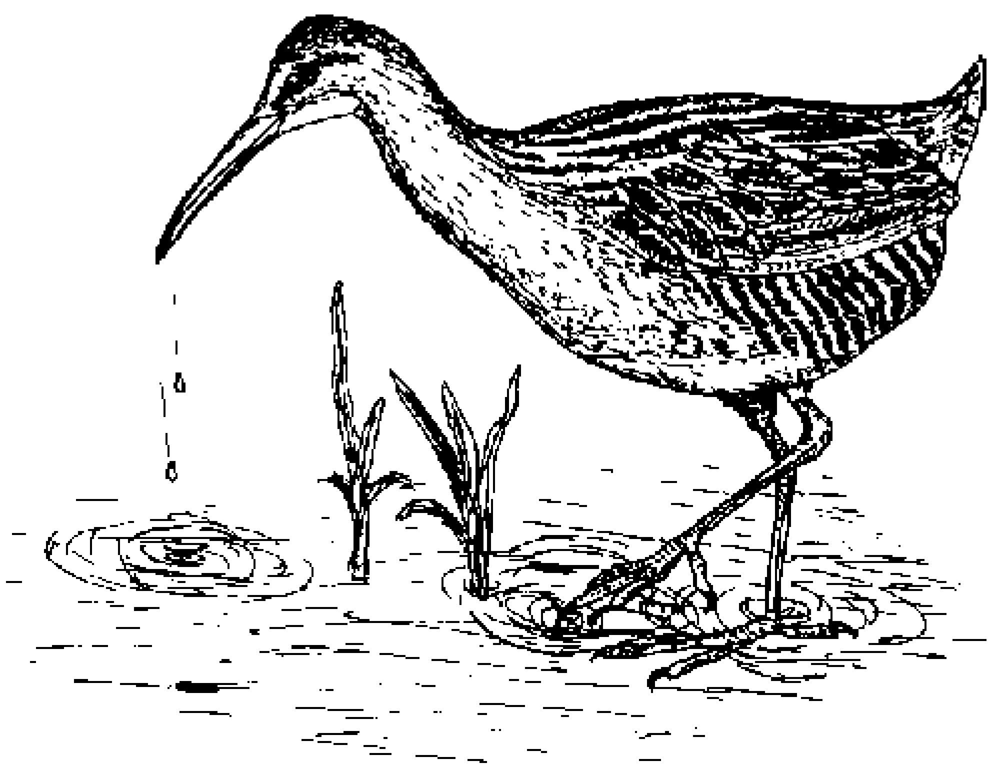
Water Logged



National Mississippi River Museum & Aquarium

Conservation Education Curriculum

Target Grades:	6 grade - adult
Key Words:	pH, dissolved oxygen
Subject Areas:	science, math
Duration:	45 minutes Time can be extended by request

Title: ***Water Logged***

Program presented on site at the museum & aquarium.

Summary:

Your class will soon be taking a field trip to study the watershed along the Mississippi River, wetland or stream. On your field trip you will be measuring certain chemical aspects of the water to determine if the water is polluted or pure. These are:

1. the oxygen dissolved in the water
2. the pH of the water

3. the temperature of the water

Objectives:

Students will perform basic water analysis for dissolved oxygen, pH, and temperature, to determine life sustaining needs that support various forms of life. Students will add information into, and review past entries on, the Mississippi River watershed database for water quality from various cities, refuge wetland areas, the museum wetland, and various stream sites draining into the Mississippi River.

Group Size: 5 - 30 students (small groups of 5 or 6 students per test kit)

Background for Educators:

The functions of wetlands make them valuable to people. Wetlands help keep our Water clean, help prevent erosion, protect our properties from flooding, and more. The ability of different types of wetlands to perform these functions depends in part upon the living components of the community -- the plants that grow there, the animals that live there and interact with and affect the plants, water, land and each other. What lives and grows in a wetland depends upon the physical features of the wetland:

- slope of the land forms the wetland and determines how wet it is.
- water -- Where does it come from? Is it fresh or full of silt? Is it there all the time or only seasonally? Does it transport nutrients and pollutants? Is it clean?
- How does weather affect the wetland?

It is important to identify these features of the wetland, so that you are aware of the resources available there and the ability of the wetland to perform its valuable functions. In studying these features, we can also become more aware of our own effect on the environment.

Your class will soon be taking a field trip to study the watershed of the Mississippi River, museum wetland, lake, pond or stream. On this field trip they will be measuring certain chemical aspects of the water to determine if the water can support life or not (is polluted or pure). These are: 1. the oxygen dissolved in the water, 2. the pH of the water, and 3. the temperature of the water.

Dissolved Oxygen

1. As you know, oxygen is important to almost all living things. Without oxygen living things would suffocate and die. Animals in the water remove oxygen from the water. This oxygen is called DISSOLVED OXYGEN (DO), and can be measured with a test kit.

It is usually measured in parts per million (ppm). One part per million (ppm) can be compared to having one green marble in a box of 999,999 red marbles. Most water animals require at least 5 ppm of oxygen in the water for growth and well being. The water itself can only contain about 20 ppm before it starts to bubble off just as the gas escapes from a bottle of warm soda. This means that you can expect the DO measurements in the water you will be studying to be between 5 and 20 ppm. Dissolved oxygen (DO) is vital to the health of aquatic habitats, since plants and animals need oxygen to survive and for metabolism. A low amount of oxygen in the water is a sign that the habitat is stressed.

How does oxygen get into the water? Oxygen is mixed in from the air above, with the help of rain, wind, waves, and currents. Faster moving water contains more DO because it has more contact with the air than still water. Underwater plants and algae also contribute oxygen that is given off during the process of *photosynthesis* (green plants use the sun's energy to make their own food).

DO is affected by weather, temperature and salinity. Cold, fresh water holds more oxygen than warm or salty water. Since trout need a high level of oxygen to survive, they live in streams with fast-moving, cold water. *Anoxic* conditions (less than 2 ppm DO) result from dry, hot weather, when the water is warmed and evaporation increases. If these conditions are severe, large "fish kills" or die offs may result.

Anoxia is also caused by runoff of fertilizer and manure from lawns and farms. These excess nutrients, nitrogen and phosphorous, encourage the growth of too much algae, which uses up oxygen quickly. When the algae, other plants and animals die and sink to the bottom, they are decayed by bacteria. This process also uses up a great deal of oxygen. When ice freezes over the water in winter, this loss of oxygen is especially severe.

It is important to monitor DO, since it is an indicator of poor water quality.

pH measurement

2. The percentage of hydrogen ions (H+) in a solution is called the pH. The pH is a measurement of the acidity or basicity (alkalinity) of a liquid. pH is measured on a scale of 1-14. A paper or a liquid that changes color when placed in liquids of different pH is usually used to measure pH.

A solution is more acidic when it contains more hydrogen ions. The level of acidity of the water in wetlands is important to the plant and animal life there. Most animals are adapted to living in *neutral* (neither acidic nor basic) conditions. Changes in pH endanger the lives of young animals in particular. Peat bogs are naturally more acidic than other wetlands -- the plants and animals there are adapted to this acidity.

People's actions can change the level of acidity in wetlands. *Acid rain is* a result of air pollution from automobiles and coal-burning utilities and factories. Sulfur dioxide (S02) and nitrogen oxides are emitted from tailpipes and smokestacks. When these compounds

combine with water in the atmosphere, they form sulfuric and nitric acids, then fall to the earth as acid rain, snow, hail, and fog. This precipitation mixes with water already on the earth, in creeks, rivers, ponds, and wetlands. The acidity of the water in wetlands can also be changed by other pollutants brought in by runoff from the land.

The following activity would be good to do with your class before the trip into the field.

Provide the students with 4 bottles of different kinds of liquids:

Bottle

#1: vinegar

#2: water

#3: sodium bicarbonate (baking soda)

#4: household ammonia

Divide the students into teams of four. Each member of the team will receive one piece of the pH testing paper. Each member of the group will place his or her paper into a different one of the liquids that have been provided. Have the students check the color of the paper on the color chart provided, to determine the pH of the liquid tested. Have the students record the name of the liquid below its pH number on a copy of the chart below. Also have them record the findings of the other members of their team.

ACID						NEUTRAL					BASE (Alkaline)		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	lemon juice		vinegar		rain	distilled water		baking soda				ammonia	

Which of the four liquids are acidic? basic? neutral? What pH do you think most aquatic animals need to live? Why do you think so?

Most aquatic animals are very sensitive to changes in pH. Some animals will die at the slightest change in pH. Other animals will survive large changes in pH. Changes in pH can be caused by pollution of the water from factories, farm runoff, and sewage.

Temperature

3. The animals that live in water are affected by the temperature of the water. Some water animals need cold water and others need warm water.

Most creatures living in water are cold-blooded, so their body temperatures and metabolism and growth rates are determined (and limited) by the surrounding water temperature. Most can tolerate only a certain range of temperatures.

Dissolved oxygen (DO), necessary for the survival of aquatic life, is also dependent upon temperature. Cold water can hold more DO than warm water. Warm water, therefore, supports less life than cold.

Water around power plants is polluted by increased temperatures (called *thermal pollution).* Water used to cool the plant's reactors picks up the heat from the reactors, then it is released into waterways. Most aquatic life cannot tolerate such an increase in temperature.

After reviewing the above information with your class you will have looked at many of the factors important to the study of conservation. They are now ready to look at these factors in the field.

For younger students omit the more difficult parts of the activities, *e.g.*, skip dissolved oxygen.

Materials Needed:

- *Hach* or *CHEMets* water test kits for dissolved oxygen, pH, and temperature (and possibly nitrates and phosphates)
- charts of the dissolved oxygen (D.O.), pH, and temperature requirements for aquatic life
- clip boards and pencils
- water from a hydrant or sink faucet

- map of the watershed where tests are to be made

Procedure:

Review the following charts of aquatic life requirements for dissolved oxygen, pH, and temperature. Discuss these needs with the class and each student should make predictions as to the estimated test result. Follow the steps for performing the water tests. If there are several groups making the tests, one group should be a control group and take their test from a hydrant or a sink faucet. The rest of the groups should test the water from a stream, prairie pothole, prairie marsh, or pond.

Use the water test kits to determine the actual dissolved oxygen count, pH, and water temperature of the pond or stream. Record your findings as well as your predictions on the appropriate space located below each chart. Make sure everyone in your team gets to do some part of the testing.

INSTRUCTIONS:

A. Dissolved Oxygen (DO) (using the CHEMetrics test kits)

1. Fill the sample cup to 25 ML mark with the water sample.

2. Place the Chemet ampoule in the sample cup and snap off the small tip by pressing it against the side of the cup. The ampoule will fill with water.

3. Remove the ampoule from the cup and mix the ampoule by inverting several times, allowing the bubble to travel from end to end each time. Wait for **2 minutes** for full color to develop.

4. Hold the comparator ampoules in a flat or horizontal position to allow the light to enter the sides of the ampoules. Place the sample ampoule between the comparison ampoules and estimate the closest reading of Dissolved Oxygen in parts per million (PPM).

Dissolved Oxygen (DO) (using the Hach test kits)

1. Fill the glass-stoppered DO bottle (A) with the water to be tested. Be certain there are no air bubbles in the bottle.

2. Use a clippers or have your teacher open the chemical pillows with a sharp knife. Add the contents of <u>one pillow</u> of DO #1 (B) and DO #2 (C). Stopper the bottle carefully so

that air is not trapped in the bottle. Grip the bottle, stopper firmly, and shake vigorously to mix. A flocculent precipitate will be formed. If oxygen is present the precipitate will be brownish orange in color. Allow the bottle to stand and then shake again.

3. Remove the stopper and add the contents of one pillow of DO #3 reagent (D). Carefully re-stopper and shake to mix. The flocculent will dissolve and a yellow color will develop if oxygen is present. This is the prepared sample you will use for testing.

4. Fill the plastic measuring tube (E) level full with prepared sample and pour it into the mixing bottle (F).

5. Add the PAO titrate (G) one drop at a time, counting each drop, until the sample changes from yellow to clear. THE DROPPER MUST BE HELD IN A VERTICAL MANNER, WITHOUT TOUCHING THE SIDES OF THE SAMPLE BOTTLE. BE SURE TO SWIRL AFTER EACH DROP IS ADDED.

6. Record the number of drops taken to turn the sample clear. The number of drops is equal to the number of parts per million (ppm) of oxygen.

Dissolved Oxygen Requirements for Native Fish and Other Aquatic Life

	Dissolved Oxygen in parts per million (ppm)
Warm-Water Organisms (including fish such as bass, crappie, and sunfish; above 68° F)	
For Life and Growth	5 ppm and above
Cold Water Organisms (including fish such as trout; below water temperature of 68° F)	
For Life and Growth	6 ppm and above
For Spawning (reproduction)	7 ppm and above

DISSOLVED OXYGEN (ppm)

I predict the dissolved oxygen count will be:________________________.

Actual dissolved oxygen tests_____________________.

Replace the parts of the DO test kit making sure the testing containers are rinsed. PLACE ALL GLASS OR PLASTIC TRASH IN GARBAGE BAG OR CAN.

B. pH (using HACH test strips)

1. Dip a test strip into the water and remove immediately.
2. Hold the strip level for 15 seconds, but do not shake excess water from strip.
3. Compare the pH test pad to the color chart above. Estimate the results if they are between two color blocks.

pH (using HACH test cubes)

Fill the test cube from the pH test kit with fresh water from the pond or stream. Fill only to the mark. Add eight drops of the phenol red indicator. Cap the cube and invert until mixed. Match the color with the color guide on the cube and record this number. Rinse the cube when done.

pH Ranges That Support Aquatic Life

	Most Acid — Neutral — Most Alkaline
	1 2 3 4 5 6 7 8 9 10 11 12 13 14
bacteria	1.0 ______ 13.0
plants (algae, rooted on bottom)	6.5 ______ 12.0
carp, suckers, catfish, some insects	6.0 ______ 9.0
bass, crappie, sunfish	6.5 ______ 8.5

snails, clams, mussels	7.0 9.0
largest variety of animals (trout, mayfly, stonefly, caddis fly)	6.5 7.5

pH

My prediction: ________________ Actual test:____________________.

C. Water Temperature

At the pond or stream, test and record the temperature of the water in several places. Do not hold the bulb end of the thermometer in your hand before taking the water temperature. To get a more accurate reading, keep the thermometer in place in the water for a minute or more and read it while it is still under water. Record this number. While you record the water temperature, leave a thermometer out to take the air temperature. How does this compare to the water temperature?

Temperature Ranges (approximate) Required for Growth of Certain Organisms

Temperature		Examples of Life
Greater than 68° F	(warm water)	Much plant life, many fish diseases, bass, crappie, sunfish, carp, catfish, caddisfly.
	upper range (55° - 68° F)	Some plant life, some fish diseases, salmon, trout, stonefly, mayfly, caddisfly, water beetles, water striders

Less than 68° F (cold water)	____________________	
	lower range (less than 55° F)	Trout, caddisfly, stonefly, mayfly

WATER TEMPERATURE

My prediction: ________________ Actual test: ____________________.

Evaluation:

By using the following activity after the field trip, or both before and after the field trip, the students grasp of how water chemistry effects aquatic life can be evaluated. This exercise can also lead to good discussion.

Name five things done in this watershed that might affect the quality of the water:

1.____

2.____

3.____

4.____

5.____

The following exercise could also be done as a follow-up assignment that would help evaluate the knowledge about water chemistry requirements and testing gained by the student.

Work in teams of 2 or 3

You are a team of scientists studying wetlands and water resources along the Mississippi River. You have been collecting evidence about the quality of the water and how the plants and animals, as well as nearby farmland affects the water quality along the Mississippi River.

Write a report based on the evidence you collected, for the U.S. Fish and Wildlife Service or the City of Dubuque. Be specific and use some of the data you collected when testing the water. Include in this report some of the problems you found existing in this watershed. Is the water pure, polluted, or in between? Include recommendations on how people could better manage the land and the watersheds along the Mississippi.

Additional resources:

- *Save Our Streams*, Izaak Walton League
- *You And Your Environment,* Jasper County Conservation Board
- *Project LS (Land Stewardship), (The* wetlands), by Mary and Jay Norton, 1992.
- *Iowa Wild,* Aquatic Wild Support materials for Iowa
- *AQUATIC, Project Wild,*

Extensions:

Related programs available at the National Mississippi River Museum & Aquarium:

Wet and Wild Along the Mississippi River

Water We Doing to Our Environment

Mississippi River Life

- pond netting to determine the diversity of species of animals living in the water, for a comparison to the water testing results
- log this information into the *Iowater* or *National Mississippi River Museum & Aquarium* computer data base

- Older students may carry the activities further: monitor these parameters of the wetland for several days, graph results and correlate with weather conditions and any noticeable polluting events *e.g.,* a rainstorm washes sediment in from a nearby construction site or parking lots.

- test for nitrates and phosphates

- have the students write a mock report to the U.S. Fish and Wildlife Service, about the water quality (see evaluation section or pre and post activities).

Credits:

Developed in 2003 by Mark D. Wagner, Iowa State University Extension, Director of Education for the National Mississippi River Museum & Aquarium; Dubuque, Iowa

***YOU AND YOUR ENVIRONMENT**,* Jasper County Conservation Board, Newton, Iowa

WOW! The Wonders of Wetlands, Environmental Concern Inc., Michaels, Maryland

Investigating Your Environment series, U.S. Forest Service, Portland, Oregon

Student Record Sheet for Water Testing

Name five things done in the Mississippi River watershed that might affect the quality of the water:

1.____

2.____

3.____

4.____

5.____

Dissolved Oxygen Requirements for Native Fish and Other Aquatic Life

Dissolved Oxygen in parts per million (ppm)

Warm-Water Organisms (including fish such as bass, crappie, and sunfish; above 68° F)

For Life and Growth -------------------------------------- 5 ppm and above

Cold Water Organisms (including fish such as trout; below water temperature of 68° F)

For Life and Growth -------------------------------------- 6 ppm and above

For Spawning (reproduction) --------------------------- 7 ppm and above

DISSOLVED OXYGEN (ppm)

I predict the dissolved oxygen count will be:________________________.

Actual dissolved oxygen tests____________________.

pH Ranges That Support Aquatic Life

	Most Acid	Neutral	Most Alkaline
	1 2 3 4 5 6 7 8 9 10 11 12 13 14		
bacteria	1.0 ——— 13.0		
plants (algae, rooted on bottom)	6.5 ——— 12.0		
carp, suckers, catfish, some insects	6.0 ——— 9.0		
bass, crappie, sunfish	6.5 ——— 8.5		
snails, clams, mussels	7.0 ——— 9.0		
largest variety of animals (trout, mayfly, stonefly, caddis fly)	6.5 ——— 7.5		

pH

My prediction: _________________ Actual test:____________________.

Temperature Ranges (approximate) Required for Growth of Certain Organisms

Temperature		Examples of Life
Greater than 68° F	(warm water)	Much plant life, many fish diseases, bass, crappie, sunfish, carp, catfish, caddisfly.
Less than 68° F (cold water)	upper range (55° - 68° F)	Some plant life, some fish diseases, salmon, trout, stonefly, mayfly, caddisfly, water beetles, water striders
	lower range (less than 55° F)	Trout, caddisfly, stonefly, mayfly

WATER TEMPERATURE

My prediction: ________________ Actual test: ____________________.