representing the water body).

4 Read the story on the next pages. Pause after each question to give students time to think and respond. After the story has been read, use the following questions for a follow up discussion.

Discussion Questions:

1 Who polluted the river or whatever water body you are describing? (everyone one played a role)

2 What effect did the increasing population have on the water quality? (More people meant less wetlands and trees – which filter water, there were more vehicles, there was less open space, etc.)

3 Can you think of any ways that population increases have helped the bay? (Higher population densities led to more efficient use of resources, stronger environmental laws, public resources like sewage treatment plants, etc.)

4 Think about the pollution in your canister. Could something be done to prevent that type of pollutant from entering the water? How? (Go around the group and let each student address the pollutant in their canister.)

5 Challenge students to come up with ways to clean up the water in the container. After all, everything has to go somewhere. (Solids can be strained out. They may also find filters or absorbent cotton helpful.)

6 Once this type of pollution has entered the bay, bow can we get it out? How can we clean up the river (bay)? Do they think it is easier to prevent pollution or to clean it up later? Have them explain their ideas.

WHO POLLUTED THE RIVER?

For many thousands of years, people have lived on the banks of the River. They hunted in the forests, harvested foods from wetlands, and caught fish from the river.

- Imagine that a Native American took the container of water in front of you from the river 500 years ago. How does it look to you?
- Would you drink this water? Would you eat the fish from this water? Would you swim in this water?

One of the first explorers to visit the river kept a journal of his discoveries. He wrote about the Native American villages, the rivers and streams and the "sweet water", and seeing so many fish that he and his crew tried to scoop them out with a frying pan.

Soon people began to arrive. They found fertile land for farming, forests full of wildlife, and a river that provided plenty of food. It was an outstanding environment for settlement, and the people prospered.

The river has changed a lot since it was first explored. This is a story of those changes. Listen for the name of the character printed on your canister. When you hear your character named, open the canister, and dump its contents into the river.

Years went by, and occasional storms drenched the area. High winds whipped through the **TREES** and blew leaves into the water.

Gradually, towns started to grow along the banks of the river. Developers cleared wetlands and forests to build houses and businesses. Rains washed loosened soil from **CONSTRUCTION SITES** into the river.

At first, towns were small. Upstream, **FARMERS** planted crops to feed the towns' growing population. Some of those crops grew right up to the river, and fertilizer washed off the land and into the water. Other farmers kept pigs, cows, and other animals in their **BARNYARDS**. As rainwater drained out of the barnyard, it carried some of the manure into a little creek behind the farm. The creek flows to the river.

As the towns grew, more and more people began to move to the nearby countryside. These country homes are not connected to the city sewer system. Wastewater (elaborate on wastewater) from these homes flows into the septic tanks under the ground. One **HOMEOWNER** has not maintained the septic tank, and poorly treated sewage seeped into the river.

To meet the electricity needs of the towns; area officials decided that they would need to generate more power. To burn coal and produce power, an **ELECTRIC POWER PLANT** was build along the river. Gases coming out of the smokestacks combine with moisture in the air to form acids. The pollution falls back to the earth as acid rain or smog.

Traffic congestion can also be a problem for **COMMUTERS** and truck drivers who drive to and from work. Exhaust fumes, just like power plant emissions, can cause acid rain. If a vehicle is not kept in good repair, it might also leak oil or other fluids, which will wash off the pavement and into the river with the next rain.

And how do the residents of the town and surrounding areas spend their time? In one

neighborhood, a lot of **GARDENERS** are out working in their yards. Some of them are using weed killer and insect spray to keep the lawns pretty. The next rain will wash some of these into a little creek nearby and into the river.

One father is teaching his daughter how to change the **ANTIFREEZE** in the family truck. They pour out the used antifreeze into the driveway. Antifreeze is sweet tasting and can poison animals in they drink it. It can also get into the nearby creek and poison fish.

Nearby, a boy is **WASHING THE CAR**. The soapy water rushes down into the driveway into the storm drain; the storm drain empties into the river. The grease and grime on a car contains asphalt from the roads, asbestos from the brakes, rubber particles from the tires, toxic metals, and rust. If the boy had gone to the local car wash, the water would have been treated before it returned to the river.

Next door, a family is cleaning out their garage. They find an old rusty can with a tattered skull and crossbones label still stuck on it. What could it be? It looks dangerous, and they want to get rid of it before someone gets hurt. But how? Junior gets an idea: "Let's pour it down the drain by the curb!" So the **MYSTERY LIQUID** goes down the storm drain. The poison is out of site, but it is headed to the river.

On nice days, many people head down to the river. Some zoom all around in **MOTORBOATS** and don't notice that a little oil leaks into the water. A group of friends have spread blankets on the shore for a **BEACH PARTY**. Lots of families are **PICNICING** in the parks too. Some of these people have left trash on the shore. With the next storm, that trash will wash into the river. One the shore, a **PERSON FISHING** snags a hook on a log and breaks off the nylon fishing line.

- Would you drink this water now?
- Would you swim or boat in it?
- Is it healthy for fish or other wildlife?

Activity adapted from "**Who Polluted the White River?"**
www.bsu.edu/web/.../Who%20**Polluted**%20the%20White%20**River**.doc

Watersheds: Connecting Weather to the Environment

PowerPoint Notes

Slide 1

This presentation was developed to accompany the *Watersheds: Connecting Weather to the Environment* course developed by the National Environmental Education Foundation (NEEF) and the Cooperative Program for Operational Meteorology, Education, and Training (COMET). It may be used for community outreach activities, and is customizable to your location.

Slide 2

This slide outlines the contents of the presentation. Clicking on a link will take you directly to that section of the presentation.

Slide 3

When it rains or snows, where does the water go? Into a "watershed." Some of the water that falls is stored in the land, some of it evaporates away, and the rest follows the slope of the land to a common river, lake, or other body of water.

Slide 4

Everyone lives in a watershed – Your own backyard is part of a watershed. Down the street, there may be a small creek or drainage ditch, which will eventually lead to a larger stream, river, pond, or lake. This means that what happens in your backyard, and your neighbor's backyard, affects your whole environmental neighborhood!

Slide 5

"Watershed" is a relative term – a watershed can drain an area as small as a few city blocks, or as large as an entire geographical region, such as the Ohio River Basin. Smaller watersheds come together to form larger watersheds, much like puzzle pieces fit together to create a larger picture.

Slide 6

Another way of looking at watersheds is that they are a nested system – larger watersheds encompass many smaller watersheds. For example, the "Lena Gulch" watershed in Colorado's Rocky Mountain Foothills drains only 14 square miles of land, but the water from Lena Gulch eventually combines with water from numerous other small watersheds in the central U.S. to form the very large Missouri River Basin.

Slide 7

(Click the map to open a web browser to the USGS Locate your Watershed website, where you can drill down to specific watersheds in your broadcast area.)Ross Barnett Reservoir is in the South Atlantic Gulf region. (Note that an Internet connection is required.)

Slide 8

None

Slide 9

(Click this picture to link out to a local web page containing an animated version of the hydrologic cycle.)

All of our freshwater starts out as rain or snow, which moves through the "hydrologic cycle." When rain or snow falls, some of it soaks into the ground, replenishing groundwater supplies in natural, underground storage areas called "aquifers." Some of the water also runs over the land into streams, rivers, and lakes. Both groundwater and surface waters eventually drain to the ocean. When water evaporates and condenses, the cycle begins again with rain or snowfall.

Slide 10

A closer look at surface waters (streams, rivers, and lakes) and groundwater reveals an interconnected system. Streams, rivers, and lakes help to replenish groundwater supplies in aquifers, while groundwater flows up into surface water bodies. During dry times, surface waters can be derived almost completely from groundwater supplies.

Slide 11

(Click the map to open a web browser to the EPA Local Drinking Water Information website, where you can look up water source information for your broadcast area. To do so, click your state on the US Map, then click the ENVIROFACTS DATA link for your state. (Note that an Internet connection is required.))

As an example, 98% of Atlanta's water comes from surface water, the Chattahoochee River, which is the smallest in the US serving a major metropolitan area.

Slide 12

(Use the resources listed to find drinking water supply. Identify whether your area relies primarily on surface or groundwater)

Slide 13

Have your audience guess the correct answer (#2). *(Go to next slide for more information.)*

Slide 14

Many people still believe that industry creates most of the water pollution in our streams, rivers, and oceans. Actually, "non-point source" or runoff pollution is the most common cause of pollution – that's water running off yards, streets, paved lots, and farm fields, which picks up pollutants along the way.

Slide 15

(Click the picture to open a web browser to the EPA Window to My Environment website, where you can find out about impairments to water bodies in your broadcast area. In the new window, enter your city and state, then click Create My Window. When the map window opens, click the Your Environment tab and follow the Are There Polluted Waters link. (Note that an Internet connection is required.))

Some of the most common water pollutants are yard care chemicals, such as fertilizers, herbicides, and insecticides; oil, grease, and other toxics from urban areas; soil; road salts used during the winter season; bacteria and nutrients found in animal waste; and air pollutants that are deposited in water bodies. As an example, key effects on water quality in Atlanta are pathogens, sediments, and habitat alteration.

Slide 16

None

Slide 17

A particularly dangerous form of flood is the "Flash Flood," which forms within just a few hours after the start of rainfall. Flash Flooding can be caused by heavy rain and slowly-moving thunderstorms, and moving water can be extremely forceful – toppling trees and moving boulders.

Slide 18

Flash Flooding can be caused by heavy rain and slowly-moving thunderstorms, and moving water can be extremely forceful – toppling trees and moving boulders.

Failures of man-made structures can also trigger flash flooding.

Slide 19

The landscape in urban areas can exacerbate flooding problems. Because urban areas contain many paved surfaces, which do not allow rainwater to soak into the ground, water instead runs off into the nearest stream or low-lying area. When these areas become overwhelmed with water, flooding occurs.

Slide 20

Tropical storms can also cause flooding – especially when heavy downpours persist.

Slide 21

Water quality impacts can include increased salinity (saltiness), turbidity (cloudiness), temperatures, levels of dissolved Oxygen, and other effects.

The above impacts can result in plant stress and increased vulnerability to insects and disease, loss of natural vegetation, croplands, and forests, habitat loss for wildlife, and reduced biodiversity. In turn, these impacts can increase the frequency and severity of wildland fires, increase soil erosion, and diminished air quality due to smoke, dust, and other particulates. All can translate to a broad range of health, economic, and social effects, even in communities far-removed from the areas experiencing drought conditions.

Slide 22

(Use the resource listed to find your drought status.)

Slide 23

Regardless of where you live, there are simple actions you can take every day to help protect your watershed and water quality in local streams, rivers, lakes, and groundwater supplies.

- Don't dump! Make sure that only rainwater and snowmelt goes into storm drains and ditches, which lead directly to local surface waters. Never put trash or household chemicals in or near a storm drain or ditch.
- Be yard smart. Choose plants that are well-adapted to your climate and water wisely. Turn those sprinklers off when there is rain in the forecast, and hold-off on outdoor fertilizer and pesticide applications until dry weather is in the forecast.
- Control the Flow. Save water by installing low-flow toilets and showerheads. These fixtures use significantly less water without sacrificing comfort!
- Pick it up. Every time you and Rover hit the road, make sure to take a plastic bag with you to pick-up waste and throw it away in a trash can. Don't forget to pick-up in your yard, too.
- Fix those leaks. Check your home for leaky faucets and fixtures, which can result in a major waste of water!
- Get involved – join a local watershed group in a cleanup or restoration activity.

The Farmer Cares for the Land

Identify the problem and the solution and the main cause and effect relationship in the information below.

Soil Erosion

Soil erosion is what happens when soil is washed or blown away. In most places, trees, grass and other plants hold soil in place. When that vegetation is removed, winds and rains can carry the soil away. Over the years, farmers have removed unwanted grass, weeds and other vegetation from soil before planting their crops. Cattle and other farm animals can also remove all the vegetation from an area if there are too many or if they are left in one place for too long. Once gone, soil is not likely to be replaced within our lifetime or within several generations.

On the Southern Plains, the soil is sandy; annual rainfall is low; there are large, open areas; and high winds are common. The first white settlers allowed their livestock to roam and graze the Plains until there was very little vegetation left to hold the soil in place. Early in the 20th century, farmers plowed up the natural grass cover on the Plains and planted ***winter wheat***. Between 1934 and 1937, the area had even less rainfall than usual. With large areas of plowed land having no grass root system to anchor it, much of the soil blew away. The dust storms and sand storms buried roads and houses. Clouds of dust reached as far east as Washington, DC.

In the Ross Barnett Reservoir area, huge sections of land are being cleared for construction of new homes, schools, and businesses. Natural grass cover and all the native trees are being cleared to make room for buildings, road, and parking lots. This land has no root system to anchor it, so during heavy rain storms, the soil can wash away into the streams and the Reservoir. All this extra soil flows into the streams that lead to the Reservoir, causing the streams to fill up, or 'silt over', with extra dirt. If the streams are clogged with dirt, they cannot help rainwater flow to the Reservoir, and the areas around the stream start to flood.

In response to the disaster, the federal government created the Soil Erosion Service and the Civilian Conservation Corp to find ways to recover the land. Workers replanted grass, planted trees and showed farmers scientific agricultural methods to help them protect the soil.

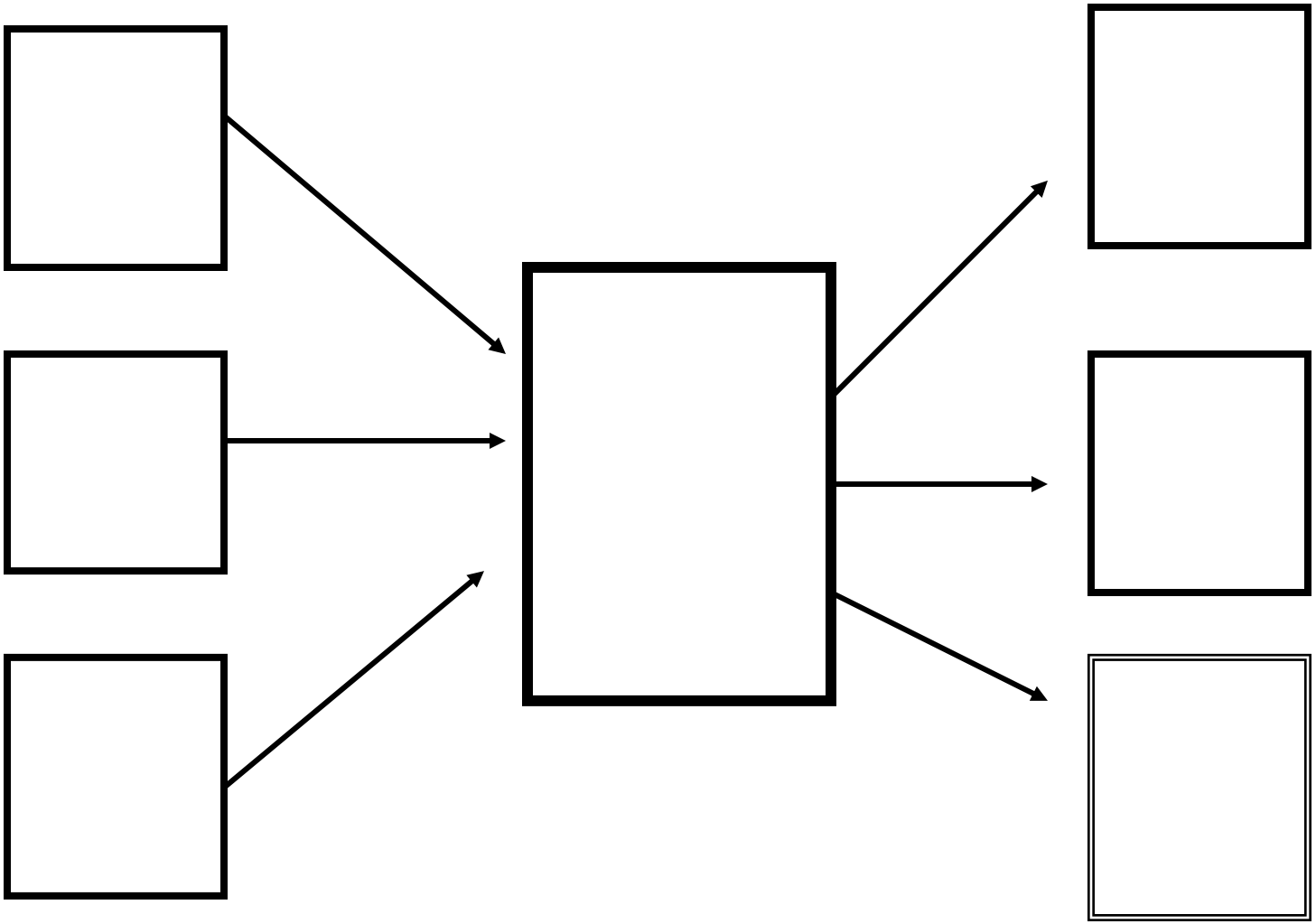
One method was to put large numbers of animals out to graze on one piece of land for a short period of time and then move them to a new pasture. This allowed the animals to get the nutrition they needed while cutting down on overgrazing and erosion.

Another method was no-till farming. A farmer using this method planted crops directly in the plant stems, stalks and leaves from the last harvest. For this method to work, the farmer must use herbicide to kill unwanted grass and weeds. This method helps stop soil erosion, but some people worry that the herbicides used might pollute the underground water supply.

A method used in the Reservoir area to help protect the land is to require all builders to use sedimentation fences. Sedimentation fences allow water to flow through them but block the soil. This helps to stop erosion from the construction site and keeps the dirt from flowing into the streams and reservoir. Sedimentation fences can be made of a special fabric designed to capture silt, hay barrels, or a combination of both.

Problem	
Solution	
Cause	
Effect(s)	

These solutions create another problem. What is it? _____



Multi-Flow Map – Cause & Effect

Simply Sediments

Name _____

Part 1: Create a sediment bottle!

1. Use a plastic bottle (1 liter or smaller) and sediments from your community to create a sediment bottle. Don't fill the bottle more than halfway full with sediments. What types of sediments did you find?

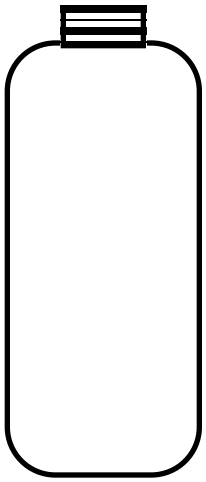
2. Add water to fill up the bottle to within one inch of the cap. Screw on the cap tightly! Use a permanent marker to write your name on the cap.

3. Shake and observe! Describe your observations in the space below.

Part 2: Experiment!

4. After your sediment bottle has been allowed to stand undisturbed overnight, what do you observe?

(a) Draw and label what you see on the diagram of the sediment bottle.



(b) Describe your observations.

(c) Predict what will happen after your sediment bottle is allowed to sit undisturbed for one week.

5. Which types of sediments float? Which ones move along the bottom?

6. If you were to continue moving the bottle for a long time, what would happen to the large sediments?

7. Would you find fossils in sedimentary rocks? Why or why not?

Erosion Experiments

Experiment #1: Splash Erosion

Materials

- large piece of white bulletin board paper
- dropper or pipette
- watch glass or shallow saucer
- 2-3 tablespoons of soil

Splash erosion instructions

- Place a large sheet of bulletin board paper on a table or desk.
- Put a shallow saucer or Petri dish in the center of the paper/
- Fill the saucer or Petri dish with soil.
- Hold the dropper/pipette approximately 1 meter above the Petri dish/saucer filled with dirt; predict what will happen when the water is dropped on the saucer full of dirt.
- Demonstrate several splashes.
- Discuss with your group: "What type of erosion is this?" (splash erosion).
- Discuss erosion patterns you observe.

Erosion Experiments

Experiment #2: Wind Erosion

Materials

- 5-10 cups of sand to create a hill
- a blow dryer with cylindrical barrel
- a trough for a wind chamber (The one in the photo was made from a 90-degree-angle frame of 2x4s with Plexiglas sides. You can also use a section of guttering from a roof.)
- wooden matches, sticks, or coins

Wind erosion instructions

- Pile the sand in a hill at one end of the wind chamber.
- Predict the results of turning on the blow dryer.
- Turn the dryer on low. Observe and discuss the changing landscape.
- Ask the members of your group: "What type of erosion is this demonstration?" (wind erosion).
- Stand a couple of matchsticks or coins in the sand and allow the dryer to continue blowing while observing.
- What happens to the sticks or coins?

Erosion Experiments

Experiment #3: Water Erosion

Materials

- large container with a spout filled with water (a watering can with a regular pour spout will work, or a ketchup squirt bottle)
- a long board to create a slope
- long sheet of plastic to cover board and drain water off
- large container for collection of the runoff water
- a small rectangular wood block
- plastic or rubber tubing
- soil
- water

Water (fluvial) erosion instructions

- Cover the board with plastic. Drape one end of the plastic off the edge of the table and into the collecting bucket.
- Tilt the board on one end so there is a gentle slope.
- Cover the entire surface of the plastic-covered board with soil. Pat into place.
- Place the spout end of the water container in the soil.
- Predict what will happen when water is gently squeezed through the spout.
- Observe and discuss the resulting land forms. Continue to squeeze water through your soil until you have several river banks and curves in your stream.
- Stand a block of wood in one of the banks along the flowing stream. This block represents construction of buildings in the area.
- Observe effects of the block on the water flow.
- Lay the wood block on its side in an attempt to dam the water. Discuss resulting changes in the flow and landforms.

Name _____ Date _____

What Are the Different Kinds of Erosion?
Information Page

Student Pages

Directions: Splash, wind, and running water (fluvial) erosion are three of many types of erosion. Using words and pictures, explain the difference between these three types.

splash erosion	

wind erosion	

water (fluvial) erosion	

Name _____ Date _____

Becoming an Erosion Expert Scavenger Hunt

1 of 4

Student Pages

Directions: Define the following terms. Use information from multiple sources to create a detailed definition with words and pictures.

erosion	

sedimentation	

soil	

Name _____ Date _____

Becoming an Erosion Expert Scavenger Hunt

2 of 4

Student Pages

Directions: Use words and pictures to describe in detail *three types of erosion other than those investigated during classroom activities.*

Name _____ Date _____

Becoming an Erosion Expert Scavenger Hunt

3 of 4

Student Pages

Directions: Use words and pictures to describe in detail *three forces that cause different forms of erosion.*

Name _____ Date _____

Becoming an Erosion Expert Scavenger Hunt

4 of 4

Student Pages

Directions: Use words and pictures to describe in detail *three negative effects of erosion on the environment.*

WATER TREATMENT PLANTS

BACKGROUND INFORMATION

Plants are essential to the health of our water supply. Plants filter pollutants out of runoff, rainwater, and wastewater before it enters the reservoir. The tangle of leaves, stems, and roots trap trash and sediment. This sediment remains in the wetland, while the cleaner water moves away. Plants also take up toxic pollutants and nutrients. Nutrients are used by the plant for growth while pollutants are stored in the tissues of the plant.

In a natural system, plants are good at keeping things in balance. However, plants cannot clean everything. We must be careful that we do not add nutrients, sediment, and toxic pollutants into the water. We also must maintain the wetlands that help keep out pollutants that we miss or cannot control.

Many pollutants run off of the land into our water. These pollutants come from construction sites, highways, streets, and the communities in which we live. Sometimes ponds or ditches are built to filter runoff from these sites. These ponds are often planted with wetland plants to aid in the filtering. Rain and runoff also rest a bit here before moving on. This means that many of the pollutants, especially soil particles, settle to the bottom while the cleaner water drains off from the top. These ponds or ditches are called storm water management ponds.

Natural and constructed wetlands are now being used for sewage treatment in some areas. One city in California transformed a 160 acre garbage dump into a series of ponds and marshes. The sewage is first pumped into the holding ponds where it undergoes the settling process. Bacteria and fungi digest organic solids. Effluent from the holding ponds then passes through the marshes. Here, the water is filtered and cleansed by aquatic plants.

Terms

effluent: liquid that flows out of a holding pond and into the marsh to be filtered and cleansed
nutrient: an element (or compound thereof), such as nitrogen, phosphorus, and potassium, that is necessary for plant growth.
pollutant: an impurity (contaminant) that causes an undesirable change in the physical, chemical, or biological characteristics of the air, water, or land that may be harmful to or affect the health, survival, or activities of humans or other living organisms.
storm water runoff: surface water runoff that flows into storm sewers.

PROCEDURE

I. Setting the stage
- A. Gather your supplies
  1. Beaker or glass jar
  2. Food coloring
  3. Celery stalk
- B. Prepare a solution in a beaker by adding several drops of food coloring to water. This food coloring represents pollution by a toxic substance (a pesticide, for example).
- C. Imagine water flowing through a wetland that has many plants. The stalks of celery are similar to plants growing in a wetland, such as sedges, cattails, and grasses.

II. Activity
- A. Cut off the bottom half inch of the celery stalks and place them in the water overnight. Over time the colored water will travel by capillary action up the stalk. This shows how plants can absorb pollutants with the water they "drink."
- B. Examine the celery stalk. The colored water may or may not be visible on the outside of the stalk. Cut off one-inch pieces of the celery and study it closely. You will see colored dots on the cross section, which are water-filled channels in the celery.

III. Follow-Up
- A. Answer the following questions:
  1. How do wetland plants help to purify water?

  2. Why is the water remaining in the beaker still polluted?

  3. Where does the water go after uptake into the plant?

  4. What happens to the pollutants?

  5. Why can't we simply dump all of our waste into wetlands?

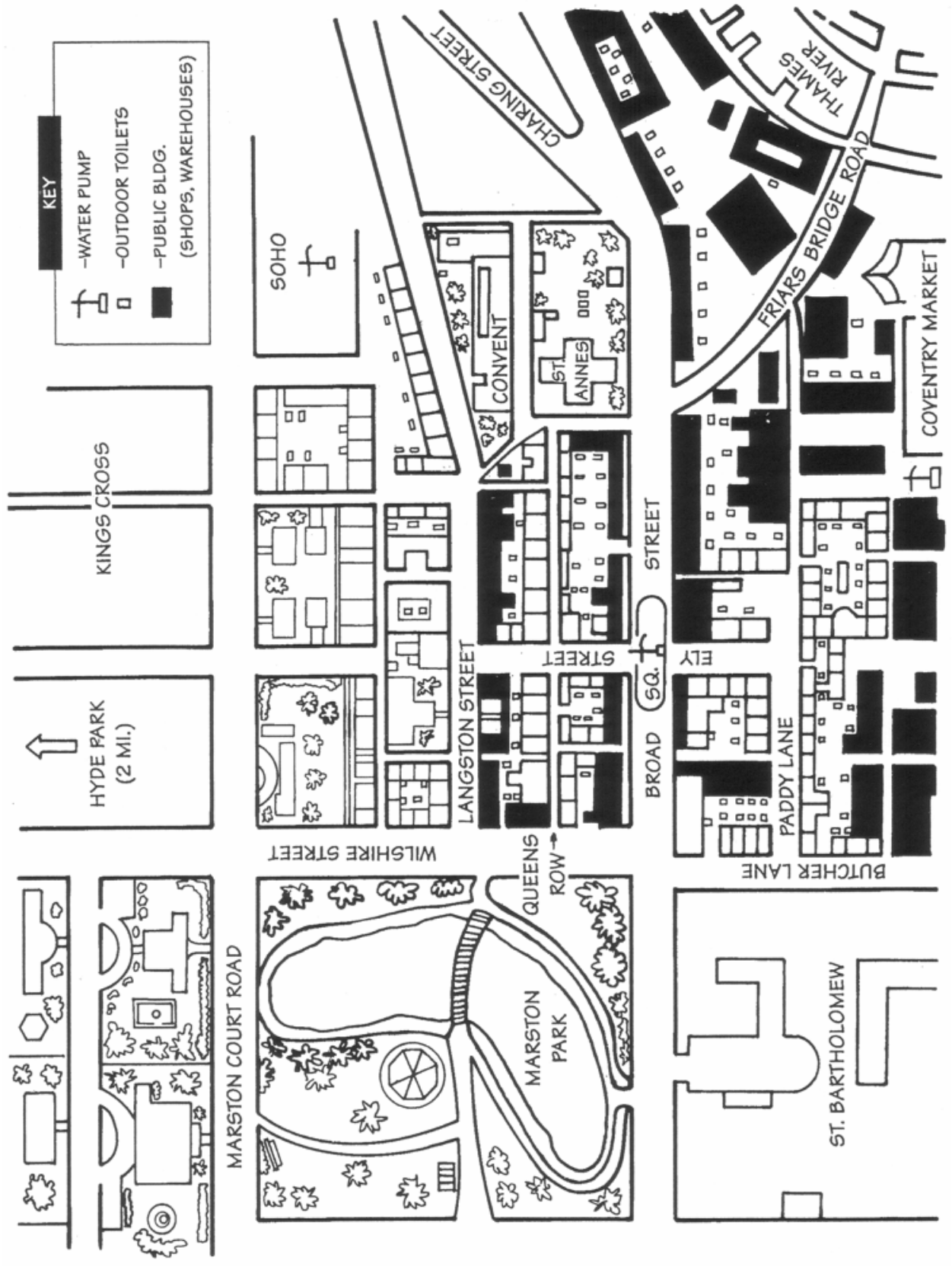
WATER TREATMENT PLANTS

III. Follow-Up

A. Answer the following questions:

1. How do wetland plants help to purify water? (They purify water by taking up pollutants from it.)
2. Why is the water remaining in the beaker still polluted? (Plants can only do so much. As new, hopefully clean, water flows into the system, the pollutants will be somewhat diluted and the water a bit less polluted. If the water continues to flow on to other parts of the wetland, other plants will continue to remove pollutants. Wetland soil also helps to filter out some pollutants.)
3. Where does the water go after uptake into the plant? (It is transpired out through the stomata in the plants' leaves and usually evaporates.)
4. What happens to the pollutants? (Some are used in the plants' metabolic processes; some are transformed into less harmful substances, while others are stored in the plants' tissues and could be re-released into the environment if the plants die.)
5. Why can't we simply dump all of our waste into wetlands? (Wetlands can only do so much; so many pollutants still end up in the water. Too many pollutants will harm or destroy a wetland. The best solution is to reduce the pollution.)

Broad Street Area Map



Poison Pump Background Information

From **Project WET Curriculum Guide**, pp. 93-94

Cholera is a disease caused by the *Vibrio cholerae* bacterium. The bacterium travels through untreated water contaminated by human or animal feces. Cholera is spread by sharing contaminated water or by eating contaminated food. Since the body does not produce a lasting immunity against the bacterium, the disease can be contracted more than once.

Cholera is characterized by rapid dehydration resulting from simultaneous vomiting, diarrhea and profuse perspiration. As victims dehydrate, their skin darkens, shrivels and loses its elasticity. Depending on general health, body mass, age, and amount of ingested bacteria, cholera victims may only suffer mild symptoms or can die in less than an hour.

In 1854, hundreds of people living in London died during a cholera epidemic. The disease spread from India to London on ships that carried contaminated drinking water. If a ship was known to carry the disease, the London port authorities refused to grant docking privileges. Rather than lose money on their cargo, some ship captains deceived the authorities by dumping contaminated water overboard into the Thames River, London's water source.

London was served by competing water companies in 1854. At least one, in an effort to cut costs, failed to adequately filter the river water being pumped into the city. While upper- and most middle-class citizens had indoor plumbing, the poor of London relied on public pumps for their water needs.

Dr. John Snow, considered the father of epidemiology, is credited with tracking and identifying the source and transmission agent of the 1854 cholera epidemic. The agent of the spread of the disease was found to be a Broad Street public pump.

Today, most people understand that unclean water carries organisms that cause disease, In the mid-nineteenth century, the idea of waterborne disease was an unpopular and frightening theory. Many people believed that the poor suffered as a result of their laziness and sinful living, and deserved punishment in the form of catastrophic disease.

Even though many people doubted and disapproved of Snow's contaminated water theory, Dr. Snow persuaded the authorities to remove the Broad Street pump handle. This simple act saved the lives of many people, and marked the beginning of the end of a tragic situation.

We now know that people can avoid cholera infection by making sure their water supplies are clean. Unfortunately, in developing countries where only 35% of the population has access to clean water, cholera epidemics continue.

Modern medicine has produced a vaccine against cholera, but it must be repeated every six to twelve months because the antibodies are short lived. Too often though, citizens in impoverished nations do not have the funds to procure the vaccine. Used for centuries in India, the most effective treatment is to provide the victim with large amounts of liquids and rehydration salts.

This method replaces lost body fluids and electrolytes, and flushes out the bacteria. After the pathogen has been purged from the body, antibiotics can promote the victim's recovery.

Cholera has been absent from the Western Hemisphere for most of the 20th Century. Nonetheless, health officials warn that the United States could experience outbreaks of cholera and other waterborne diseases. As population increases, more waste products are generated, a situation that can strain the abilities of municipalities to maintain plentiful and clean water supplies.

Table 1 Summary of selected waterborne disease outbreaks[1]

[1]from: *A fatal waterborne disease epidemic in Walkerton, Ontario: comparison with other waterborne outbreaks in the developed world***, Water Science and Technology** Vol 4 No. 3 pp 7-14, IWA Publishing 2003

Location and Dates	Characteristics	Reference
Richmond Height, FL, USA January–March 1974	1,200 cases of gastroenteritis, likely *shigellosis* served by chlorinated shallow (6–15 m) groundwater	Weissman *et al*., 1976
Bradford, PA, USA Sept–Dec 1979	3,500 cases of gastroenteritis of unidentified aetiology in a chlorinated groundwater supply	Akin & Jakubowski, 1986
Bramham, England July 1980	3,000 cases of gastroenteritis of unidentified aetiology in a direct filtered and chlorinated supply	Short, 1988
Eagle-Vail, CO, USA March 1981	80 cases of gastroenteritis likely rotavirus in a direct filtered and chlorinated supply	Hopkins *et al*., 1986
Orangeville, ON, Canada April 1985	241 cases of *campylobacteriosis* in an unchlorinated groundwater supply	Millson *et al*., 1991
Pittsfield MA, USA Nov 1985–Jan 1986	3,800 cases of giardiasis in a chlorinated but unfiltered water supply	Kent *et al*., 1988
Disraeli, PQ, Canada August 1986	50 cases of gastroenteritis associated with three cases of *campylobacteriosis* in an unchlorinated, unfiltered surface supply	Tessier *et al*., 1987
Penticton, BC, Canada June 1986	3,000 cases of *giardiasis* in a chlorinated, unfiltered, surface/groundwater supply	Moorehead *et al*., 1990
Oakcreek Canyon, AZ, USA April 1989	11/240 guests surveyed had gastroenteritis likely caused by a Norwalk-like virus in an unchlorinated private well	Lawson *et al*., 1991
Cabool, MO, USA Dec 1989–Jan 1990 2	243 cases of gastroenteritis including 86 cases of bloody diarrhea, 2 cases of HUS and 4 deaths caused by *E. coli* 0157:H7 in an unchlorinated community water supply	Swerdlow *et al*., 199
Uggelose, Denmark Nov 1992–Feb 1993	1,400 cases of gastroenteritis of suspected viral aetiology in filtered, unchlorinated municipal supply	Laursen *et al*., 1994
Warrington, England Nov 1992–Feb1993	47 confirmed cases of *cryptosporidiosis* in a water supply zone serving 38,000 consumers by groundwater with chlorination only	Bridgman *et al*., 1995
Milwaukee, WI, USA March–April 1993	Possibly 400,000 cases of *cryptosporidiosis* in a filtered, chlorinated surface supply	MacKenzie *et al*., 1996
Gideon, MO, USA December 1993 -	600 cases of salmonellosis, 15 hospitalisations and 7 deaths in an undisinfected groundwater supply	Clark *et al*., 1996
North Battleford, SK, Canada April 2001 1	1,900 cases of cryptosporidiosis in a chlorinated, filtered surface supply	Stirling *et al*., 200

CLUE CARDS

#1

The people living around Broad Street are poor. Large families are crowded into on- and two-room apartments. None has indoor plumbing; residents use outdoor toilets and haul their water from the nearest public pump.

#2

Thomas Sutterfield fell ill two hours after stopping off to visit his great-aunt "Tilda". He had tea, biscuits and sausages with his great aunt. It was a hot day and he took a drink of cool water before leaving.

#3

Following his fight with another boy, Tolkly Martin washed the blood off his mouth at the Broad Street pump and ran off with a sausage stolen from the butcher shop.

#4

Matilda Wright refused to drink water from the faucets in her home. She would only drink the sweet-tasting water that her gardener hauled from the Broad Street pump.

#5

Ausley and Marthy Brown and their two children are the only people on Ely Street who didn't get cholera. Marthy's family lives in Soho. The Browns haul their water from the Soho pump, which allows them to visit their relatives

VICTIM CARDS

Thomas Sutterfield, Esquire, lawyer:

- Lives in Hyde Park with wife and two children
- Only member of his immediate family to contract cholera
- Won most recent case, defending a Broad Street butcher accused of selling spoiled meat.
- Recovering.

Matilda Wright, wealthy 90-year-old spinster:

- Lived alone (with her three servants) in the family mansion on Marston Court.
- Great-aunt of Thomas Sutterfield.
- Only member of the household to contract cholera.
- Died in a matter of hours.

Tolly Martin, 10 years old, professional pickpocket:

- Homeless orphan who slept in doorways around Soho Square.
- Occasionally roamed quite far from Soho looking for wealthier citizens to rob.
- Died of cholera two days after a fist fight in Broad Street Square.

Owen and Obedience Turner, and three children

- Lived on Paddy Lane behind butcher shop on Broad Street.
- Owen Turner, who was lame, earned small change cleaning up the day's slops at the butcher shop.
- Entire family died of cholera.

9 Families on Butcher Lane:

37 individuals dead; 8 recovering

12 families on Ely Street:

60 individuals dead; 10 recovering

Slye Children, ages 7, 8 and 10:

- Three of the eight fchildren of Gideon and Lucy Slye
- Gideon Slye is a Broad Street Butcher accused of selling spoiled meat.
- Sly family recently moved to Kings Cross from Broad Street and now have indoor plumbing.
- When not in school, three of the Slye children ofetn accoompanied their father to work and played on Broad Street Square.
- These three children are the only family members to contract cholera
- 2 died; 1 recovering.

Mucky Johnson, 18, delivery boy from Coventry Circle:

- Delivered seafood from Coventry Market to wealthy homes in Marston Street.
- Often stopped to eat lunch and talk to people on Broad Street Square; said the water from the Broad Street pump was the best in the city.
- Died.

John and Mary Canty, tinkers from Soho

- Pulled their cart through wealthy neighborhoods, mending pots and pans for the well-to-do.
- Often stopped to visit John's ailing mother who lived on Butcher Lane.
- Both died of cholera.

Twenty-five families on Queens Row:

89 individuals dead; 31 recovering.

18 Families on Paddy Lane:

83 individuals dead; 7 recovering

Poison Pump

In 1854 a cholera epidemic broke out in the slums of London.

Throughout history, the disease called "cholera" killed millions of people, and hundreds died in the 1854 epidemic. One man, Dr. John Snow, discovered the source and stopped the epidemic.

You now have the same information that Dr. Snow possessed and you will try to solve the mysterious epidemic.

Procedure:

1. Collect your materials (*Broad Street Area Map, Victim Cards*, marking pen). Do not look at the *Clue Cards* yet.
2. Mark the location of victims on the map.
3. Study the *Victim Cards* and write down all common characteristics.
4. Mark your suspected source of the epidemic.
5. Imagine you are with Dr. Snow and you have to convince the city leaders to take action on the source of this terrible epidemic. Write a defense of your decision as to the source of the disease.
6. One at a time, read from the Clue Cards. These cards reveal additional information uncovered by Dr. Snow. As more information is given, either confirm or revise your conclusions.

This disease broke out in India before it became a London epidemic. Using a map, locate India and London. Discuss how the disease might have traveled to London. Write a group explanation of how this disease traveled across so many countries.

Quiz: Answer as a group and give your paper to the teacher.

1. How did cholera get into the water used by the people who lived on Broad Street?

2. Why are we unlikely to contract cholera living in North America?

3. What are the symptoms of cholera?

MATERIALS:

pond water
rain water
dirty water (mix dirt and water)
four clear plastic cups labeled A, B, C, and D
small can with holes in bottom
paper towel
sand
microscopes
bottle with eye dropper filled with bleach
slides
goggles for each student
student sheet

I. Activity

A. Get three samples of water from your teacher. Pour some pond water (A), rain water (B), and "dirty" water (C) into clear plastic cups. Label each.
B. Observe a drop of pond water under the microscope and draw what you see.
C. Observe a drop of rain water under the microscope and draw what you see.
D. Observe a drop of dirty water under the microscope and draw what you see.
E. Pour dirty water into a can with a paper towel and sand and set the can over a clear cup labeled D. Allow this to stand for 30 minutes.
F. Add several drops of bleach to cup A. Observe what happens to the organisms after bleach is added.
G. Compare cup A to cups B and C. Even water that appears to be clear must be disinfected with chemicals to make sure it is safe to drink.
H. Treat the water in cups B and C by putting several drops of bleach in each.
I. Stir cup A and compare it with the treated water in cups B and C. Look at a sample of each again with a microscope.
J. Observe a sample of the water in cup D under the microscope.

II. Follow-Up Name: _____

Answer the following questions:

1. What did you observe?

2. What is the difference between the water in cups A, B, and C?

3. Is this filtered water clean enough to drink? Why or why not?

4. What are possible uses for this water?

5. What do you see in the microscope?

6. What happens to the microorganisms when bleach contacts them?

7. What is potable water?

Environmental Planning

Watershed Management

Stormwater, the nonpoint source polluter

Stormwater is drainage runoff that flows over the surface of the land resulting from rain events or snowmelt. The water enters a drain known as a storm sewer where it is either taken to a detention basin and is held before it is slowly released into the ground or nearby stream or it is discharged directly into a stream.

Stormwater can become a problem when it picks up debris, chemicals, and other pollutants as it flows overland. Stormwater can also add large volumes of water to local creeks and streams causing erosion of stream banks and flash flooding.

Below are some ideas as to how you can help prevent stormwater pollution and additional links for further information.

Things you can do to help prevent stormwater pollution

1. Use pesticides and fertilizers sparingly, avoiding excess to prevent polluted runoff.
2. Sweep up driveways, sidewalks, and roads.
3. Never dump anything down storm drains and report anyone who does. Dispose of your hazardous wastes properly. The County offers several household hazardous waste drop-offs throughout the year.
4. Vegetate bare spots in your yard to prevent soil erosion.
5. Compost your yard waste – it makes a great garden additive!
6. Report any discharges from stormwater outfalls during times of dry weather, a sign there could be a problem with the storm sewer system.
7. Direct downspouts away from paved surfaces. Install innovative stormwater practices on residential property such as rain barrels or rain gardens that capture stormwater and keep it on site to infiltrate back into the groundwater instead of washing off into the nearby storm sewer system.
8. Take your car to the car wash instead of washing it in the driveway.
9. Check your car for leaks and recycle motor oil.
10. Pick up after your pet.

http://www.co.delaware.pa.us/planning/environmental/stormwater.html

Tie Vllp$-t niolt, **Jacksonville, Wednesday.** August 4, 199?

Fish-killing bloom could harm humans

By Dana Treen
Times-Union staff writer

An algae bloom scientists suspect is responsible for more than 1,000 dead fish in the St. Johns River over .the past, two days also could pose health problems for people and animals.

Water managers; are sending samples of the blue-green algae to a lab for analysis.

The - species, which was collected Monday in canals off the river from south of the Shands Bridge, can product toxins suspected in past wildlife maladies, said John Burns, a biologist with the St. Johns River Water Management District.

Burns said the last major, fish kill in the main stem of the St. Johns River occurred in the mid-1980s in the Talleyrand area.

"I wouldn't let livestock or animals drink it. ... I wouldn't swim in it. "

John Burns, biologist

"I wouldn't let livestock or animals drink it," said Burns, who visited a canal off Jack Wright Island Road in northwest St. Johns County yesterday. "I wouldn't swim in it."

Burns said samples of the algae **also have been** collected in the main stem 'of the river but that the concentrations are not as high as in the cant Is.

"It's all in the main stem of the river now," he said.

Burns said the blue-green algae is mixed with another, more common algae. As the tiny plants moved upstream from fresher waters near the Shands Bridge to saltier Jacksonville waters, they began dying. The decomposition process has likely robbed the water of oxygen, causing the fish kill.

Yesterday Burns said 1,000 dead fish, including gizzard shad and speckled trout, were counted be-

See ALGAE, Page B-3

From Page 8-1

tween Point La Vista and the Mathews *Bridge.*

Those fish are particularly sensitive to drops in the amount of dissolved oxygen in the water.

By state water quality standards, the amount of dissolved oxygen in the water should be at least 5 milligrams per liter for fish to be healthy. In the past few weeks, those levels have dropped into the 4 milligram per liter range, accord-' ing to measurements taken by Jacksonville environmental scientists.

Chris Williams, the project coordinator of a water management district survey of toxic algae, said once the blue-green algae' called Anabaena circinalis dies it does not pose a health threat.

But the living bloom encapsulates toxins that are released as the plant dies.

Williams said the algae would most likely pose a health threat if people ingested it while it was alive.

According to a study by Burns. cert.'iin species of blue-green algae can release toxins harmful to the liver or nervous system. The toxins are on a list of possible causes for alligator deaths in Lake Griffin in Lake County.

The St., Johns County bloom was first reported last week by residents like Jim Hyde, who lives on Jack Wright. Island Road.

Hyde said the canal behind his home was a bright blue, initially leading investigators to suspect a chemical toilet dumping.

. The water had a strong cesspool stench and previously clear water became cloudy, Hyde said.

"The odor was so bad we were just going to leave here," said Hyde. Nvh

er seen anything like the bloom. "it a devastating odor."

By yesterday the blue color was from the water, as was most of the smell.

Burns said there was evidence of a secondary bloom of a smaller blue-green ipecies in the canal.

"This is a major *bloom,"* he said.

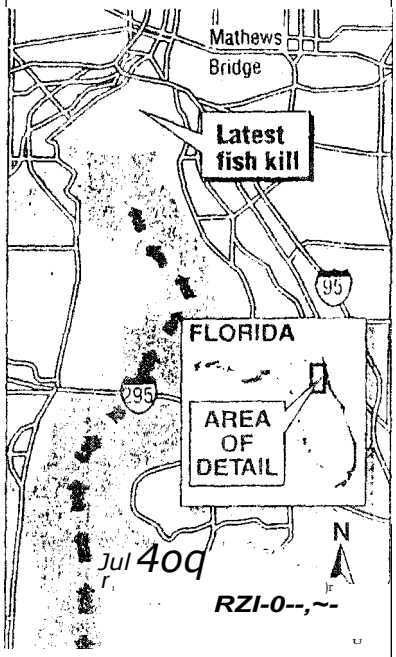
Burns said the eruption of algae in tie river is caused *by* hot conditions. little wind and nutrients in the water.

Nutrients leaching into the river from fertilizers, stormwater runoff and even airborne nitrogen emissions from ca.- are all food to the algae. Combining that with the heat and still air conditions creates the perfect incubator for the algae. Burns said.

Algae bloom

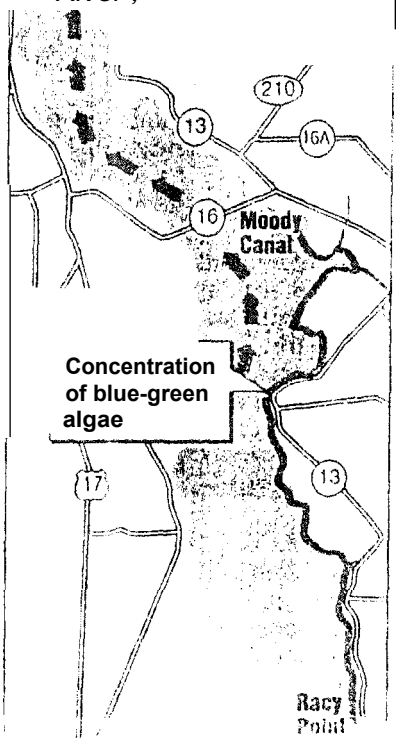
HITTING HOME

Hot, calm conditions and high nutrient concentrations have produced an algae bloom in the St. Johns River that is the ||kely culprit in a kill of more than 1;000 fish in Jacksonville and could pose health problems in livestock or humans. Decaying algae that has robbed the river of oxygen has been blooming in northern St. Johns County and flowing north into Jacksonville.



St *River ,*

▪ Northward ainae flow



UNDERSTANDING WATER QUALITY

Read the attached information *"Fish-killing bloom could harm humans"* by Dana Treen and then answer these questions. Go back and re-read as needed.

1. The article gives information about how poor water quality is related to pollution and weather. Identify and then list the abiotic and biotic factors that influence the quality of the water in this area.

Abiotic Factors that Influence Water Quality	**Biotic Factors that Influence Water Quality**

2. Explain which factors an individual or a family living near the St Johns River would be able to influence and which factors over which they would have little or no control.

3. Next to oxygen, water-clean water-is our most valuable resource. Imagine that you are the public relations director for the St Johns River Water Management District. As public relations director, you need to educate the public about what they can do to have good healthy water quality. Using information, details and examples from the two articles and your experiences with water quality in this unit, explain what causes many water quality problems and what an everyday citizen can do to reduce water quality problems. (Use a separate sheet of paper for your answer.)

Fertile Green: Nutrients and Water

Observe the effects of nutrients on algae growth in water samples.

Materials:

- 6 clear plastic containers
- measuring spoons
- water samples from a lake or pond
- plant fertilizer
- tap water
- dissolved oxygen kit (optional)
- digital camera (optional)
- electronic probe for measuring turbidity (optional)

Procedure:

1 Water pollution is any human-caused contamination that lessens its value to humans and nature. Read the article “Water Pollution: Nutrients”. Make a list of all potential sources of pollution that might wash into a body of water during a heavy rain.

2 Get 6 jars of water from your teacher and label them:
   - #1 tap water (control)
   - #2 tap water + fertilizer
   - #3 tap water + double-strength fertilizer
   - #4 pond water
   - #5 pond water + fertilizer
   - #6 pond water + double-strength fertilizer

3 Fill each jar with the appropriate water sample and the appropriate amount of fertilizer to jars #2, #3, #5 and #6 (For example, if the instructions for fertilizer use call for one teaspoon per quart, use two teaspoons in the double-strength jars).

4 Set all the jars without tops, on a windowsill or other place where there is good sunlight (remember a constant temperature is best for good algae growth).

5 Wash your hands after preparing the jars.

6 Write a hypothesis of what you think will happen. Estimate a time frame for your prediction (such as "2 days", or "2 weeks").

Follow-up Procedure:

Observe the jars every day for a week and then once a week for a month if possible. Record any changes in the jars on a data sheet. You may want to photograph the jars at the beginning and at regular intervals. If possible, check the dissolved oxygen

in all 6 jars once a week at the same time of day (oxygen levels vary during the day and night). If electronic probes that can measure turbidity are available, compare turbidity levels.

At the end of the experiment, write up your results and present them to other groups.

Discussion:

1 Which jar had the greatest algal growth? Why?
2 Which jar had the least algal growth? Why?
3 As algal growth increases, what happens to the dissolved oxygen?
4 In the jars with algal growth, what probably happens to the oxygen levels at night? Why?
5 Name land uses and activities that can contribute nutrients to streams.
6 What effects do nutrients have on aquatic life?

Water Pollution: Nutrients

from the Streamkeeper's Field Guide

All living things need nutrients so they can grow and reproduce. Many of these nutrients occur naturally in stream water.
If you have too many nutrients in the water, plants and algae grow too fast. They get so numerous that they can clog waterways. When these plants die, they are decomposed by bacteria. This rotting stuff causes dissolved oxygen levels in the water to drop dramatically. Without enough oxygen in the water, fish and aquatic invertebrates die.

Where does the water get these extra nutrients? Sources include:

- fertilizers applied to crops, timbered areas, gardens and lawns;
- poorly maintained septic systems, sewage treatment plants, industrial effluent;
- pet, livestock, and other animal wastes;
- detergents.

Nitrogen and phosphorus are the two most common nutrients in water. Too much of these nutrients cause problems. Nitrogen and phosphorous occur in natural waters in various forms. Both forms are present in aquatic systems and may be either dissolved in the water or suspended (attached to particles in the water column).

BACKGROUND INFORMATION

Water treatment is the process of cleaning water and making it safe for people to drink. Because water is a good solvent it picks up all kinds of contaminants. In nature, water is not always clean and safe enough for people to drink. Our drinking water comes from both surface and groundwater. Water in lakes, rivers, and swamps contains impurities that may make it look and smell bad. Water that looks clean may contain harmful chemicals or bacteria and other organisms that can cause disease.

In the past, waterborne diseases were a major public health concern but today these diseases are no longer a health threat in the United States because of the improved water treatment. Technicians working in drinking water facility laboratories make thousands of tests each year to insure that our drinking water supply is free of disease-causing bacteria. These test results are reported to the state and local governments

It takes the efforts of both federal and state governments as well as local water supply systems to keep our drinking water safe and in good supply. The Safe Drinking Water Act and its amendments set the standards for public drinking water. The Environmental Protection Agency administers these standards. Water treatment plants clean and maintain the quality of drinking water by taking it through the following processes: (1) aeration, (2) coagulation, (3) sedimentation, (4) filtration, and (5) disinfection (see definitions in “Terms” below).

Terms

aeration: to expose to circulating air; adds oxygen to the water and allows gases trapped in the water to escape; the first step in water treatment.
coagulation: the process by which dirt and other suspended solid particles are chemically “stuck together” so they can be removed from the water; the second step in water treatment.
disinfection: the use of chemicals and/or other means to kill potentially harmful microorganisms in the water; the fifth step in water treatment.
filtration: the process of passing a liquid or gas through a porous article or mass (paper, membrane, sand, etc.) to separate out matter in suspension; the fourth step in water treatment.
groundwater: water that infiltrates into the earth and is stored in usable amounts in the soil and rock below the earth’s surface; water within the zone of saturation.
sedimentation: the process that occurs when gravity pulls particles to the bottom of the tank; the third step in water treatment.
sludge: solid matter that settles to the bottom of septic tanks or wastewater treatment plant sedimentation tanks; must be disposed of by bacterial digestion or other methods or pumped out for land disposal or incineration.
surface water: precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration, and is stored in streams, lakes, wetlands, reservoirs, and oceans.
water treatment: a method of cleaning water for a specific purpose, such as drinking.

PROCEDURE

A. Discuss the water treatment plant and what it does.

1. Examine the diagram of a water treatment plant.
2. Discuss the process that takes place during each step. Use the definitions given to explain each step:
   a. Aeration – Vigorously stirring up water to add air to it and drive out other gases that might be dissolved in it; similar to "whipping" it with a mixer (as in cooking).
   b. Coagulation – Adding chemicals to make dirt and other particles clump together.
   c. Sedimentation – Letting the clumps settle out (they're heavier than water, so they sink to the bottom).
   d. Filtration – Pouring the water through a filtering system that has lots of layers of materials that trap things that did not settle out (including things too small to see).
   e. Disinfection – Adding chlorine to kill germs that might make people sick (similar to swimming pool methods).

B. Create a model of a water treatment plant. Look at the picture to help you create your model.

- Cut one 2-liter bottle in half, cut the bottom from another bottle, and cut the top from a third bottle.
- To prepare the filter use the bottle with its bottom cut off to construct the filter. Turn the bottle upside down. Loosely put a cotton plug in the neck of the bottle.
- Pour the fine sand over the cotton plug followed by activated charcoal, coarse sand, fine gravel, and coarse gravel.
- Clean the filter by slowly and carefully pouring through 1-2 gallons (4-8 L) of clean tap water.

C. Use your water treatment plant to clean some dirty water.

AERATION

1. Collect some dirty water from your teacher. Describe the water.
2. Put the cap on the bottle and shake for 30 seconds.
3. Pour the water back and forth between two bottles or jars 10 times.
4. Describe any changes you observe.

COAGULATION

1. Pour the aerated water into the 2-liter bottle with the top cut off.
2. Add 2 tablespoons (30 mL) of alum to the water. Stir the mixture slowly for 5 minutes. While you stir, predict what will happen.
3. Describe any changes you observe.

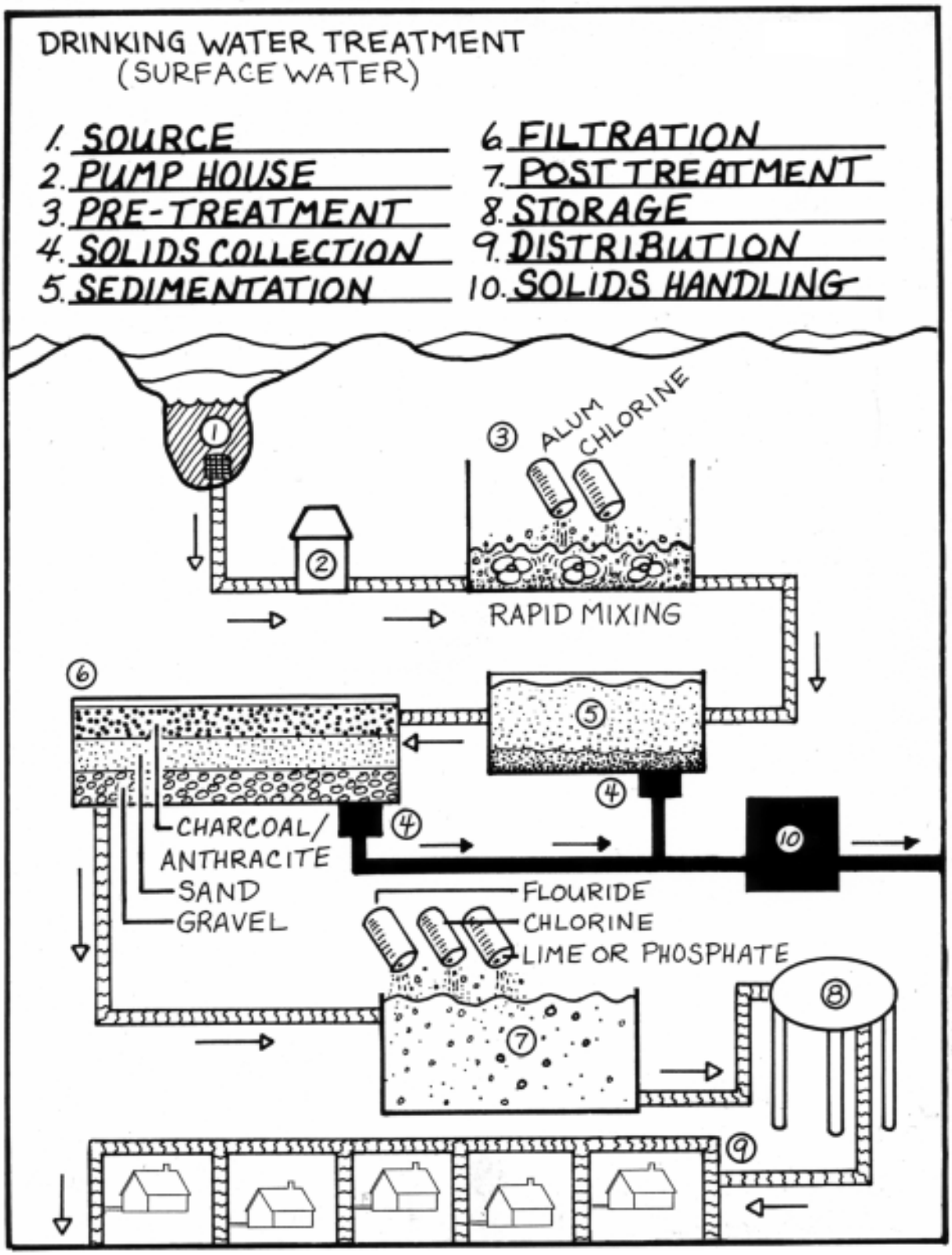
SEDIMENTATION

1. Allow the water to stand undisturbed for 20 minutes.
2. Observe the water at 5 minute intervals and record your observations as to changes in the appearance of the water.
3. Describe any changes you observe.

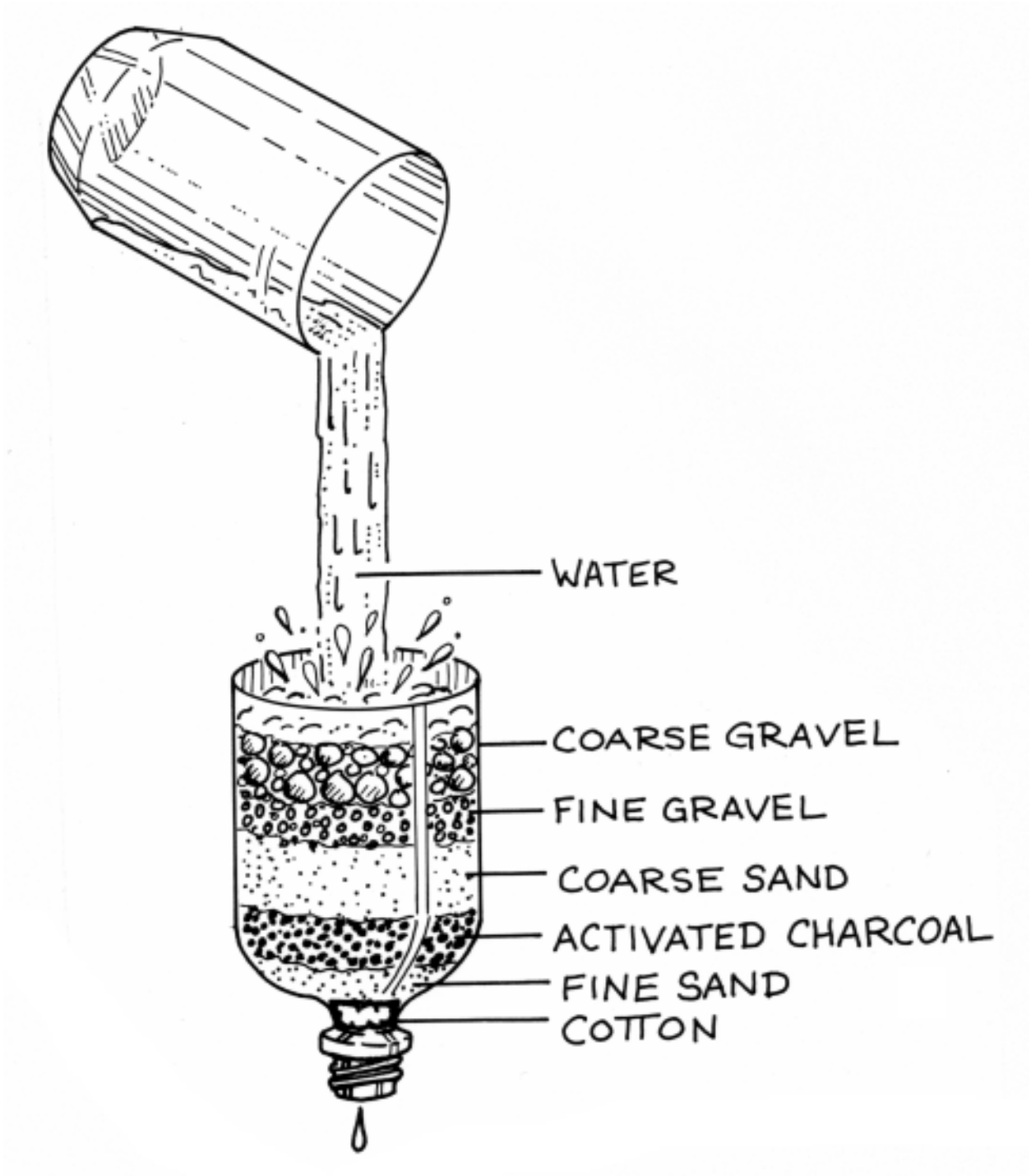
FILTRATION

1. Without disturbing the sediment, pour the top two-thirds of the water through the filter.
2. Quickly rest the filter model in the 2-liter bottle cut in half to collect the filtered water.
3. After waiting until you have collected more than half of the water poured through the filter, add 2 tablespoons (30 mL) of bleach to the filtered water. The bleach represents the chlorination process. (CAUTION: Wear eye protection when handling bleach and quickly wash it off your skin if some should splash.) This is **disinfection.**
4. Discuss with your group: "Did we recover the same amount of water we started with?" Measure approximately. Discuss that there is a certain loss of usable water in the water treatment process.

D. Compare the treated and untreated water. How has treatment changed the appearance and smell of the water? IMPORTANT: This is a simulation of the process that a water treatment plant does; therefore, this water is not safe to drink


DRINKING WATER TREATMENT
(SURFACE WATER)
1. SOURCE
2. PUMP HOUSE
3. PRE-TREATMENT
4. SOLIDS COLLECTION
5. SEDIMENTATION
6. FILTRATION
7. POST TREATMENT
8. STORAGE
9. DISTRIBUTION
10. SOLIDS HANDLING
ALUM
CHLORINE
RAPID MIXING
CHARCOAL/
ANTHRACITE
SAND
GRAVEL
FLOURIDE
CHLORINE
LIME OR PHOSPHATE

FILTER MODEL



Pesticides and Wildlife

Pesticides include things like insect repellants, weed killers, disinfectants and swimming pool chemicals. These pesticides are designed to control pests. They are also sprayed on the land to help reduce weeds and fungi. When used in the water, they help kill bacteria and viruses.

When used incorrectly, pesticides can harm our watershed. Fish, birds and other creatures can be killed. Different animal habitats can be destroyed.

Pesticides are used in nearly every home, business, farm, school, hospital and park in the United States. Pesticides can be found anywhere in our environment.

Pesticide Facts:

- In recent studies of major rivers and streams, one or more pesticides were detected more than 90% of the time in water, in more than 80% of fish sampled, and in 33% of major water sources.
- Pesticides are one of the 15 leading causes of pollution for streams.
- Pesticides can cause amphibian mutations and deformities. Some examples of these mutations are frogs with extra legs or fish with no eyes.
- Pesticides kill helpful insects. Some of these insects include honey bees, butterflies, and mosquito-hawks (they eat mosquito larvae).

Most pesticides are harmful because they are designed to kill certain plants or animals. Even when they are used correctly, pesticides still kill millions of fish and birds each year. However, pesticides are useful because they control or kill insects, weeds and other pests.

The US government requires that pesticides be studied before they can be sold and used in the United States. Before a pesticide can be used, it has to meet these requirements.

- It cannot pose *unreasonable* dangers to human health.
- It cannot pose *unreasonable* dangers to the environment.
- It cannot harm endangered or threatened species.

Seepy Sandwich

Adapted from: http://www.nps.gov/archive/ozar/seepy.htm

If a farmer in northern Mississippi uses too many pesticides on his cotton field, how does it get to the Ross Barnett Reservoir? Complete this activity to find out.

Materials:

1. Food coloring to represent pesticides.
2. Slices of bread to represent the soil and rock.
3. A sprayer to produce rainwater.
4. A waterproof work area.

Procedure:

Student No. 1 - hold a slice of bread vertically.
Student No. 2 - add a drop of food coloring (pesticide) to the top crust edge of the bread
Student No. 3 - spray water (rain) on the food coloring (top of the bread only – do not spray the front of the slice)

Let the drainage (water) seep through the crust into the bread. As the polluted water seeps down it spreads out, making it difficult to locate where the pollution originated. The water and food coloring will remain together as the water moves.

This illustrates three facts about pesticides as pollutants.

1. Pesticides are carried by water
2. Pesticides are not filtered out by the ground
3. Human activities can affect groundwater quality.

Questions:

1. How did the pesticides (food coloring) move through the bread? Were they filtered out, leaving only clean water to progress downward, or did they spread throughout the bread, polluting larger and larger areas?

2. Describe the pattern of movement of the water as it moved through the bread.

3. How do human activities on the surface have effect groundwater quality?

4. What kinds of pesticides might come from common household products?

5. What kinds of pesticides come from landfill seepage?

6. How can groundwater contamination be prevented?

How do pesticides affect the food chain?

Materials needed:

75 – 100 corn kernels (2/3 yellow, 1/3 another color).
Pie pan or other shallow container
Stopwatch
Tweezers (one per student)
Snack sized plastic bags (five per student)
Sandwich sized plastic bags (one per student)
Large sack (plastic grocery bag)
One die or number cube
"Mystery card" in a sealed envelope

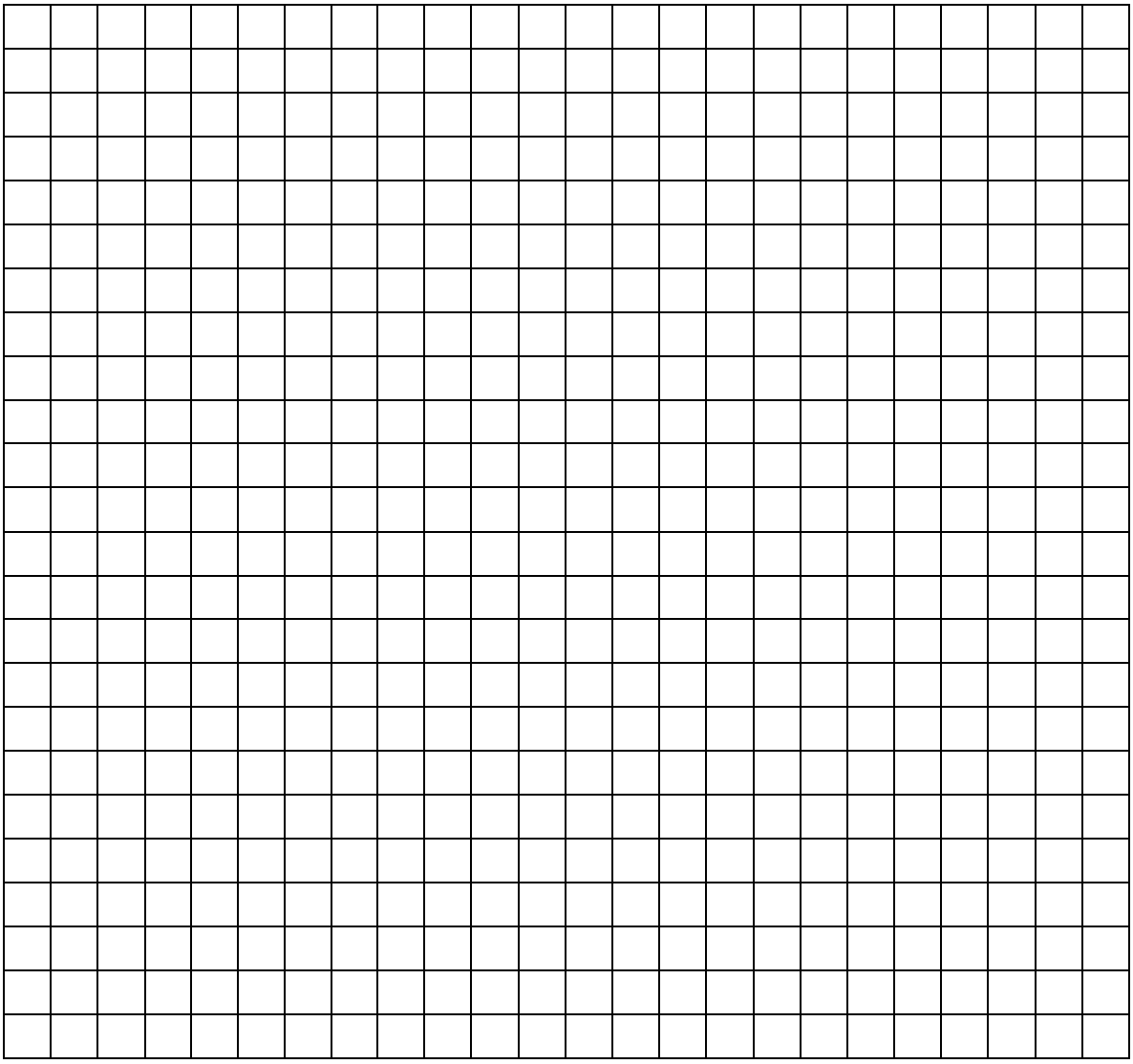
Procedure:

1. Part One: Grasshoppers need food. Grasshoppers eat corn.
    a. Pour the corn kernels into the pie pan. Mix the colors.
    b. Each student is now a grasshopper looking for food. Using the tweezers, you have only 15 seconds to pick up one kernel of corn at a time and place it in your plastic bag (the grasshopper's "stomach"). DO NOT TAKE TURNS – YOU ARE COMPETING FOR FOOD!
    c. Repeat this process until you have been a grasshopper 5 times.
    d. Put all grasshopper stomachs into a sack or plastic grocery bag.
2. Part Two: Shrews need food. Shrews are small mammals that look like mice but eat grasshoppers.
    a. Taking turns, reach into the bag and select one grasshopper.
    b. Keep taking turns until every student has "eaten" 2 grasshoppers.
    c. Put your 2 grasshoppers into a larger bag. This is the stomach of the shrew.
    d. Do steps a and b again so you each have 2 shrews.
    e. Number your shrew stomachs 1 and 2.
3. Part Three: Hawks need food. Hawks eat shrews.
    a. Roll the die.
    b. If the number is even, "eat" the number 2 shrew. If the number is odd, "eat" the number 1 shrew.

Results:

1. Examine the contents of the hawk's stomach.
    a. Divide the corn into two groups – yellow and not yellow
    b. Create a bar graph of each hawk's stomach contents.
2. Open the "Mystery Envelope" and read it. What is the fate of your hawk?

How do pesticides affect the food chain?



1. Was your grasshopper alive or dead when the shrew ate it?

2. Did your shrew live after eating the grasshopper or did it die? How do you know?

3. How healthy is your hawk? How do you know?

Yellow corn is good corn. The other color corn has been sprayed with pesticides and is poisonous.

If your grasshopper's "stomach" contained any other colored corn, your grasshopper is considered dead from pesticide poisoning. However, the shrew may have eaten it before it died.

If half or more of your shrew's food supply was other colors, then your shrew is also dead.

The hawk may not die at this time. However, if the hawk continues to eat these shrews, a large amount of pesticide will build up in the hawk's body. This may result in damage to the reproductive system. The eggs produced may have shells too thin to survive the nesting process.

The Farmer Cares for the Land

Identify the problem and the solution and the main cause and effect relationship in the information below.

Wetlands

Wetlands are low areas that are saturated with water. Marshes and swamps are wetlands. Most of the wetlands in Mississippi are the areas along creeks and rivers, between the water and the land. These are called ***riparian areas***. Mississippi has some marsh and swamp areas, too.

Wetlands are an important part of the earth's ecosystem. They act like sponges to store water during the wet times of the year and release it into the aquifers and underground streams where we get most of our drinking water. When there are no wetlands to soak up the water, rains are more likely to turn into floods which destroy homes, businesses and farms. Plants that grow in wetlands hold the soil and help keep it from being washed away.

Wetlands also help purify water. They filter out harmful chemicals and wastes. Dirty water gets a good cleaning when it flows through a wetland.

Wetlands provide homes for many birds and animals that need wet places to grow and reproduce. They are important rest and food stops for many migrating birds. Many endangered plants and over 1/3 of our endangered animals live in or use wetlands.

At the time of European settlement, there were about 215 million acres of wetlands in the lower 48 states. In the last 200 years, over 54 percent of these wetlands have been lost. Most were converted to agricultural uses. For many years people thought of wetlands as obstacles to farming and breeding grounds for mosquitoes. The government even encouraged landowners to turn wetlands into dry lands.

Now we know more about wetlands. We realize how much they help the environment, wildlife and humans. Federal laws have been passed to protect and preserve them. Some people don't like the wetland laws. People who have wetlands on their property think they should be able to use their property to earn money to support their families.

Problem	
Solution	
Cause	
Effect(s)	

This solution creates another problem. What is it? _____

Youth Activity

How People Get Their Water

Reservoirs: "Holding Tanks" for Drinking Water

Let your students **"Ride the Water Cycle"** with the following activity. It will help them understand the role of reservoirs in maintaining a reliable supply of drinking water.

Materials Needed:

- Plastic Box
- Spray bottle
- Pebbles
- Soil
- Sand
- Leaves

Objective: To illustrate how a reservoir works.

Target Audience: Primary (K-6)

Teacher's Notes:

Water moves in a continuous cycle between the air, ground, and plants and animals. Most water does not naturally exist in a pure form or in a form that is safe for people to drink. That is why water must be cleaned before we drink it. Water utilities provide such treatment before water is sent through pipes to homes in the community.

The demand for water varies. The availability of water also varies in different areas of the world. To meet those varying needs, water utilities may store extra water in places known as reservoirs. Water is usually contained in reservoirs by a dam. Reservoirs help ensure that communities do not run out of water at any given time regardless of the communities' total water use.

Questions to Expand Students' Thinking:

Q What are some of the sources of water for a reservoir?

A Precipitation in the form of rain and snow. Other bodies of water that feed the reservoir, such as lakes and rivers.

Q How does water get into a reservoir?

A It seeps over and through the soil above the reservoir.

Q What contains or holds water in a real reservoir?

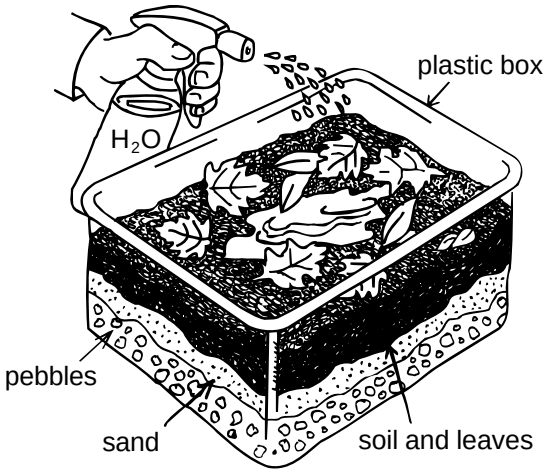
A Dams.

Q What kind of natural treatment does water receive in a reservoir?

A Natural filtration through leaves, grass and soil. Some settling also occurs in the reservoir.

Activity Directions:

1) Construct a model of a reservoir using a clean, clear plastic box. Line the bottom of the box with small pebbles and then layer sand, soil, and leaves on top.
2) Carefully spray water on the four corners of the model until the soil mixture is saturated and the water has seeped through to the open area (the reservoir).



Source: U.S. Environmental Protection Agency, adopted from "Water Wizards," Massachusetts Water Resources Authority, Boston, MA, 1993.

Every "Litter" Bit Hurts

Definition of "litter": human-generated waste (or trash) that is discarded in an inappropriate place (streets, playgrounds, streams, etc.), or improperly stored trash which has escaped from its container (trash can, dumpster, back of truck, etc.).

Part One: What litter is “bad” litter?

1. Get a “litter” bag from your teacher
2. Empty your trash bag and arrange the items so everyone can see them.
3. List the items in your bag, and don't forget to include the paper bag.
4. Rank the items from "least harmful" to "most harmful."
5. Ranking should be a group decision.
6. Write why you chose one item over another as harmful.

All litter is harmful. Littering is an inappropriate behavior and a bad habit that people have learned.

Part Two: Educating Others

Create a group poster that explains/shows why litter is undesirable. Some ideas are: litter is pollution; it is an eyesore that destroys the beauty of a place. Litter can be dangerous; broken glass or metal can injure. Litter is often eaten by wildlife and this can lead to injury or death. Litter can be a threat to public health; illegally dumped tires are breeding grounds for mosquitoes, and rodents frequent waste piles. Even the odor of trash piles can be offensive.

Name: _____

Every "Litter" Bit Hurts

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1. Name three sources that contribute to litter.

2. State three reasons litter is harmful to people, wildlife, and our natural resources.

3. Name three ways they can help "reduce" litter in their community.

HOW CAN WE HELP PROTECT OUR WATER RESOURCES?

Litter and Debris in Our Waterways

Adapted from: http://www.vaswcd.org/documents/Education/NRCW/Sec3.litterinwaterways.pdf

WHAT IS LITTER AND DEBRIS?

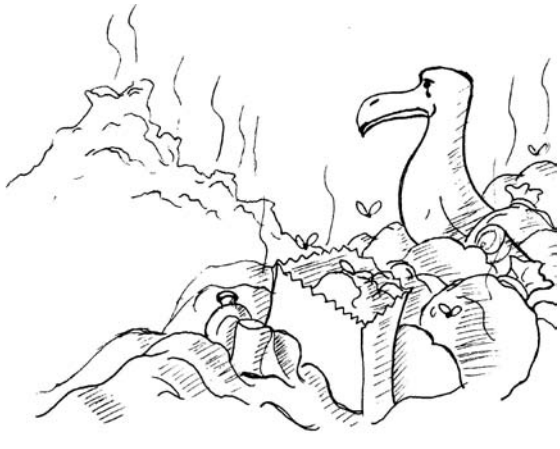
Aquatic litter and debris are any manufactured or processed solid waste that enters the aquatic environment from any source. In short, it is our misplaced waste and trash. It is a highly pervasive and visible form of pollution that has harmful impacts on wildlife and human health.

Aquatic ecosystems – streams, rivers, wetlands, and estuaries – are under considerable pressure from human activities, including incorrect disposal of trash. While the world's oceans are vast, they do not have an infinite ability to safely absorb our wastes. Preserving and restoring the quality of freshwater and marine environments requires that we understand how much trash we create, what we do with that trash, and how we can prevent it from entering our waterways.

SOURCES OF AQUATIC DEBRIS

According to The Ocean Conservancy, all the trash in our water shares a common origin: "…at a critical decision point, someone, somewhere, mishandled it, either thoughtlessly or deliberately."

The debris we find in our waterways comes from land-based sources, including people who litter, landfills, and storm drains. Another source of land-based debris is from combined sewer overflows. The water that enters a storm drain during a rainstorm enters the same pipes that take wastewater from homes and businesses. This mixture of wastewater and storm water travels to the cities' wastewater treatment plants. During times of heavy rain, the volume of this water coming into the wastewater treatment plant can overwhelm the capacity of the plant, thereby causing an overflow. In combined sewer overflow situations, untreated wastewater (including raw sewage and untreated pollutants) directly enters the receiving stream or river. Therefore, items flushed down the toilet can end up in our waterways. Millions of dollars are being spent in Mississippi and across the U.S. to eliminate this problem.



It should be noted that in most towns and cities, storm drains flow directly to streams and rivers. Litter on sidewalks and streets and in gutters is swept into the storm drain system when it rains. Just as a drop of rain can travel from a small stream to a river to the Mississippi Gulf Coast, so can a piece of litter. According to The Ocean Conservancy, 60% to 80% of debris found on beaches is washed, blown, or dumped from shore.

BEHAVIOR BEHIND THE DEBRIS

Deliberate littering and illegal dumping contribute debris to our waterways, as do other non-deliberate actions – such as having a piece of debris blow out of your car window or off your boat. Sometimes our trash cans will be knocked over by animals or the wind, resulting in more accidental litter. One important idea to understand is that there is a behavior and a person behind every piece of debris we find in our waterways. Some of these behaviors are:

Litter from Recreational Activities
This category includes trash from fast-food restaurants that is littered by people in cars, or is left behind after a picnic. People who litter fast-food items contribute a significant amount of debris to our waterways. Other items include bags, balloons, beverage containers, clothing, and toys.

Debris from Waterway Activities
This category includes fishing-related items from recreational and commercial fishermen like nets, fishing line, and bait boxes.

Illegal Dumping Activities
This category includes household waste, refrigerators and other appliances, building and construction waste, tires and sometimes entire cars.

Personal Hygiene and Medical Debris
This category includes items from sewers that overflow, diapers, needles, and other related items.

Litter from Smoking
This category includes cigarette butts, cigar tips, lighters, and the wrappers on cigarette packs. Smoking-related activities account for a tremendous amount of litter—in some places cigarette butts make up more than 85% of all littered items.

CIGARETTE BUTTS—A SPECIAL PROBLEM

During the International Coastal Cleanup, sponsored by The Ocean Conservancy, cigarette butts are the #1 most frequently found litter item. Trillions of cigarette butts are disposed of yearly, many directly tossed into the environment. Cigarette filters are made out of cellulose acetate, a plastic that takes several years to degrade.

Cigarette butts accumulate outside of buildings, on parking lots, and in streets where they can be transported through storm drains into streams and rivers. In addition to being unsightly, the chemicals that leach out of cigarette butt litter present a toxic threat to aquatic animals. The compounds in discarded cigarette butts (the filters and remnant tobacco) are biohazards to the water flea, *Daphnia magna*, a small crustacean at the lower end of, but important to, the aquatic food chain. Cigarette butts in the environment are an important litter issue – not a smoking issue.

Whether these items enter the aquatic environment from dumping, litter, or accidental routes, debris not only looks ugly, but it can harm the animals and plants that make their homes in stream, lake, wetland, and coastal environments.

TYPES OF AQUATIC DEBRIS

Every year, volunteers across the world participate in the International Coastal Cleanup, picking up aquatic debris and collecting data about the quantity and types of litter they find. The top ten list from these cleanups gives us a tremendous amount of information about the behaviors and activities that contribute most to the aquatic debris problem. The Top Ten items vary little year-to-year.

Any trash that is improperly disposed of can potentially enter a waterway and have negative impacts on aquatic animals, plants, and humans. Aquatic debris can be categorized in several ways:

- By material (plastic, metal, glass, cloth, paper)
- By source or by the activity which led the trash to be in the water. Some activities include fast food consumption, smoking, fishing, illegal dumping, sports/ games, balloons used in advertising, etc.
- By impact the items have on the environment and wildlife
- By biodegradable / non-degradable (Much of our solid waste contains synthetic materials that do not degrade quickly, if at all.)
- By recyclable / non-recyclable

PLASTICS — A SPECIAL PROBLEM

Plastic is widely used due to its light weight, strength, durability, versatility, and low cost. We use plastic bags, bottles, cups, forks, spoons, straws, and six-pack rings. Many toys are made from plastics, as are tools including strapping bands, and plastic sheeting. Plastic is also used in making packing materials and fishing gear. Plastics can take hundreds of years to break down, so they may continue to entangle and kill animals year after year. One study found that almost 90 percent of the debris floating on our oceans is plastic. The filters on cigarettes are also made from plastic fibers.

Top Ten Litter Items in the United States

In the 2001 International Coastal Cleanup, these items comprised 82% of all debris found in the U.S.

1. Cigarette butts/cigarette filters
2. Bags/food wrappers
3. Caps, lids
4. Beverage bottles (glass)
5. Beverage cans
6. Cups, plates, forks, knives, spoons
7. Plastic bottles 2 liters or less
8. Straws, stirrers
9. Fast food Containers
10. Cigar tips

IMPACTS OF AQUATIC DEBRIS

Litter not only detracts from the beauty of a riverside park or beach, but also can be a health and safety hazard for humans, and aquatic wildlife. Another big impact of litter is the cost to society. Millions of dollars are spent every year in Mississippi by state and local governments, parks, schools, and businesses to pick up litter.

Impacts on Aquatic Habitat
Habitat destruction or harm is caused when submerged debris (for example, a piece of plastic sheeting) covers water grass beds, or smothers bottom-dwelling species. Some debris can also cause physical damage.

Impacts on Water Quality
Debris can also affect the water quality by adding chemicals to the water. Construction waste illegally dumped in a stream can include buckets that once held paints, solvents, and other chemicals that can enter the water. Cigarette butts and some other littered items contain toxic chemicals that leach into the water.

Impacts on Aquatic Animals
Aquatic debris can be particularly dangerous and often lethal to wildlife. As many as 2 million seabirds die every year due to debris ingestion and entanglement. Fishing line, fishing nets, strapping bands, and six-pack rings can hamper the mobility of aquatic animals. Once entangled, animals have trouble eating, breathing, finding food, escaping predators, or swimming, all of which can have fatal results. Entanglement can also cause wounds that can become infected. According to the National Oceanic and Atmospheric Administration (NOAA), marine debris threatens over 265 different species of marine and coastal wild-life through entanglement, smothering, and interference with digestive systems.

Birds, fish, and mammals often mistake plastic items for food. With plastic filling their stomachs, animals have a false feeling of being full, and may die of starvation. Ingested items can also block the intestinal tract and prevent digestion.

Impacts on Human Health and Safety
Trash in our waterways can also affect human health and safety. Hazards include glass and metal left on the beach. Fishermen and recreational boaters can also be endangered as nets and monofilament fishing line wrap around a boat's propeller. Plastic sheeting and bags can also block the cooling intakes on boats. Such damage is hazardous and costly in terms of repair and lost fishing time.

Economic Impacts from Aquatic Debris
A tremendous amount of time, effort, and machinery is devoted in Mississippi to cleaning up litter on the land and in our waterways. Many communities and parks have regular schedules to remove trash left behind by visitors.

In addition to costly cleanup procedures, there are other economic impacts that are harder to put a price on. Littered parks, marinas, and beaches suffer from lost tourist income, and fisheries that are full of debris can result in decreased yield of food such as crabs and fish.

SOLUTIONS TO AQUATIC DEBRIS

Cleanup

One solution to the aquatic debris problem is cleaning up the trash using paid employees and volunteers.

Cleaning up pollution after it has entered the water is important, but it can be only a temporary solution if the sources of pollution are not also addressed. As mentioned above, the costs associated with cleanups can also be high. While both pollution cleanup and pollution prevention are needed, when it comes to the very preventable problem of aquatic debris, emphasizing prevention will yield greater results.

Pollution Prevention

There are two main approaches to preventing litter and trash from entering our waterways.

1. Proper Disposal. Educate people on the need to dispose of their trash properly, and make it easy for them to do so.
2. Waste Reduction. Examine how much waste we produce, and find ways to reduce it.

Proper Disposal

What a difference proper disposal of waste can make! As seen above, the vast majority of the aquatic litter is from items we can all easily carry until we find a trash can. Fast-food wrappers, bottles, cans, and cigarette butts are more than 80% of the litter we find in our waterways.

Waste Reduction

In the United States, we have 4.6% of the world's population, but we produce about 33% of the world's solid waste. Each of us can make incredible strides in reducing the amount of waste we are responsible for creating by employing the three "**Rs**" – **Recycle**, **Reuse**, **Reduce**. For every item we recycle or reuse, there will be one less piece of trash that can become a part of the aquatic debris cycle.

People can reduce the amount of trash they dispose of by:

- Buying reusable items rather than disposable ones. This can include reusable lunchboxes, plates, cups, eating utensils, and food containers instead of disposable items.
- Reusing items several times before throwing them away.
- Recycling plastics, glass, metals, and paper, and buying recycled goods too.
- Choosing items that have the least packaging.
- Not buying helium-filled balloons, and discouraging the release of balloons. Ask communities to celebrate in a way that doesn't add these deadly balloons to our aquatic environment.
- Composting kitchen and yard waste.
- Using rechargeable batteries and recycling them when their useful life is over.
- Using a canvas or string bag to carry groceries and other items.
- Using cloth napkins, dishtowels, and handkerchiefs instead of paper ones.

Littering is often times a bad habit. Each member of your group is to select one of the following types of litter bugs. You are to take 5 minutes to create a skit for the class, showing them the types of littering your bug does. Perform your skit for the class.

a. The Sport Bug – This litterbug loves to attend all type of sporting events and cheer on his team, he samples every type of food from the concession stand, and leaves a pile of food wrappings under his seat.

b. The Traveling Bug – This bug is constantly on the go. When traveling in his car he can be seen continually throwing items out of his window.

c. The Picnic Bug – A true nature lover, this bug loves to enjoy a meal in the outdoors. When he leaves the site (littered with the remains of his meal), he is surprised to find the site not as pretty as he originally found it and vows to find a better spot next time.

d. The Bad Aim Bug – This bug makes a game out of throwing trash in the trash can. He gets one point if the toss is good. I he misses, he figures there's always next time.

e. The Good Intentions Bug – This bug leaves school every day and stops at the convenience store to pick up a snack. After eating the snack the bug looks for a trash can bug can't find one. Thinking it will be out of site this bug drops his trash in a storm drain.

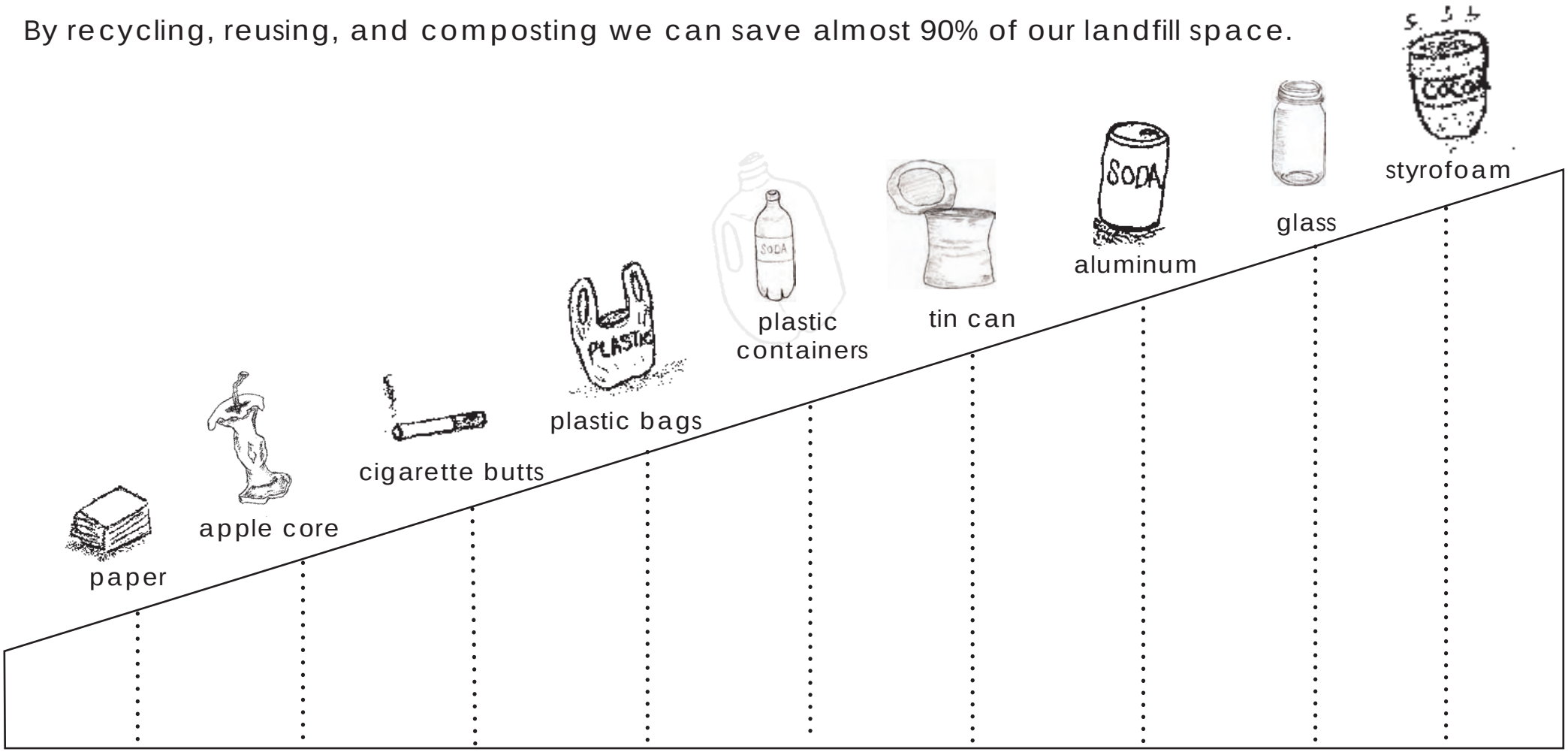
(The above portion of the activity was adapted from *Waste in Place* by Keep America Beautiful)

LITTER LIFELINE

kab
KEEP AUSTIN BEAUTIFUL

These are common litter items and the time it takes each item to decompose.

By recycling, reusing, and composting we can save almost 90% of our landfill space.



Definition in your own words

Draw a picture

Watershed

Examples: Names of different watersheds in Ohio

List Nonexamples

Invasive Species Game

Materials:

- 4-cups
- 2-plastic knives
- 1-plastic spoon
- 3-forks
- 1-large binder clip
- 8 red pom-poms
- 10 black pom-poms
- 8 white pom-poms
- 3x4 piece of felt
- 20 bingo chips

Set-up the Game

1. Place the piece of felt on the table. Scatter the pom-poms randomly on top of the felt.
2. Select one species of native fish as your game piece. Collect your tools for feeding.
3. IMPORTANT! You may only hold your tools in one hand when you feed. So, if you have 2 knives or 2 forks you must put them both into the same hand.
4. Give each group member 3 bingo chips. These chips represent three lives.

Type of Fish	Feeding Style	Food type (pom-poms)
Perch	Plastic spoon	White only
Walleye	Two knives	White and red only
Blue gill	Fork	Black only
Bass	Two forks	Black and red only

Play the Game – Part A (A Stable Ecosystem)

1. You only have 30 seconds to collect food using your tools and one hand. During those 30 seconds, everyone in your group works as fast as possible to collect as much food as possible.
2. Remember – you may only collect the type of food your fish actually prefers to eat – you may NOT collect any other colors of pom-poms.
3. At the end of the round, count your pom-poms.
    a. If you have 5 pom-poms, you have survived the round.
    b. For every 3 pom-poms more than 5, you have one offspring, which counts as an extra life. Collect one extra bingo chip for this new life.
    c. If you have fewer than 5 pom-poms you did not survive. Lose one bingo chip.
4. Repeat this process for 3 rounds.

Play the Game – Part B (Introducing the Invasive Species)

1. Set up the game the same way as in Part A.
2. One member of the group (the one with the fewest bingo chips) now becomes a Goby – an invasive species of fish that can eat anything in the reservoir. This person's fish for Part A is now extinct.
3. It is a great idea for the Goby to eliminate native species of fish, so you should try and eat the food that will hurt the native species the most (i.e. eating only white).
4. Play the game for 3 rounds just as in Part A. At the end of every round, count your pom-poms and determine how many chips you have. Any fish that is out of lives (chips) becomes extinct. That player becomes another Goby.

Answer the discussion questions.

DISCUSSION QUESTIONS

Part A

What species of fish were you?

How well were you able to compete with the other native species for resources (food) necessary to your survival and reproduction?

Part B

How well could the native species compete with the invasive species (Goby) for resources necessary for survival and reproduction? Why? What made the Goby so successful?

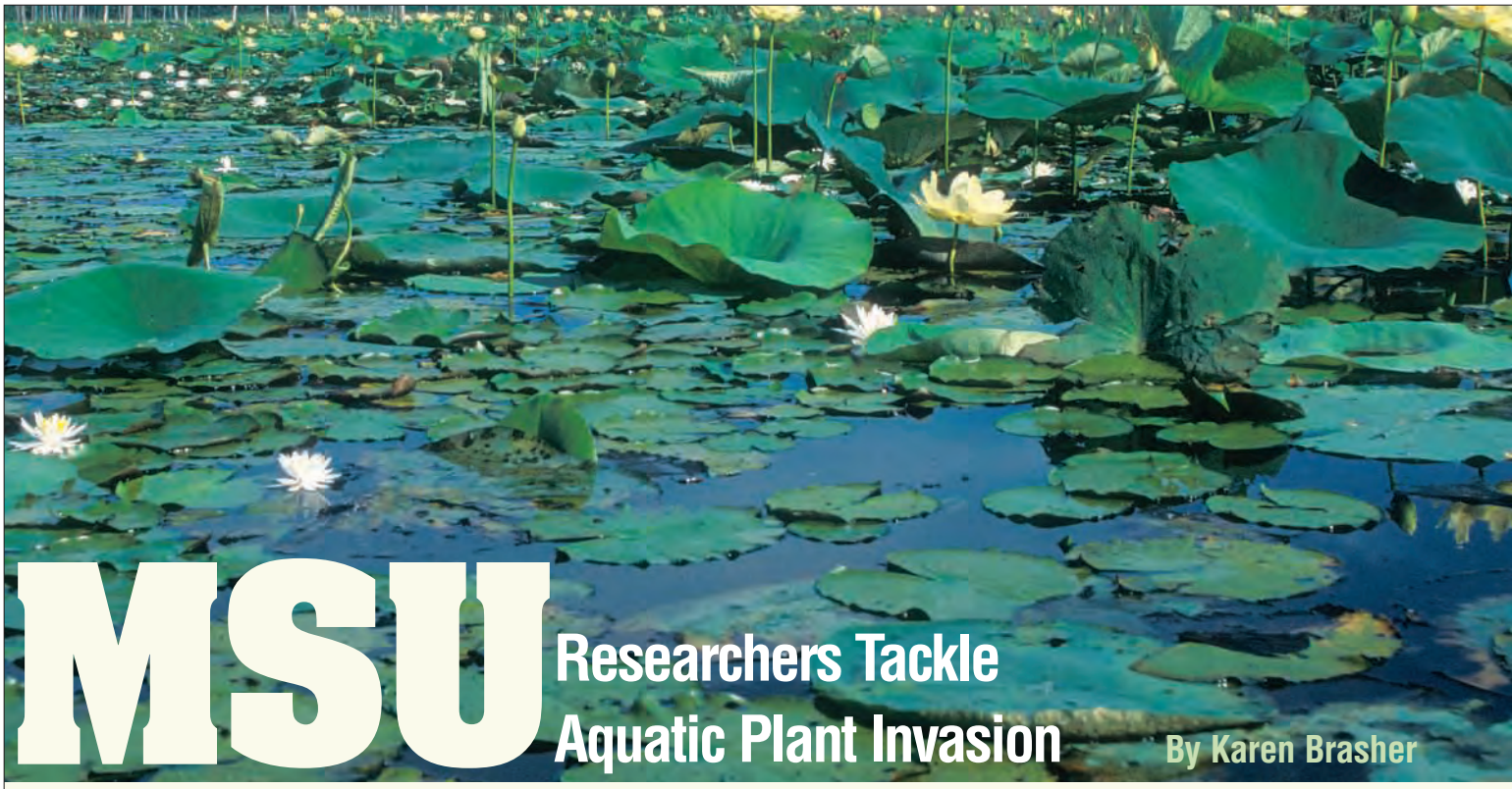
What could be the consequences of organisms entering an ecosystem?

MISSISSIPPI LANDMARKS

Volume 2, Number 4 FALL 2006

Research, Education and Outreach in the Division of Agriculture, Forestry and Veterinary Medicine

Mississippi State University



MSU Researchers Tackle Aquatic Plant Invasion

By Karen Brasher

Many species of alligators, fish and birds make their home at Mississippi's largest surface water impoundment, the Ross Barnett Reservoir. Now, however, new residents—aquatic plants that are not native to the area—are invading the reservoir.

Built in 1966, the Ross Barnett Reservoir contains 33,000 acres, mostly between Madison and Rankin counties. The reservoir, managed by the Pearl River Valley Water Supply District, is the primary source of drinking water for the city of Jackson.

"The reservoir provides many recreational opportunities, including campgrounds, parks and trails, as well as residential areas," said John Madsen, assistant research professor in MSU's GeoResources Institute. "However, in recent years, invasive species have become an increasing problem on the reservoir."

Introduced from other parts of the world, invasive aquatic plants affect aesthetics, drainage, fish and wildlife habitat, water quality, irrigation, navigation, recreation, and ultimately land values, Madsen added.

To gain a better understanding of the plant invasion, scientists in the Mississippi Water Resources Research Institute and MSU's GeoResources Institute are developing an aquatic plant management plan for the Ross Barnett Reservoir.

"The first step in developing a long-term aquatic plant management plan is to assess the reservoir's plant community by mapping their current distribution," said Ryan Wersal, research associate in the GeoResources Institute.

To map the distribution of plants, the team used a handheld personal digital assistant outfitted with a GPS receiver. Scientists mapped more than 1,423 points during the study. In addition to sampling for aquatic species, researchers also recorded light intensity and environmental parameters, such as depth, pH and water temperature.

"Of the 14 aquatic plant species observed, only three were exotic or invasive," said Mary Love Tagert, assistant research professor in Mississippi Water Resources Research Institute. "However, these invasive species occurred one-third as many times as native plants."

The invasive plants are so prevalent now, Tagert added, that a series of warm winters could allow them to spread to new areas throughout the reservoir.

One of the problems with these invasive species is that they are floating and mat-forming plants that shut out light for more desirable native species.

"The reservoir is a shallow body of water and has the potential to support many rooted submersed native plants," Tagert said.

Invasive species not only affect water quality, in particular oxygen and temperature, they also can play havoc with fish populations.

"Invasives completely change the structure of the shallow, weeded areas of the reservoir, which impacts the growth, survival and health of fish populations," said Eric Dibble, associate professor and fisheries biologist in MSU's Forest and Wildlife Research Center.

The problem is, Dibble added, that invasive species add so much structure to the system compared with native plants, that they can reduce fish populations and health. The long-term result would be a significant reduction in recreational fishing on the reservoir.

The new plants also affect other wildlife, such as birds,

making it difficult for them to find a good meal because of the massive floating plant communities. Fewer birds would impact another popular recreational activity at the reservoir—bird watching.

One of the newest invasive species found in the reservoir is hydrilla.

"Hydrilla is a submersed rooted plant that forms a dense mat and has been detected in several locations in the reservoir," Wersal said. "If invasive species such as hydrilla are not controlled, an infestation could easily encompass more than 7,000 acres of the reservoir."

Funded by the Pearl River Valley Water Supply District, scientists are actively working to assess changes and the spread of nuisance species populations on the reservoir.

"We will continue to monitor the distribution of invasive species as well as implement and assess techniques to control the nuisance plants," Wersal said. "Our goal is to promote the growth of desirable native plants and improve the water quality in the reservoir and other bodies of water in Mississippi."

The Mississippi Water Resources Research Institute is a unit of MSU's Forest and Wildlife Research Center. The GeoResources Institute is an affiliate of MSU's High Performance Computing Collaboratory.

Photos by Joe Mac Hudspeth, Jr.

Wildlife photographer Joe Mac Hudspeth, Jr., often has to navigate an ocean of invasive aquatic plants as he photographs birds and animals at Ross Barnett Reservoir. (Photo by Jim Johnston)

Invading Plants Squeeze Out Wildlife Photographer

Joe Mac Hudspeth, Jr., wildlife photographer and native Mississippian knows firsthand the problem with invasive species. Hudspeth has been photographing Ross Barnett Reservoir for more than 20 years.

"I've all but lost all of the places I've photographed over the last 16 years. You can't get to the place where the image of me in the boat was taken," Hudspeth said. "The east side of Pipeline Road on the east side of the reservoir (Rankin County) was 'taken over' five or six years ago."

Hudspeth went on to say that he would probably lose complete access to the wetlands off Pipeline Road on the west side of the reservoir (Madison County) within the next two years.

One of Hudspeth's favorite reservoir spots to photograph blue-winged teals is now uninhabitable because of invasive plants.

"I wasn't able to photograph blue-winged teals last spring because the 'hole' they had been frequenting for several years is so thick that they can't land in any water, and I can't walk to it," Hudspeth added.

The problem is such that Hudspeth did not even attempt to photograph on Pipeline Road this year or last year.

Hudspeth indicated that other places in Mississippi are also suffering from the invasion.

"The back waters of Bluff Lake at Noxubee National Wildlife Refuge were invaded so badly that park officials drained Loakfoma Lake to try to stop the nuisance plants," Hudspeth said.

Hudspeth, a Lafayette County native, has been published more than 900 times in national, regional and statewide publications. In 1993, he received national recognition when his image of an immature least bittern, taken on Ross Barnett Reservoir, was selected from more than 2,000 wildlife calendar photographs and awarded the Grand Prize for Wildlife by the Roger Tory Peterson Institute for Natural History.

Hudspeth's photos have appeared on nine Mississippi Duck Stamps and 10 Mississippi sportsman's licenses.

Rival for Survival Game Instructions

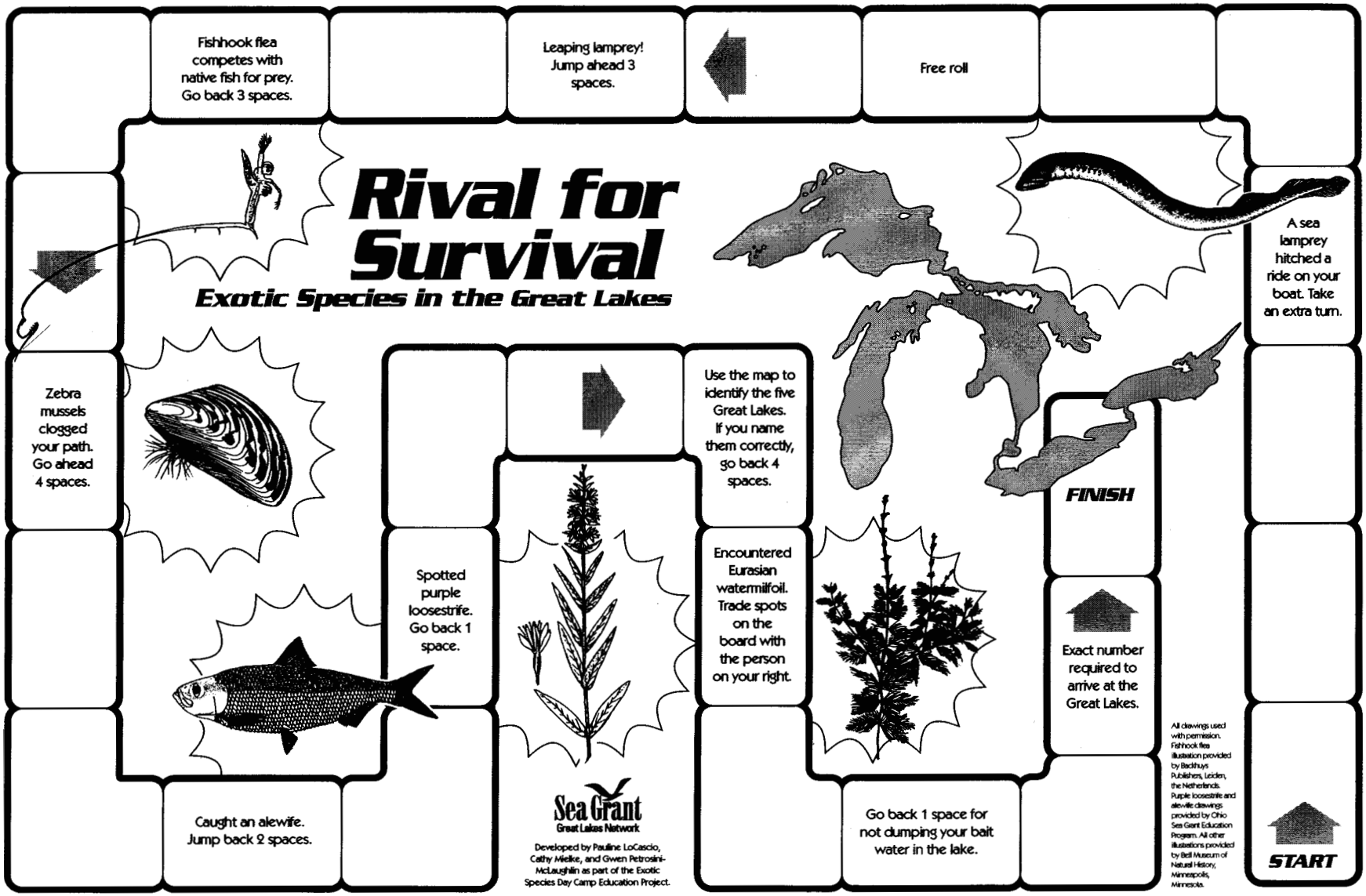
Materials	*Number of Players*
Game board	2–5
Movable pieces	
Game cards	
Score paper	
Die	
Pen or pencil	

Objective

To have the **most points** when all players have reached the “Finish” position, at the Great Lakes.

Directions

1. Each player rolls the die, and the player with the highest number goes first.
2. Player 1 rolls the die and moves the playing piece the number of spaces shown on the die. Player 1 chooses a question card and hands it to the player on the left, who reads the question aloud. Player 1 chooses the best answer.
3. Points received are based on the player’s answer and are recorded on the score sheet.
4. When landing on a space that requires the player to move ahead or backward, the player moves the game piece before picking a question card.
5. Some answers will cause a player to lose points. If the player has no points, however, he or she cannot go below zero, even if told to subtract a point.
6. Play continues in a clockwise direction until all players reach the Great Lakes region or the time limit is reached. The player with the **most points** is the winner—not the player who reaches the Great Lakes first. Finishing first may not necessarily be a good thing in this game!


Fishhook flea competes with native fish for prey. Go back 3 spaces.
Leaping lamprey! Jump ahead 3 spaces.
Free roll
Rival for Survival
Exotic Species in the Great Lakes
A sea lamprey hitched a ride on your boat. Take an extra turn.
Zebra mussels clogged your path. Go ahead 4 spaces.
Use the map to identify the five Great Lakes. If you name them correctly, go back 4 spaces.
FINISH
Spotted purple loosestrife. Go back 1 space.
Encountered Eurasian watermilfoil. Trade spots on the board with the person on your right.
Exact number required to arrive at the Great Lakes.
Caught an alewife. Jump back 2 spaces.
Go back 1 space for not dumping your bait water in the lake.
START
Sea Grant
Great Lakes Network
Developed by Pauline LoCascio, Cathy Mielke, and Gwen Petrosini-McLaughlin as part of the Exotic Species Day Camp Education Project.
All drawings used with permission. Fishhook flea illustration provided by Backhuys Publishers, Leiden, the Netherlands. Purple loosestrife and alewife drawings provided by Ohio Sea Grant Education Program. All other illustrations provided by Bell Museum of Natural History, Minneapolis, Minnesota.

Game Cards—Front a

Q Your aquarium is no longer functioning. You decide to get rid of the fish. You should

a. flush them.
b. find them a new home in another aquarium.
c. drop them in the local pond.

Q To prevent the transfer of exotic species from one lake to another, you should

a. pull your boat quickly from one lake to another.
b. inspect your boat trailer and equipment.
c. wash your boat in cold water.

Q How many of these species are exotic: goldfish, purple loosestrife, sea lamprey, starling?

a. one
b. three
c. four

Q Bringing in natural predators may be the way to handle exotic species such as purple loosestrife. Choose a potential problem with the above idea.

a. Purple loosestrife would decrease.
b. Predators may not die out after plants are gone.
c. Native plants would repopulate area.

Q Some exotic species can be a nuisance. How many of these are nuisance species: carp, alewife, purple loosestrife, zebra mussels, sea lamprey?

a. two
b. three
c. five

Q You find a beautiful plant while on vacation in Mexico. Do you

a. take a picture?
b. dig it up and transplant it in your garden?
c. pick the flowers off of it?

Q The role an organism has in its environment is its niche. Exotic species

a. try to take over the niche of another organism in an ecosystem.
b. have no niche in an ecosystem.
c. are not organisms.

Q Zebra mussels each filter about

a. 0.25 liter of water per day.
b. 0.50 liter of water per day.
c. 1.0 liter of water per day.

Q How could you gain information about exotic species in your area of the country?

a. Contact the Wildlife Service.
b. Complete an Internet search on the topic.
c. Both a and b.

Q The sea lamprey is an exotic species in Lake Erie. Why is it so damaging to other fish?

a. It eats their eggs.
b. It carries a large number of diseases.
c. It sucks out the blood and body tissues of other fish through its suckerlike mouth.

Q In any ecosystem, there is a limited amount of resources. If an exotic does well in a new ecosystem, that usually means native species are

a. getting more resources than before.
b. getting the same amount of resources than before.
c. getting less resources than before.

Q Exotic species are

a. rare organisms.
b. organisms brought into an environment not their own.
c. worth a lot of money.

A
a = 0 pts. No! You might transfer species from one body of water to another.
b = 3 pts. Good decision! You ensure there are no organisms transported on your boat.
c = 1 pt. You're trying to remove all organisms—use 140°F water.

A
a = 0 pts. Not a good choice!
b = 3 pts. This is the best thing to do.
c = –1 pt. Take a point away. You could be introducing a new species to the pond and upsetting the ecosystem!

A
a = 0 pts. This is what we would want to happen!
b = 3 pts. Could be a very real problem. You'd just be trading one exotic species for another.
c = 0 pts. This is a positive effect of introducing a natural predator; the question asked for negative effect.

A
a = 1 pt.
b = 2 pts.
c = 3 pts.
All four are exotic!

A
a = 3 pts. Correct! You can enjoy the plant without damaging it or carrying it into an ecosystem not its own.
b = –1 pt. Take a point away. You risk creating an invader species that could damage the ecosystem back home.
c = 0 pts. This could damage the plant.

A
a = 1 pt. True, but not the best food answer.
b = 2 pts. You are getting closer.
c = 3 pts. This is right! All are nuisances!

A
a = 0 pts. Not right!
b = 0 pts. Closer, but still not right.
c = 3 pts. You got the right answer!

A
a = 3 pts. They try to do this.
b = 0 pts. No.
c = 0 pts. All living things are organisms.

A
a = 0 pts. Not true.
b = 0 pts. Not the problem.
c = 3 pts. Gross, but true.

A
a = 1 pt. Good choice, but not the best!
b = 1 pt. Good choice, but not the best!
c = 3 pts. This is the best choice!

A
a = 0 pts.
b = 3 pts. This is the correct answer.
c = 0 pts. b is a much better choice.

A
a = 0 pts. Have new competition for and usually get less.
b = 0 pts. No! If there are more organisms trying to eat the same food, they won't get as much.
c = 3 pts. Correct, because there are more species competing for the resources.

Game Cards—Front b

Q You find some zebra mussels on a beach. You should
- a. leave them where they are.
- b. take them home.
- c. put them in a pond near your home.

Q Exotic species are
- a. plants.
- b. animals.
- c. both.

Q Zebra mussels are believed to have entered the Great Lakes
- a. by traveling in the ballast water of commercial freighters.
- b. by attaching to large fish.
- c. because people brought them here to increase the mussel population.

Q Purple loosestrife was brought into the United States to
- a. beautify wetlands.
- b. be used in landscaping.
- c. feed large herbivores.

Q While traveling through another part of the country, you encounter a small tortoise. Do you
- a. put it in your aquarium?
- b. sell it to a pet store?
- c. leave it alone?

Q Purple loosestrife is an exotic species that is invading North American
- a. deserts.
- b. forests.
- c. wetlands.

Q Indigenous plants and animals are those
- a. that are naturally found in an ecosystem.
- b. are imported into an ecosystem.
- c. make you sick if you eat them.

Q Exotic species
- a. are good for the environment they enter.
- b. are bad for the environment they enter.
- c. can be either good or bad, and some have no effect.

Q The effect zebra mussels have on water intake pipes is to
- a. help rebuild them.
- b. clog them.
- c. clean them.

Q Round gobies can eat up to
- a. five sea lampreys per day.
- b. 1 pound of purple loosestrife per day.
- c. 78 zebra mussels per day.

Q How are yellow perch affected by aquatic invaders?
- a. The round goby eats yellow perch eggs.
- b. The fishhook flea competes for the same food as the yellow perch.
- c. The yellow perch swallows zebra mussels that get stuck in its digestive system.

Q The fishhook flea keeps from being eaten because
- a. its long tail, shaped like a fishhook, makes it difficult for larger fish to swallow.
- b. it latches on to fishhooks and escapes when fishermen pull their poles out of the water.
- c. it stays away from fishhooks and thus is not eaten by fish.

A
a = 1 pt. True, but not the best choice.
b = 1 pt. Also true, but not the best choice.
c = 3 pts. Exotic species can be plants or animals.

A
a = 3 pts. This is the best choice.
b = 0 pts. You risk spreading them to new locations.
c = –1 pt. Take 1 point away. This is a very poor choice because you may infest the pond.

A
a = 0 pts. Not true.
b = 3 pts. This was why people brought purple loosestrife into the United States.
c = 0 pts. Purple loosestrife has no natural enemies in the United States.

A
a = 3 pts. True. Ballast water is used by freighters to keep the ship evenly weighted.
b = 0 pts. Sea lampreys attach to fish; zebra mussels do not.
c = 0 pts. Not true.

A
a = 0 pts. Wrong.
b = 0 pts. Wrong.
c = 3 pts. Purple loosestrife is a wetland plant.

A
a = 0 pts. While this wouldn't hurt the environment, it could be an endangered species and should be left alone.
b = 0 pts. Same reason as choice a.
c = 3 pts. Best choice. Allows the animal to remain in its ecosystem; wouldn't negatively affect another ecosystem.

A
a = 1 pt. Might be true, but unlikely.
b = 1 pt. True often, but not always.
c = 3 pts. This is the best choice.

A
a = 3 pts. This is the correct definition of indigenous.
b = 0 pts. This is the definition of nonindigenous.
c = 1 pt. Some may make you sick, others may not. Not the best choice.

A
a = 0 pts. This would be helpful, but it is not true.
b = 0 pts. This is also incorrect.
c = 3 pts. This is correct.

A
a = 0 pts. No, zebra mussels do not help rebuild pipes.
b = 3 pts. Yes! Zebra mussels cause problems because they clog water intake pipes.
c = 0 pts. This is also incorrect. They clog pipes, not clean them.

A
a = 3 pts. Exactly! This is why it is called the fishhook flea.
b = 0 pts. Sorry, this is incorrect.
c = 0 pts. This is also a wrong answer.

A
a = 3 pts. Good answer!
b = 3 pts. This is also a correct answer!
c = 0 pts. The yellow perch do not eat zebra mussels.

Game Cards—Front c

Q Boaters or anglers can prevent the spread of zebra mussels by

a. wearing gloves while they are fishing.
b. emptying their bait buckets on land only.
c. washing their boat, tackle, trailer, and other equipment in 104° F water.

Q A sea lamprey can grow

a. up to 6 inches long.
b. up to 36 inches long.
c. up to 18 inches long.

Q The fishhook flea most likely traveled to the United States

a. attached to other fish migrating toward the United States.
b. because it got lost.
c. in the ballast water of freighters.

Q How might a native brown trout be killed by an aquatic invader?

a. Round gobies could eat eggs of the brown trout.
b. A sea lamprey could carve a hole in the side of the brown trout and suck out its bodily fluids.
c. The brown trout could try to swallow a fishhook flea and get it stuck in its digestive system.

Q A female zebra mussel can produce up to

a. 10,000 eggs a year.
b. 100,000 eggs a year.
c. 1 million eggs a year.

Q What do round gobies do to make fishermen angry?

a. They eat all the eggs of the native fish, leaving no more fish to catch.
b. They tease them that they can't catch fish.
c. They aggressively take bait from hooks used by fishermen.

A
a = 0 pts. Sea lampreys can get bigger than that!
b = 0 pts. Wow, that would be one giant sea lamprey.
c = 3 pts. That is correct!

A
a = 0 pts. Unfortunately, wearing gloves has nothing to do with it.
b = 3 pts. Good job! This will help prevent the spread of zebra mussels.
c = 3 pts. This too will aid in the prevention of zebra mussel infestation.

A
a = 2 pts. This is close. Round gobies eat the eggs of the lake trout.
b = 3 pts. Exactly, this is why the sea lamprey is so dangerous!
c = 1 pt. This might be possible.

A
a = 0 pts. No, it is the sea lamprey that attaches to fish.
b = 0 pts. This is incorrect.
c = 3 pts. You got it!

A
a = 1 pt. This is a possibility.
b = 0 pts. This is unlikely.
c = 3 pts. That's right!

A
a = 0 pts. This isn't even close.
b = 1 pt. This is getting closer.
c = 3 pts. Yes, this is correct.

Rival for Survival

Trip at a Glance

This game presents real-life choices involving exotic species found in the Great Lakes, such as zebra mussels and purple loosestrife. Students are to analyze a situation related to ecology and make an environmentally sound decision. After playing the game, students organize what they learned into a concept map.

Destination

Students will be able to

- Analyze situations and factors affecting ecosystems.
- Recognize exotic species found in the Great Lakes.
- Create a concept map that interrelates the topics presented in the game.

Adventure Levels

Grades 6–9
This activity can be adapted for younger students.

Areas of Interest

Science and Citizenship

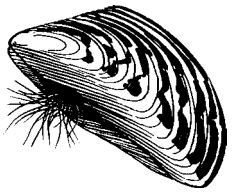
Locale

Classroom tables, desks, and/or the floor

Length of Stay

Two class periods

Invader Background Check



Exotic species are organisms that are brought into an ecosystem that is not their own. These organisms attempt to fill the niche of organisms that are already present. There is a limited amount of resources in any environment. Adding new species means that species already present now have more competition for food and shelter. If an exotic species does well, it usually means a preexisting species begins to decrease in numbers through intense competition for ecosystem resources.

Exotic species have been introduced into new environments both intentionally and unintentionally. For example, purple loosestrife was introduced for landscaping purposes. Other species, such as zebra mussels, were transferred unintentionally through the ballast water of ocean freighters.

Foreign Language

Alewife
Eurasian watermilfoil
Exotic species
Fishhook flea
Indigenous species
Niche
Organism
Purple loosestrife
Round goby
Sea lamprey
Zebra mussel

Amenities Provided

Rival for Survival game board found in "Posters and Games"
Game Cards 15.1–15.6
Rival for Survival game Instructions 15.7

Things to Pack

Dice
Movable game pieces
Paper for keeping score
Pen or pencil

Itinerary

Preparing for the activity

1. Copy and assemble the game boards for each learning group. See "Travel Tips" for a way to prepare the game board and other materials.

2. Copy game cards and instructions. Copy one set of cards for each game (matching front and back by letters, such as "Front a" to "Back a"). Copy one game instruction page for each game.

First class period: Introducing and playing the game

3. Divide students into cooperative learning groups of two to five people.

4. Provide an introduction to exotic species. Ask the following questions:
   What are exotic species?
   How do you think exotic species affect the environment?
   (See "Invader Background Check.")

5. Explain that students will be playing this game to learn about exotic species—how they affect the ecosystem and how our actions affect the control or spread of exotic species.

6. Distribute the games and materials. Read the directions and rules of the game. Explain that students will be allowed to play the game for the majority of the class hour. Establish a time limit for play so that they are aware that all points will be counted at a certain time.

7. Clean up with five minutes left in class.

Second class period: Building concept maps

8. Give each student a sheet of paper and request that a concept map be developed for the term "exotic species." Ask the following questions to direct students to the relevant topics that should be included:
   Can you name some exotic species?
   What are the potential problems of taking a species out of its natural habitat?
   How did some exotic species get transported to the Great Lakes region?

9. After their individual concept maps have been collected for evaluation, create a "class" concept map for the term "exotic species" using an overhead projector or the chalkboard. Discuss how their concept maps compare to the one the class created.

Directions

1. The objective of the game is to have the most points when all players have reached the "Finish" position, at the Great Lakes.

2. Each player rolls the die, and the player with the highest number goes first.

3. Player 1 rolls the die and moves the playing piece the number of spaces shown on the die. Player 1 chooses a question card and hands it to the player on the left, who reads the question aloud. Player 1 chooses the best answer.

4. Points received are based on the player's answer and are recorded on the score sheet.

5. When landing on a space that requires the player to move ahead or backward, the player moves the game piece before picking a question card.

6. Some answers will cause a player to lose points. If the player has no points, however, he or she cannot go below zero, even if told to subtract a point.

7. Play continues in a clockwise direction until all players reach the Great Lakes region or the time limit is reached. The player with the **most points** is the winner—not the player who reaches the Great Lakes first. Finishing first may not necessarily be a good thing in this game!

Travel Tips

- Here is a great way to preserve and store your games. Glue each game board inside a file folder, and glue the game instructions on the back of the folder. For each game, make an envelope to store the cards for that game. Laminate everything: the folders, the game cards, and the envelope. Place the envelope into the file folder. Then it's ready to store.

- To help the game move more smoothly, you can
  Make sure you keep the numbers in the cooperative groups as low as possible.
  Have each player keep track of his or her own score on a sheet of paper, or assign one scorekeeper per group if you feel there will be arguments about the scores.
  Assign one student to pick up and return the game so that there is no confusion at the end.

- This activity relates to several 9th Grade Proficiency Test Learning Outcomes [noted for the state of Ohio but likely relates to other states as well]:
  Science: Trace the flow of energy and/or interrelationships of organisms in an ecosystem.
  Science: Describe how a given environmental change affects an ecosystem.
  Citizenship: Identify opportunities for involvement in civic activities.

Debriefing

Use a rubric similar to the following to evaluate the concept map and assess what the students have learned:

Exotic Species Concept Map Rubric

Demonstrates what an exotic species is	1
Mentions at least three exotic species	3
Includes one method of transport of exotic species	1
Includes one way native species are affected	1
Total:	6

Sample Concept Map Information

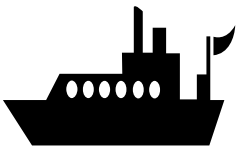
Exotic species are nonindigenous organisms that have invaded an ecosystem.
Some exotic species are purple loosestrife, goldfish, zebra mussels, sea lamprey, and starlings.
Some were transported intentionally by people, such as purple loosestrife for landscaping.
Some were transferred unintentionally, such as zebra mussels, through the ballast water of ocean freighters.
If exotics do well, they can lower the numbers of some native species in an ecosystem through intense competition for the ecosystem resources.

Extending the Visit

- Take a field trip to places where students can observe actual specimens of exotic species. If possible schedule a talk by park staff or a water-resource manager knowledgeable about the effects of the organisms and any actions that have been taken to control them.

- Add more questions to the game that are geared specifically to your curriculum.

Places to Go



Web Sites

Great Lakes Information Network (GLIN)
Main Web site: http://www.great-lakes.net
Exotic Species Web site: http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html

National Aquatic Nuisance Species Clearinghouse Web site: http://www.entryway.com/seagrant

U.S. Geological Survey, Biological Resources Division
Nonindigenous Aquatic Species Web site: http://nas.er.usgs.gov

Fact Sheets and Publications

Great Lakes Commission. *ANS (Aquatic Nuisance Species) Update* quarterly newsletter. View at the Great Lakes Commission Web site: http://www.glc.org/ans/ansupdate/ansupdate.html or e-mail: shwayder@glc.org

Multimedia

Zebra Mussel Information System CD-Rom, available from the U.S. Army Corps of Engineers:
Waterways Experiment Station
3909 Halls Ferry Rd.
Vicksburg, MS 39180
Phone: 601-634-2972

Travel Agents

Pauline LoCascio
Birmingham Elementary—Grade 1
Toledo, OH

Cathy Mielke
Byrnedale Junior High—Grades 7–8
Toledo, OH

Gwen Petrosini-McLaughlin
Byrnedale Junior High—Grade 8
Toledo, OH

Distribution and Management of Invasive Aquatic Plants in the Ross Barnett Reservoir

Adapted from M.S. Thesis Research Proposal by Michael C Cox

Introduction

Invasive aquatic plants are a big problem in Mississippi. People first brought these plants to Mississippi because they were pretty or could serve as a food source for animals. Since then, these plants have become weeds that harm the use of water sources by people, native plant species, and wildlife. These plants grow in thick patches that choke out native plants. They also harbor disease-carrying insects, decrease property values, and decrease water quality.

The Ross Barnett Reservoir is a 33,000 acre fresh water lake. This lake serves as the drinking water supply for the City of Jackson and areas in Hinds and Rankin counties. It is surrounded by over 4,600 homes. This lake provides recreation such as fishing, boating, camping, and hiking. However, invasive plant species have become a problem to the reservoir. These problems include blocking boat channels, decreasing fishing areas, and reducing access to the reservoir .

Alligator weed

Alligator weed is a mat-forming weed introduced from South America into the United States in 1897. It has rapidly spread across the southern portion of the nation. It has the ability to grow in a variety of conditions. Alligator weed is an amphibious plant because it can grow on land or in the water. Alligator weed does not use seeds to reproduce. Instead, it makes new plants by sending out shoots and roots . Alligator weed in aquatic habitats has larger hollow stems, which provide buoyancy and gives them a free-floating mat-like habit. Terrestrial-growing alligator weed has smaller diameter stems.

Many techniques and procedures are being used to control alligator weed. Herbicides are one method being used. These do not work very well because the poison cannot easily reach roots. To solve this problem, the herbicides are applied in high concentrations, many times each year. This can become very expensive. For these reasons, herbicide use as a control for alligator week is quite limited.

Using insects to control alligator weed was done in the 1960s. Scientists used a flea beetle, a moth, and a thrips from South America . Control of alligator weed from damage done by the flea beetle was observed in various locations. However, the flea beetle survives only in aquatic habitats and has no effect on terrestrial alligator weed . The flea beetle also has a more limited survival zone than alligator weed due to climate restrictions. Using both chemical and insect control methods provides the most effective and cost efficient control of alligator weed.

Water hyacinth

Water hyacinth is a mat-forming, floating water plant. It came to the United States before 1890 from South America. Water hyacinth can grow in many aquatic environments including lakes, ponds, rivers,

ditches, and backwater areas. Water hyacinth can double its population in under a month's time and is one of the fastest growing plants on earth.

Problems associated with water hyacinth include: decreasing water quality, poor mosquito control, and blocking water flow. Water hyacinth grows so fast and so thick that fishing areas are blocked, fish and native plants die, and water evaporates too quickly. Control of water hyacinth, like alligator weed, is mainly performed by chemical methods. Small and limited applications of herbicides have been used. In order to work, these herbicides need to be used frequently, which makes them expensive.

Several insects have been introduced to control water hyacinth. Some of these insects include weevils, mites, moths, and grasshoppers. Insects mainly stop water hyacinths from flowering. This limits their ability to reproduce.

Hydrilla

Hydrilla has been referred to as "the perfect aquatic weed" because of is can survive in many aquatic areas. A native of warmer areas in Asia, hydrilla was first discovered in the United States in 1958 on the west coast of Florida. Over the next 25 years, hydrilla presence was reported to be found in 13 more states in the United States.

Hydrilla populations can impose serious problems on water flow and recreational activities including: filter clogging in irrigation pumps, boating, water skiing, fishing, and swimming. Hydrilla also chokes out native aquatic plants. Hydrilla can outcompete native aquatic species for sunlight and nutrients, which lets it take over the area. A very fast growth rate of up to one inch per day allows hydrilla to reach the water surface very quickly. It then branches out and produces a dense mat of stems.

Control of hydrilla can be accomplished in several ways, depending upon how the water in which it lives is used. Using machines to pull it out of the water is a very expensive option. This method is only used if hydrilla is growing in rapidly flowing water, or if it exists close to water supply intakes. Grass carp were introduced in 1970 in Florida for a potential biological control agent of hydrilla. Although they do a good job of controlling hydrilla, grass carp cannot be used water bodies like the reservoir. That is because the carp also eat the plants that are necessary for good fishing and waterfowl habitat .

Over 40 species of insects have been found to control hydrilla. Some of these include a weevil, a leaf mining fly, and an aquatic moth. The most damage of hydrilla observed by an insect was from the larvae of aquatic moths. However, these insects can also cause damage to other plants and are effective only in the spring and summer. Hydrilla can grow year-round in Mississippi. Most herbicides do not kill hydrilla. Reasons for this include hydrilla's fast growth and multiple means of propagation.

Bacteria and Disease

Create a flow map showing the path a drop of water takes as it travels from a drain in your house to the reservoir and back to your house. Be sure to include what happens in the water treatment plant.

Write a paragraph explaining the path the water takes as it goes from being dirty to being clean enough to drink.

Bacteria and Disease

CATEGORY	4	3	2	1
FOCUS	Maintains focus on topic/subject throughout response.	May exhibit minor lapses in focus on topic/subject.	May lose or may exhibit major lapses in focus on topic/subject.	May fail to establish focus on topic/subject.
ORGANIZATION	Organizational structure establishes relationship between/among ideas/events.	Organizational structure establishes relationships between ideas/events, although minor lapses may be present.	Organizational structure establish some relationship between/among some of the ideas/events. The structure is minimally complete.	Organizational structure does not establish connection between/among ideas/events. The overall stucture is incomplete or confusing.
SUPPORT	Support information is related to and supportive of the topic/subject.	Support information has minor weaknesses in relatedness to and/or support of the topic/subject.	Support information has major weaknesses in relatedness to and/or support of the topic/subject.	An attempt has been made to add support information, but it was unrelated or confusing.
STYLE - Vocabulary	Exhibits skillful use of vocabulary that is precise and purposeful.	Exhibits reasonable use of vocabulary that is precise and purposeful.	Exhibits minimal use of vocabulary that is precise and purposeful.	Lacks use of vocabulary that is precise and purposeful.
STYLE - Sentence Fluency	Demonstrates skillful sentence fluency (varies length, good flow rhythm, and varied structure).	Demonstrates reasonable sentence fluency.	Demonstrates minimal sentence fluency.	Sentence fluency is lacking.

What happens to water and sediment and nutrients and other things as they go through the water treatment process?

Write a story or draw a 6-panel cartoon about "Betty Bacterium," "Sediment Sam," or other fictional characters and describe what happens to these characters as they go through the water treatment process.

- Be sure to include all 5 steps of the water treatment process in your story.
- Be creative – write a story or cartoon that readers will want to read.
- Be neat and colorful – cartoons capture the eye of the reader and stories capture their imagination!

You will share the stories/cartoons with your home team.

Story Writing : 6 panel cartoon or story

CATEGORY	4	3	2	1
Creativity **X 4**	The story contains many creative details and/or descriptions that contribute to the reader's enjoyment.	The story contains a few creative details and/or descriptions that contribute to the reader's enjoyment.	The story contains a few creative details and/or descriptions, but they distract from the story.	There is little evidence of creativity in the story.
Spelling and Punctuation **X 1**	There are no spelling or punctuation errors in the final draft.	There is one spelling or punctuation error in the final draft.	There are 2-3 spelling and punctuation errors in the final draft.	The final draft has more than 3 spelling and punctuation errors.
Requirements **X 2**	All of the written requirements (# of pages/panels, # of graphics, type of graphics, title, etc.) were met.	Almost all (about 90%) the written requirements were met.	Most (about 75%) of the written requirements were met, but several were not.	Many requirements were not met.
Illustrations **X 3**	Illustrations are detailed, attractive, and creative and relate to the text on the page.	Illustrations are somewhat detailed, attractive, and relate to the text on the page.	Illustrations relate to the text on the page.	Illustrations are not present OR they are not original.

Total Points: _____

Grade Conversion Chart:

# of points	Grade
40	100
39	99
38	98
37	96
36	95
35	94
34	93
33	92
32	90
31	89
30	88
29	87
28	86
27	84

# of points	Grade
26	83
25	82
24	81
23	80
22	78
21	77
20	76
19	75
18	74
17	72
16	71
15	70
14	69
13	68

# of points	Grade
12	66
11	65
10	64
9	63
8	62
7	60
6	59
5	58
4	57
3	56
2	54
1	53

Name _____ Date_____

Dig This! Erosion Investigation Proficiency Assessment

Student Pages

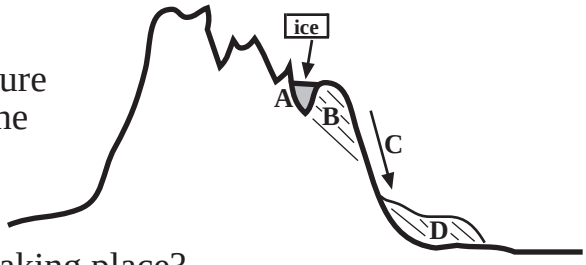
Directions: Multiple choice and extended multiple choice.

1) Geologic erosion moves at a slow and creeping pace. In a lifetime natural processes cause soil build-up that is scarcely noticeable. How does human activity, such as farming, development, and construction, affect the rate of the erosion process?

a) Human activity tends to slow the rate of erosion.
b) Human activity does not alter the rate of erosion.
c) Human activity accelerates the rate of erosion slightly.
d) Human activity accelerates the rate of erosion significantly.

Directions: Use the following diagram and informational paragraph to answer questions 2-9.

Water fills a crack on the side of a mountain. The water freezes and expands, exerting pressure on area B. Precipitation and wind also cause the weathered rock material to be transported and deposited in area D.



2-3) At which point on the picture is sedimentation taking place?

a) point A
b) point B
c) point C
d) point D

Explain _____

_____

_____

4-5) At which point on the picture is erosion taking place?

a) point A
b) point B
c) point C
d) point D

Explain _____

_____

_____

Name _____ Date_____

Dig This! Erosion Investigation
Proficiency Assessment
(continued)

Student Pages

Directions: Short Answer.
6-8) Name and describe three forces involved in the erosion of the mountain in the diagram.

Force #1 _____

_____

_____

Force #2 _____

_____

_____

Force #3 _____

_____

_____

Directions: Multiple choice.
9) What erosion force is represented by arrow C?
a) splash
b) fluvial
c) gravity
d) slope

10) Erosion processes have negative effects on
a) air quality
b) water quality
c) plant growth
d) all of the above

Dilemmas! You Make the Decision

Adapted from: http://www.rivanna-stormwater.org/litter.pdf Retrieved December 12, 2009

Assignment:

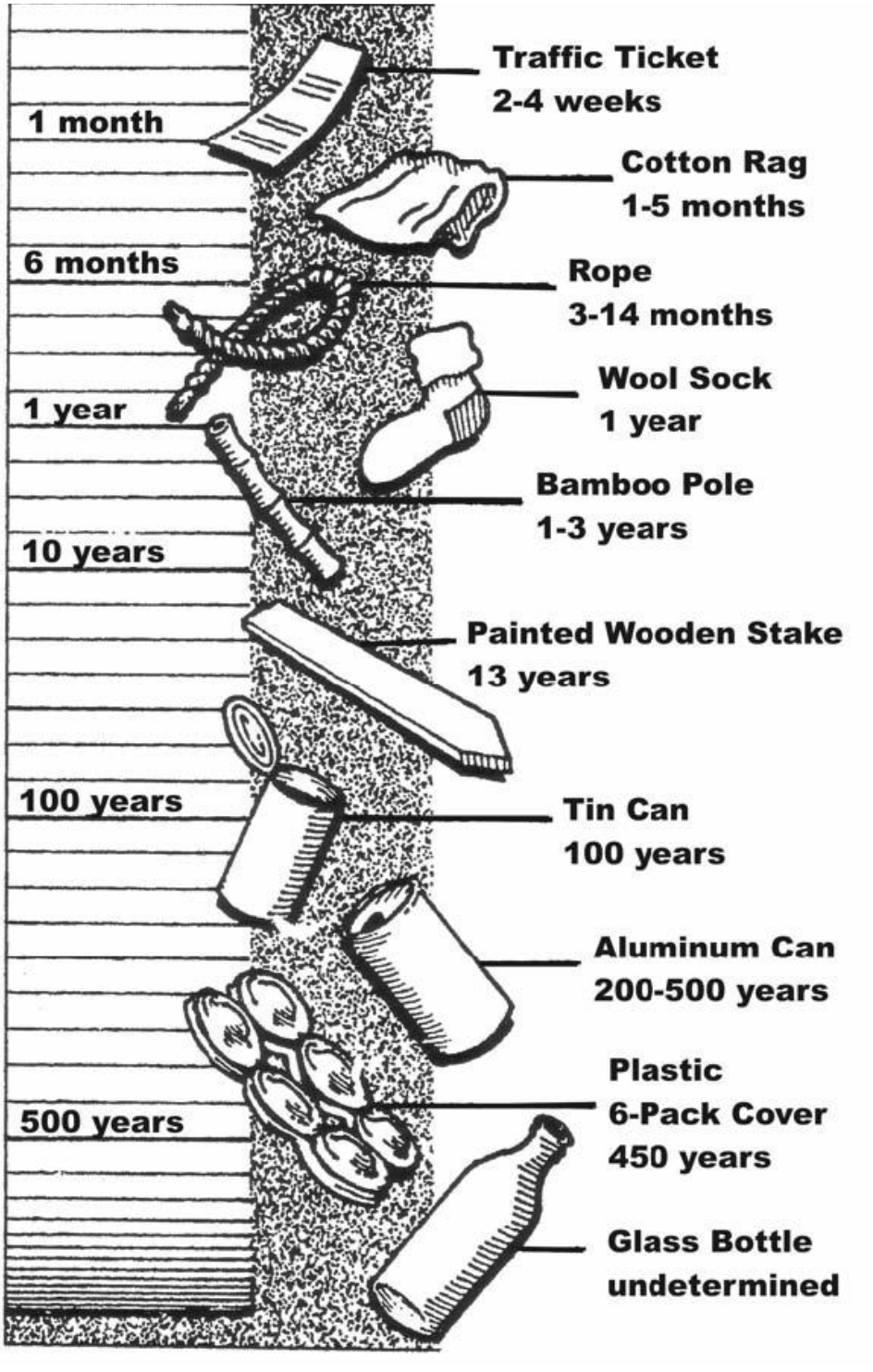
1. Select one of the Dilemmas shown below. Develop a logical solution to your Dilemma.
2. Writing assignment: Write a persuasive report that will convince the reader that you have the best solution to your dilemma.

Dilemma Cards

The city wants to build a ballpark for a local soccer team in an empty field. A baseball stadium in a nearby city has had huge problems with people not placing their trash in trash cans. Many concerned citizens are worried this new soccer field will have the same problem, and that all this trash will get blown into the wetlands. You are the town council and must make a decision regarding the building of the soccer field. Should you allow the soccer field to be developed? If you do, how would you reassure the citizens that the soccer field will not have the same litter problems?	Your school is having their 10th anniversary celebration with a picnic. The plans include lunch, cake, and giving each student a helium-filled balloon to release as the band starts playing "Happy Birthday". Air currents will carry the balloons high up into the atmosphere and over the bay. It is known that balloons will explode due to pressure and changes in temperature. Fragments of bright- colored balloons will float on the water and look like food to many animals living in the reservoir. The school ecology club wants to stop the balloon release. The final decision has been passed to you, a group of school officials. If you decide not to release the balloons, you need to suggest an alternate activity.
Your town park is right on the reservoir and has a healthy population of ducks. Many families go to the reservoir on weekends to feed the ducks and use the playground. Every Monday, park personnel spend several hours cleaning all the litter and debris left from the weekend. Due to recent budget cuts, the personnel that have been taking care of the litter are needed for other assignments. As members of the local Friends of the Reservoir organization, the reservoir officials have asked you to help find a solution to the litter problem.	As a member of the high school Athletic Association you are attending an emergency meeting to solve a litter problem. Several of the visiting sports teams have been leaving large amounts of trash in the parking lot and in the locker room. Other schools have been complaining that your teams are guilty of littering their parking lots and locker rooms, too. What type of solution can you suggest that would prevent this type of littering problem?
You are the members of the church council. There has been a school bus stop in front of your church for the area's students for many years. Recently you have been having a problem with the students cleaning out their backpacks and leaving litter all over the front yard of the church. This litter is being blown and washed into the storm drains that lead to the reservoir. You need to come up with a solution that will provide a safe bus stop for the students and, at the same time, keep your church yard clean.	You are the owners of a new boutique and do not have a lot of money to spend on advertising. You cannot afford newspaper and radio advertisements, so you have been making fliers and having them distributed on car windshields. People in the community have begun to complain that your fliers are littering parks and neighboring yards. You investigate and find that drivers are simply tossing the fliers on the ground. What can you do to advertise on a very low budget, or keep the fliers from being a litter problem?

Enduring Litter

Litter at the roadside is ugly, and dangerous to some wildlife. How long will it stay before decaying may be an ugly surprise!



Persuasive Essay : You Make the Decision!

Student Name:

_____

CATEGORY	4 – Above Standards	3 - Meets Standards	2 - Approaching Standards	1 - Below Standards
Attention Grabber x 1	The introductory paragraph has a strong hook or attention grabber that is appropriate for the audience. This could be a strong statement, a relevant quotation, statistic, or question addressed to the reader.	The introductory paragraph has a hook or attention grabber, but it is weak, rambling or inappropriate for the audience.	The author has an interesting introductory paragraph but the connection to the topic is not clear.	The introductory paragraph is not interesting AND is not relevant to the topic.
Position Statement x 2	The position statement provides a clear, strong statement of the author's position on the topic.	The position statement provides a clear statement of the author's position on the topic.	A position statement is present, but does not make the author's position clear.	There is no position statement.
Support for Position x 2	Includes 3 or more pieces of evidence (facts, statistics, examples, real-life experiences) that support the position statement. The writer anticipates the reader's concerns, biases or arguments and has provided at least 1 counter-argument.	Includes 3 or more pieces of evidence (facts, statistics, examples, real-life experiences) that support the position statement.	Includes 2 pieces of evidence (facts, statistics, examples, real-life experiences) that support the position statement.	Includes 1 or fewer pieces of evidence (facts, statistics, examples, real-life experiences).
Transitions x 1	A variety of thoughtful transitions are used. They clearly show how ideas are connected	Transitions show how ideas are connected, but there is little variety	Some transitions work well, but some connections between ideas are fuzzy.	The transitions between ideas are unclear OR nonexistent.
Closing paragraph x 2	The conclusion is strong and leaves the reader solidly understanding the writer's position. Effective restatement of the position statement begins the closing paragraph.	The conclusion is recognizable. The author's position is restated within the first two sentences of the closing paragraph.	The author's position is restated within the closing paragraph, but not near the beginning.	There is no conclusion - the paper just ends.
Grammar & Spelling x 1	Author makes no errors in grammar or spelling that distracts the reader from the content.	Author makes 1-2 errors in grammar or spelling that distract the reader from the content.	Author makes 3-4 errors in grammar or spelling that distract the reader from the content.	Author makes more than 4 errors in grammar or spelling that distracts the reader from the content.
Capitalization & Punctuation x 1	Author makes no errors in capitalization or punctuation, so the essay is exceptionally easy to read.	Author makes 1-2 errors in capitalization or punctuation, but the essay is still easy to read.	Author makes a few errors in capitalization and/or punctuation that catch the reader's attention and interrupt the flow.	Author makes several errors in capitalization and/or punctuation that catch the reader's attention and interrupt the flow.

Grade Conversion Chart:

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40	100
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8	62
7	60
6	59
5	58
4	57
3	56
2	54
1	53

You have a beautiful house on the edge of a beautiful lake. However, ugly weeds are growing along the edge of your property, along the shore of the lake. To easily remove these weeds, you spray them with poison. What happens to the water in the lake when too many people spray herbicides on the weeds on their property?

Write a story or draw a 6-panel cartoon about "Carly Catfish," "Edgar Egret," or other fictional characters and describe what happens to these characters as they live on the lake.

- Be sure to include water in your story what happens to them as they eat food from the lake and drink its water.
- Be creative – write a story or cartoon that readers will want to read.
- Be neat and colorful – cartoons capture the eye of the reader and stories capture their imagination!

You will share the stories/cartoons with your home team.

Story Writing : 6 panel cartoon or story

CATEGORY	4	3	2	1
Creativity **X 4**	The story contains many creative details and/or descriptions that contribute to the reader's enjoyment.	The story contains a few creative details and/or descriptions that contribute to the reader's enjoyment.	The story contains a few creative details and/or descriptions, but they distract from the story.	There is little evidence of creativity in the story.
Spelling and Punctuation **X 1**	There are no spelling or punctuation errors in the final draft.	There is one spelling or punctuation error in the final draft.	There are 2-3 spelling and punctuation errors in the final draft.	The final draft has more than 3 spelling and punctuation errors.
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Illustrations **X 3**	Illustrations are detailed, attractive, and creative and relate to the text on the page.	Illustrations are somewhat detailed, attractive, and relate to the text on the page.	Illustrations relate to the text on the page.	Illustrations are not present OR they are not original.

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Invasive Species assessment – teacher page

Create a food chain and a food web involving one invasive species, plankton, and a native fish demonstrating the impact of invasive species on native food chains and the food web.

For example: plankton gets eaten by minnow, which gets eaten by perch, which gets eaten by walleye, which gets eaten by northern, which gets eaten by people. However, invasive species can affect the food chain by decreasing food supplies (Zebra Mussels) and eating large amounts of native fish eggs (Ruffe).

- Students will also write a paragraph explaining the effects of invasive species on food chains/webs and how that impacts us.

Invasive Species

Create a food chain and a food web involving one invasive species, plankton, and a native fish demonstrating the impact of invasive species on native food chains and the food web.

Write a paragraph explaining the effects of invasive species on food chains/webs and how that impacts us.

Invasive Species

CATEGORY	4	3	2	1
FOCUS	Maintains focus on topic/subject throughout response.	May exhibit minor lapses in focus on topic/subject.	May lose or may exhibit major lapses in focus on topic/subject.	May fail to establish focus on topic/subject.
ORGANIZATION	Organizational structure establishes relationship between/among ideas/events.	Organizational structure establishes relationships between ideas/events, although minor lapses may be present.	Organizational structure establish some relationship between/among some of the ideas/events. The structure is minimally complete.	Organizational structure does not establish connection between/among ideas/events. The overall stucture is incomplete or confusing.
SUPPORT	Support information is related to and supportive of the topic/subject.	Support information has minor weaknesses in relatedness to and/or support of the topic/subject.	Support information has major weaknesses in relatedness to and/or support of the topic/subject.	An attempt has been made to add support information, but it was unrelated or confusing.
STYLE - Vocabulary	Exhibits skillful use of vocabulary that is precise and purposeful.	Exhibits reasonable use of vocabulary that is precise and purposeful.	Exhibits minimal use of vocabulary that is precise and purposeful.	Lacks use of vocabulary that is precise and purposeful.
STYLE - Sentence Fluency	Demonstrates skillful sentence fluency (varies length, good flow rhythm, and varied structure).	Demonstrates reasonable sentence fluency.	Demonstrates minimal sentence fluency.	Sentence fluency is lacking.

"Deadly Waters"

Adapted from Project Wild, by permission of Mississippi Museum of Natural Science

Overview: Water pollution remains a significant global problem and a major threat to the Ross Barnett Reservoir. Students will "test" the water quality of the reservoir to ensure that the water they drink will adversely affect the health of their family. Students will be given a random quantity of "pollution" from the Reservoir to identify and graph. Finally, students will attempt to identify the source(s) of their most concentrated pollutants.

Suggested Grade Range: 3 – 7

Time: 45 minutes

Materials Needed:

1. Pre-punched paper pollution tokens from 6 different colors of construction paper
2. Plastic spoon to distribute the paper tokens (pollution)
3. Pollution Information Sheet
4. Colored pencils, crayons, or markers
5. Data sheet (includes: instructions, graph area and questions)

Objectives:

1. Students will be able to create a bar graph with data from their reservoir.
2. Students will be able to identify the major sources of water pollution and the consequences for aquatic habitats.
3. Students will be able to infer possible pollution sources. (extension)

Procedures:

1. Prior to class, use a hole-punch to create approximately one teaspoonful each of punches for 6 colors of paper. Each color will represent one of the forms of water pollution shown on the pollutant sheet. Since paper colors will vary for each teacher, have students write the "representing color" in the box beside each pollutant type.
2. Review the water cycle.
3. Using projected copy of the pollutant sheet, discuss the various types of water pollution and their sources (include point and non-point sources).
4. Provide each student with a lab sheet.
5. Tell the students that they have been given the option to purchase land that is adjacent to the reservoir. However, before spending their money, they will need to "test" the water quality of the reservoir to ensure that they are not purchasing an ecological disaster that may adversely affect the health of their family.

6. Provide each student with a spoonful of "pollution" from the container holding the paper tokens with each token representing parts per million (ppm).
7. Each student will classify and quantify the pollution in the "reservoir" by separating their pollutant punch outs (ppm) by color (pollutant type) and creating a bar graph to represent the “pollution” in the reservoir. They will record their results on the lab sheet. Remind students that each has a different reservoir. Their results are not going to be the same!
8. Each student will construct a bar graph to depict the pollution in the reservoir. Pollutants on the graph should appear in the same order as on the pollution information sheet to facilitate reservoir comparisons.
9. Based on the pollution in the reservoir, each student will answer the questions on the data sheet. Tell students that any quantity over 5 units of each kind of pollutant is considered damaging to wildlife habitats.
10. Time permitting; students can share the story of their reservoir and any actions they will be taking to ensure higher water quality.

Suggested Evaluation:

1. Collect the data sheets. Check to see that the graph accurately depicts the recorded data.
2. Use the attached rubric to evaluate student responses. Questions 2 and 5 are ungraded. A rubric conversion scale is also attached to help you convert the rubric score to a percentage grade.
3. Describe what is meant by *non-point source* pollution. Give an example of how this pollution is caused and how it can be prevented.

Extending the Lesson:

1. Students can test water samples from a water body near their school or home and identify possible sources for the pollution, if any.
2. Students can take a field trip to the old-growth forest at the Francis Beidler Forest and test the water in the reservoir using kits provided at the nature center.

Resources:

1. *Project Aquatic Wild*, Western Regional environmental Education Council, Inc. 1992.

Student Data Sheet for Deadly Waters

1. Calculate the percentage that <u>each</u> pollutant is of the total pollution in your reservoir. (Remember that a percentage is the part divided by the whole.)

Type of Pollutant	Count	Percentage in the Reservoir
Bacteria		
Fertilizers		
Invasive Species		
Litter		
Pesticides, Herbicides, Fungicides		
Sediments		

2. What are the two greatest pollutants in your reservoir?

3. Write a BRIEF paragraph describing possible causes for the top two pollutants in your reservoir, the probable land use in the area, and the consequences to your aquatic habitat.

4. Write a BRIEF paragraph describing some reasonable solutions for minimizing the top two pollutants in your reservoir. Use one sentence to describe how you contribute toward this pollution or how you contribute toward the pollution solution.

Compare/contrast your reservoir with others in your class. Which pollutants would be likely to cause the most damage to wildlife and wildlife habitat? Based on this, which reservoir is the “safest”? The “least safe”?

Deadly Waters

Problem: Where does water pollution come from?

Background: Please read the Pollution Information Sheet. It briefly describes the Ross Barnett pollution problems you've been studying.

Procedure:

1. Collect your scoop of polluted water from the teacher.

2. Each particle represents one part per million (PPM). Obtain a total for each type of pollution. Record on Data Sheet.

3. On the Data Sheet, construct a bar graph showing the total for each pollutant in your reservoir.
    - Title
    - Label X axis and Y axis
    - Arrange the pollutants along the X-axis in the same order as shown on the Pollution Information Sheet.
    - Color-code the graph to match the colors of the paper punch outs.

4. Record the pollutants of your reservoir on your Data Sheet.

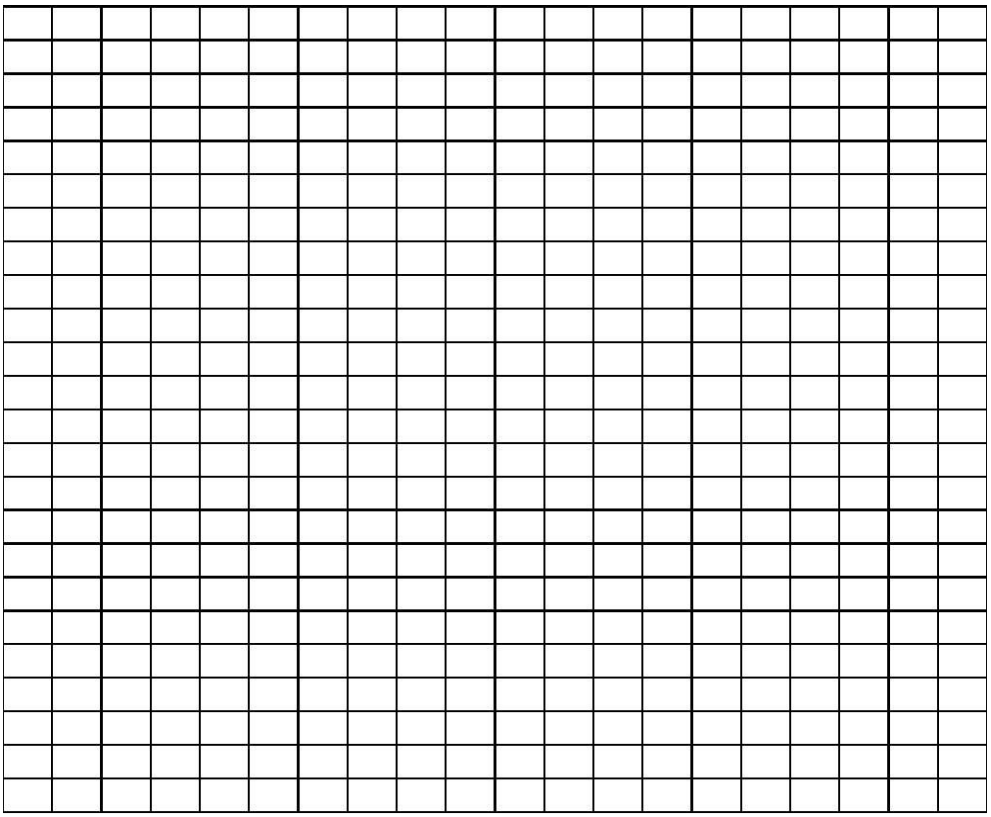
5. Calculate the percentage of the total for each of your pollutants. (Hint: A percentage is the part of the whole… part/whole.). Record.

6. On your Data Sheet, write a brief paragraph describing the possible causes for the top two pollutants of your reservoir. You may locate your imaginary reservoir anywhere in South Carolina and use the surrounding area to explain those causes.)

7. Write a brief paragraph describing some <u>reasonable</u> solutions for minimizing the top two pollutants in your reservoir. Use one sentence to describe either
    - How you or your family contributes to this type of pollution
    - How you can contribute to the solution.

8. Classify these ten pollutants as either point or non-point on the Data Sheet.

Name: _____



POLLUTANT INFORMATION SHEET

SEDIMENTS

Particles of soils, sand, silt, clay, and minerals wash from land and paved areas into creeks and tributaries. In large unnatural quantities, these natural materials can be considered a pollutant. Construction projects often contribute large amounts of sediment. Certain lumbering practices affect sediments in runoff. Sediments may fill stream channels and harbors that later require dredging. Sediments suffocate fish and shellfish populations by covering fish nests and clogging the gills of bottom fish and shellfish.

BACTERIA

Human wastes that are not properly treated at a waste treatment plant and then released to water 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. The main source of this problem is sewage getting into the water. People can come into contact with these microorganisms by drinking the polluted water or through swimming, fishing, or eating shellfish in polluted waters. Often unexpected flooding of barnyards or stock pens can suddenly increase the toxic effects of animal waste in water. Animal waste can also act as a fertilizer and create damage by increasing nutrients (see fertilizers).

Domestic sewage treatment plants, food processing plants, paper mill plants, and leather tanning factories release organic wastes that bacteria consume. If too much waste is released, the bacterial populations increase and use up the oxygen in the water. Fish die if too much oxygen is consumed by decomposing organic matter.

FERTILIZERS

The major source of pollution from agriculture comes from surplus fertilizers in the runoff. Fertilizers contain nitrogen and phosphorous that can cause large amounts of algae to grow. The large algae blooms cover the water's surface. The algae die after they have used up all of the nutrients. Once dead, they sink to the bottom where bacteria feed on them. The bacterial populations increase and use up most of the oxygen in the water. Once the free oxygen is gone, many aquatic animals die. This process is called eutrophication.

PESTICIDES, HERBICIDES, FUNGICIDES

Agricultural chemicals designed to kill or limit the growth of life forms are a common form of pollution. This pollution results from attempts to limit the negative aspects of undesirable species on agricultural crop production. Irrigation, groundwater flow, and natural runoff bring these toxic substances to rivers, streams, lakes, and oceans.

LITTER

The only source of litter pollution is from human activity. Litter is unsightly and makes an area look "trashy". Litter also has a harmful effect on people and animals. Littered containers can trap water, providing breeding grounds for disease-carrying mosquitoes. Plastic rings from six-packs can get caught around bird and turtle necks, preventing them from eating. Food-borne diseases can thrive in litter and get transferred to the people using the recreation area. Also, once people see litter in an area, the often think that they can litter the same area, so the once pleasant recreation area becomes a trash dump.

INVASIVE SPECIES

Sometimes plants and animals are introduced to an area where they do not have natural predators. Without animals around to eat them, or natural elements to kill them, they grow and spread out into the entire area. They use up the nutrients needed for the native plants and animals to grow and survive. Native plants and animals cannot compete for food so they begin to die. Soon, an area that once had dozens of different species of plants and animals only has a few. Its *biodiversity* has decreased. This might mean that fishermen can no longer catch bass because invasive plants have choked out the bass breeding areas. Or, migratory birds might no longer nest in the Reservoir because the plants they use for food have died out. Or, the catfish all die because the invasive all the available oxygen in the reservoir is gone.

Graphing : Deadly Waters

Student Name: _____

CATEGORY	4	3	2	1
Graph	Title is creative and clearly relates to the problem being graphed. It is printed at the top of the graph. The X and Y axis have clear, neat labels that describe the units used for the variables.	Title somewhat relates to the problem being graphed and is printed at the top of the graph. The X and Y axis have labels that somewhat describe the units used for the variables.	A title is present at the top of the graph. The X and Y axis has a label.	A title is not present. The X and/or Y axis is not labeled.

QUESTION THREE

Focus on Topic (Content)	There is one clear, well-focused topic. Main idea stands out and is supported by detailed information.	Main idea is clear but the supporting information is general.	Main idea is somewhat clear but there is a need for more supporting information.	The main idea is not clear. There is a seemingly random collection of information.
Support for Topic (Content)	Relevant, telling, quality details give the reader important information that goes beyond the obvious or predictable.	Supporting details and information are relevant, but one key issue or portion of the storyline is unsupported.	Supporting details and information are relevant, but several key issues or portions of the storyline are unsupported.	Supporting details and information are typically unclear or not related to the topic.
Accuracy of Facts (Content)	All supportive facts are reported accurately.	Almost all supportive facts are reported accurately.	Most supportive facts are reported accurately.	NO facts are reported OR most are inaccurately reported.

QUESTION FOUR

Focus on Topic (Content)	There is one clear, well-focused topic. Main idea stands out and is supported by detailed information.	Main idea is clear but the supporting information is general.	Main idea is somewhat clear but there is a need for more supporting information.	The main idea is not clear. There is a seemingly random collection of information.
Support for Topic (Content)	Relevant, telling, quality details give the reader important information that goes beyond the obvious or predictable.	Supporting details and information are relevant, but one key issue or portion of the storyline is unsupported.	Supporting details and information are relevant, but several key issues or portions of the storyline are unsupported.	Supporting details and information are typically unclear or not related to the topic.
Accuracy of Facts (Content)	All supportive facts are reported accurately.	Almost all supportive facts are reported accurately.	Most supportive facts are reported accurately.	NO facts are reported OR most are inaccurately reported.

Date Created: **Dec 01, 2009 02:28 am (UTC)**

Name: _____

Water Quality Test

Matching: Write the letter of the correct vocabulary word in the space provided.

_____ 1. Water that lies under the ground in natural reservoirs such as springs and wells

_____ 2. Any substance that can make air, land, or water dirty or impure

_____ 3. A poison that is used to kill pests such as insects, rodents, and weeds

_____ 4. Matter falling to the bottom of a body of liquid

_____ 5. Science that studies the ways that organisms and environment are interrelated

_____ 6. Microscopic vegetable organism

_____ 7. Nourishing

_____ 8. Science or occupation of farming

_____ 9. An enormous pit where trash is buried under shallow layers of dirt

_____ 10. Needless consumption of expenditures

a) groundwater

b) ecology

c) pesticide

d) waste

e) bacteria

f) pollutant

g) agriculture

h) sediment

i) landfill

j) nutrients

Short Answer: Write the correct word or phrase in the space provided.

11. Name one way agriculture can cause Nonpoint Source pollution problems

12. Overusing _____to make your grass grow green can cause pollution to the water in the Ross Barnett Reservoir.

13. Why is “Nonpoint Source Pollution” called Nonpoint Source Pollution?

14. Name one way to prevent soil erosion.

15. _____ or dispose of used oil, antifreeze, paints or other household chemicals properly.

16. Pollutants reaching our waters get into the food chain and harm _____ life.

17. Aquatic means _____

18. Name one type of aquatic animal.

19. Water moves from clouds to land and back to the ocean in a never-ending cycle. Name this cycle.

For questions 20 – 24, circle the correct term.

20. Muddy water, excess plant growth, dead fish, stained water or soil, oily or foul-smelling water can indicate that a stream is (polluted not polluted).

21. Recycling a 3-foot stack of newspapers will save (one two three) trees?

22. The average person per day uses (22,000 gallons 10 gallons 2,000 gallons) of water?

23. True or False Litter can be life-threatening to wildlife.

24. True or False When someone dumps dirty oil on the ground, it can seep into ground water.

25. Water covers how much of the earth? ¾ ½ ¼