MONITORING THE MISS

OBJECTIVES

Students will be able to:

1. define the three categories of water quality variables
2. identify some of the major contaminants in the Mississippi River System
3. describe the source and potential environmental impacts of different variables affecting water quality
4. identify possible ways to reduce contamination of the Mississippi River

METHODS

Students prepare and present verbal and poster presentations on different water quality variables commonly monitored by Mississippi River managers. Students simulate taking a water quality sample of the Mississippi River and "analyze" the sample for variables typically measured by river managers and graph the concentrations of different water quality variables. Students make recommendations about actions that could be taken to improve Mississippi River water quality.

Grade Level: 6 - 12

Subjects: Math, Social Studies, Science

Duration: 2, 45 minute sessions

Group Size: Individual, small group and large group

Setting: Classroom

Key Vocabulary: pollution, monitoring, water quality

Materials:

- *11 different colors of paper or 3 mm beads*
- *Set of water quality variable fact sheets*
- *handout graph (1/student)*
- *copies of table 2 (1/student)*
- *paper punch*
- *Water Quality Variables Sheet (1/Student)*
- *9 pieces of tag/poster board*
- *9, 8.5x11 in. sheets of paper*
- *10 copies of rubric*
- *Possible Solutions handout/student*
- *½ tablespoon for paper punches, or 1 tablespoon for beads*

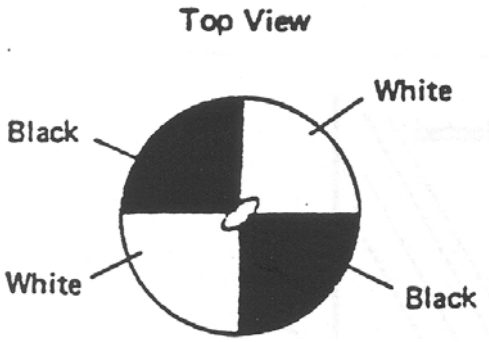
BACKGROUND

Water quality monitoring is not just looking for pollution or contamination in the water. Water quality monitoring also focuses on monitoring aspects of water that determine the health of the River's water and consequently that of plants and animals that call the Mississippi River home.

Water quality is not simply determined by looking at how "clean" the water is; it is a combination of variables that cumulatively describe the properties of the waterbody being sampled. **These variables can be placed into one of three categories: physical, chemical or biological.**

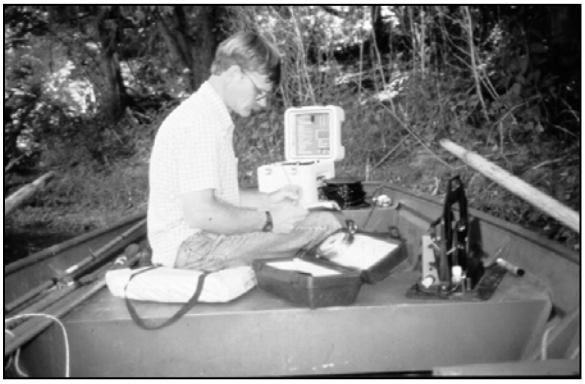
Physical variables *can be thought of as properties of water we can "see"*. These variables of water quality include color, clarity and temperature (you can see three temperatures of water – ice, liquid and steam – however, thermometers are used when taking water samples). Temperature, and it's variability throughout the year, is one factor that affects the presence or absence of some aquatic organisms. For example, trout prefer waters where the temperature does not

exceed 68° Fahrenheit. Trout will become stressed and eventually die if the water temperature exceeds 68°F. Since water temperatures for much of the Mississippi River exceed this threshold, trout are not found in the Mississippi River. Color literally refers to the color of the water. Water color in the northern reaches of the Mississippi River and near tributary mouths such as the Black River, in Wisconsin, may have a "stained" or brownish color due to tannic acid that has entered the water as it passed through bogs and forests. Further south (St. Louis, Missouri) the color of the water may be called "muddy" due to the high suspended sediment load. Clarity is commonly measured using a secchi disk. A secchi disk has alternating black and white patterns broken into 4 quarters. The disk is attached to a rope or pole marked in increments to measure the distance below the water surface an observer can see the disk. Water clarity is affected by algae, suspended sediment and dissolved solids. The clarity of water roughly correlates to the depth plants can grow in a body of water. The greater the clarity, the greater the water depth aquatic vegetation may be found growing.



A secchi disk is used to measure the clarity of water. It is a round disk with alternating patterns of white and black.

Chemical variables *are elements and compounds that are dissolved or suspended in the water column*. Chemical variables are responsible for water's color, taste, toxicity and the types of aquatic life it can support. Chemicals may be naturally occurring as with iron, heavy metals, calcium, oxygen, nitrogen, and phosphorus. Chemical variables can also be elevated due to human actions. Human actions that introduce or elevate the levels of naturally occurring chemicals in the water are one form of pollution or contamination. Some chemical variables of water quality are unnatural and cause pollution or contamination of aquatic environments. Pesticides, fertilizers, and PCBs are three examples of human manufactured chemical compounds that can affect water quality.


Water quality monitoring on the Mississippi River.

Dissolved oxygen (DO) is a vital component of water quality necessary for the existence of most aquatic organisms. Dissolved oxygen is what aquatic organisms "breathe" using their gills. The concentration of DO in the Mississippi River has a definite seasonal variation that is strongly influenced by temperature. As temperatures increases, the amount of dissolved oxygen water can "hold" decreases. The dissolved oxygen

concentrations on the Upper Mississippi for the years 1977-1987 ranged from 5 mg/l in the summer to 12-15 mg/l in the spring. The lowest values of dissolved oxygen typically occur in the summer when temperatures were highest. Plants can also greatly affect the concentrations of dissolved oxygen. During the summer, plants can cause wide swings in the daily DO concentration of backwaters. During the day, plants input oxygen into the water through photosynthesis causing an increase in DO. After the sun sets, plants begin to respire and if there are a lot of plants in the area, their respiration can cause very low levels of DO. While plants produce dissolved oxygen as a byproduct of photosynthesis, DO is considered a chemical variable of water because it is dissolved in the water and can enter the water from the atmosphere.

Biological variables *of water quality are best thought of as being related to a living organism or produced by a living organism*. Bacteria, algae, animal waste/manure and sewage are examples of biological properties that can affect water safety and aesthetic appeal. Fecal coliform bacteria are routinely measured due to its effect on humans. It is often associated with runoff from feedlots or inadequate sewage treatment. Algae is often correlated with nitrogen levels in the water. Certain types of blue-green algae may even release toxins deadly to fish when it occurs in extremely high concentrations. This may be brought on by high nitrogen levels, high water temperatures or low water flows associated with drought. Algae levels are measured by analyzing the level of Chlorophyll *a* in the water. High levels of these biological variables are considered pollutants that affect the quality of water.

MATERIALS

- 11 different colors of construction paper (2 sheets each)
- Optional- 11 different colors of 3 mm beads in the quantity listed below. Designate a different color for each variable)
- Monitoring the Miss graph (1 for each student or group)
- Copy of table 2 (1 for each student)
- 9 pieces of poster paper or tag board
- 9, 8.5x11 sheets of white paper
- pencil, markers or crayons
- paper punch
- Rubric (1 for each group)
- Water quality variable fact cards from pages WQ 15-19 (1 for each variable)
- Possible Solutions handout (one for each student)
- 1/2 tablespoon measure (for paper punch tokens). 1 tablespoon for 3 mm beads

PROCEDURES

1. Prior to beginning the activity, refer to Table 1 and assign each water quality variable a color. The number of tokens to be used for each variable is indicated in Table 1. These numbers of tokens will result in a representation of water quality

values that might be found in the Mississippi River. Stir paper tokens or beads in a container so the colors are thoroughly mixed.

2. Make a copy of the Water Quality Variable fact sheets and cut into cards, one card per variable.

Table 1. Number of tokens to represent each water quality variable.

WATER QUALITY VARIABLE	VARIABLE TYPE	WATER QUALITY STANDARD NOT MET WITH:	NUMBER OF TOKENS	COLOR
Total Suspended Solids	*Chemical*	>5 Tokens	100	
Nitrogen	*Chemical*	>3 Tokens	50	
Fecal Coliform	*Biological*	>2 Tokens	10	
Chlorophyll *a*	*Biological*	>2 Tokens	5	
Heavy Metals	*Chemical*	>5 Tokens	25	
PCBs	*Chemical*	>4 Tokens	25	
Phosphorus	*Chemical*	>4 Tokens	25	
Temperature	*Physical*	>1 Token	5	
Pesticides	*Chemical*	>5 Tokens	50	
Dissolved Oxygen	*Chemical*	<5 Tokens	200	
Water	*Not Applicable*	Not Applicable	200	

3. Explain what a water quality variable is and why river managers do water quality monitoring. Present the 3 categories water quality variables can be grouped into: physical, chemical and biological. Describe each of the categories.

> ***Physical*** *variables can be thought of as properties of water we can "see".*
> ***Chemical*** *variables are elements and compounds that are dissolved or suspended in the water column.*
> ***Biological*** *variables of water quality are best thought of as being related to a living organism or produced by a living organism.*

4. Tell the class that they will be learning about different water quality variables monitored in the Mississippi River. Divide the class into 9 groups. Assign each group one of the water quality variables and provide them with the fact sheet for that variable reserving the dissolved oxygen fact sheet to use as an example. Read the Dissolved Oxygen fact sheet aloud. Ask the students, "What water quality category would dissolved oxygen fit into? What are the sources of dissolved oxygen in the environment? How may it be harmful/beneficial to the environment? What may cause low levels of dissolved oxygen?" Explain that dissolved oxygen is one variable that the primary environmental impact happens when it is found in too low of a concentration. However, many of the other variables commonly monitored can be harmful to the environment if they are found in too high of concentrations.

Optional: *Assign each group one of the water quality variables and have them research it. Their research should include finding answers to the following questions:*

> ***What category of water quality does the variable fit into?***
> ***What are the natural and human caused sources of their variable?***
> ***What are some negative environmental impacts of this variable?***
> ***Does the variable have any positive impacts to the environment?***
> > ***(Note: Some variables occur naturally in the environment and are necessary, at low levels, for a healthy environment. However, some variables do not have any positive impacts on the environment.)***
> ***What might cause high levels of their variable in the environment?***

5. Explain that each group will do a presentation on their variable to the class. Pass out the presentation rubric (WQ 22). Thoroughly discuss expectation of the poster and presentation. Allow for work time.

   When the groups present, use the first four sections of the rubric to assess the presentation and poster. Hang up the posters in the classroom for reference during remainder of activity and for use in step 8.

6. Explain to them that they will now be simulating a series of water quality samples taken from the Mississippi River in the vicinity of La Crosse, WI. Each student or group will take a sample of water (in this case, a tablespoon of beads, or 1/2 tablespoon of paper punches) and determine the levels of each varible they have sampled. Sort the sample by variable (color). Egg cartons or ice cube trays may be helpful for sorting.

7. Hand out graph on Page WQ 20. Have them graph the water quality variable concentrations of each color of bead or paper punches. They should not graph the amount of water in the sample.

8. Pass out Table 2 (Page WQ 13). Have the students check to see if any of the variables do not meet the water quality standard. For example, if they have more than 5 tokens representing total suspended solids, then the water quality standard for this variable has been exceeded and environmental damage may occur. If they do not have one or more of a token representing a variable, then the levels present were below the detection level of the techniques used in the lab. The one exception is dissolved oxygen. If they do not have any tokens that represent dissolved oxygen, tell them that the sample they took was anoxic and did not have any oxygen in it. For dissolved oxygen, five tokens or less would be considered hazardous to aquatic live.

9. Compare all of the graphs. Ask the students if any of the variables in their sample did not meet water quality standards? Explain to the class that the samples they took represent different snapshots of water quality taken throughout the year at the same location. It is common to see high levels of some variable, or "spikes," caused by human or climatic events. These would include: spills, floods, droughts, etc.

10. Pass out the Possible Solutions hand-out (WQ 21). Read the dissolved oxygen information aloud. Ask, "How can the dissolved oxygen levels of the Mississippi River be improved?"

    Divide the students into the their original groups. Have them create an 8.5X11 poster of ways to reduce the amount of their variable in the water. Complete the last section of the rubric when groups present possible solutions. Hang up possible solutions next to the first poster.

Table 2. Number of tokens needed to "meet" water quality standards.

WATER QUALITY VARIABLE	WATER QUALITY STANDARD NOT MET WITH:
Total Suspended Solids	>5 Tokens
Nitrogen	>3 Tokens
Fecal Coliform	>2 Tokens
Chlorophyll *a*	>2 Tokens
Heavy Metals	>5 Tokens
PCBs	>4 Tokens
Phosphorus	>4 Tokens
Temperature	>1 Token
Pesticides	>5 Tokens
Dissolved Oxygen	<5 Tokens

ASSESSMENT

During:

Use presentation rubric to assess group presentations and posters for understanding of water quality variable, impacts of variables on the environment, and possible solutions.

Post-Activity:

1. Name the three categories of water quality measurements? (Physical, chemical, and biological)

2. Explain why higher levels of dissolved oxygen are more desirable, while lower levels of all other variables were desirable. (Dissolved oxygen is not a contaminant. Dissolved oxygen is a necessary component of the aquatic environment, just as air is a necessary component of the terrestrial environment. High levels of the other variables are usually due to some impact from humans.)

3. Take one pollution type and explain: type of water quality category, source, potential environmental impacts and possible solutions.

EXTENSIONS

1. Do the activities “Critter Contamination” and “Moving up the Food Chain” to demonstrate how contaminants bioaccumulate and biomagnify in the food chain.

2. Water quality sampling in a single location on the Mississippi River cannot provide a picture of water quality along the length of the Mississippi River. This can only be done through the cooperation of many state and federal agencies and can also be done through coordinated citizen programs.

   One program designed to monitoring the long-term health of the Upper Mississippi River is the Environmental Management Program Long Term Resources Monitoring Program. Water quality data collected by this program is available on the internet at: http://www.umesc.usgs.gov

   Assign students a stretch of river to obtain water quality information from the internet site and have them look for differences along the Upper Mississippi River.

TOTAL SUSPENDED SOLIDS

Category: Chemical. Total suspended solids (TSS) represent the amount (milligrams) of silt, clay and minerals that can be filtered from a liter of water. This yields a TSS measurement reported in mg/L.

Sources: Erosion from agricultural fields, construction site, streambanks and islands. Runoff from roads and parking lots in urban areas can also contribute suspended solids to the River.

Impacts: Suspended solids remain suspended in flowing water, but settle to the bottom of the river in areas where the water flow is slowed, such as in wetlands and lakes. This is called sedimentation. High rates of sedimentation can cover fish eggs, freshwater mussels and invertebrates. Over time, sedimentation can cause a loss in wetlands because the areas fill in and become land.

Increased quantities of suspended sediment in the water column causes decreased light penetration in the water column. Without sufficient light, aquatic plants are unable to carry out photosynthesis and soon die.

Suspended solids have a beneficial effect. The suspended solids can bring nutrients to the land areas in the Mississippi River's floodplain when the river floods. A fine layer of silt and clay gets deposited on top of islands as the floodwaters recede. This brings needed nutrients to the islands that help plants and trees grow.

Factors Contributing to High Levels in Water Samples: Some of the primary factors related to high levels of suspended solids are storm events that cause erosion in rural and urban areas. Wave action from recreational boats and barges can also cause increases in suspended solids.

NITROGEN

Category: Chemical. Nitrogen in water is usually measured in four ways: Total Nitrogen, Total Nitrite + Nitrate Nitrogen, Total Ammonia Nitrogen and Un-ionized Ammonia Nitrogen. Each of these forms of nitrogen is measured in milligrams per liter (mg/L).

Sources: The different forms of nitrogen occur naturally in aquatic environments, mainly due to the decomposition of nitrogen containing organic material (i.e. plants) but also from the air. However, nitrogen is commonly used as one component of fertilizers applied to fields and lawns. Runoff from areas with intensive agriculture or livestock operations is a primary source of nitrogen contamination in the Mississippi River. Another source of nitrogen comes from sewage treatment plants.

Impacts: The growth of aquatic plants depends on the availability of nitrogen. High levels of nitrogen can have toxic affects on aquatic life. This is particularly true of Un-ionized Ammonia Nitrogen that can cause fish and aquatic insects to die if it is found in high levels. Humans can be become ill or die if they drink water high in nitrate. Therefore, most states have a drinking water standard of 10 mg/L for Nitrate. High levels of nitrogen can cause excessive growth of aquatic plants and algae that can accelerate eutrophication (aging) of lakes. High levels of nitrogen runoff from the Mississippi River watershed have been linked to what is termed the "Dead Zone" in the Gulf of Mexico. The nitrogen input from the Mississippi River leads to algae blooms in the Gulf of Mexico. When the algae dies, it begins to decompose. The decomposition of the algae uses up oxygen in the water. The very low levels of oxygen cause die-offs of fish and shrimp in the Gulf.

Factors Contributing to High Levels in Water Samples: Improperly operating waste treatment plants and runoff from agricultural fields and farm feedlots are some of the main factors contributing to high nitrogen levels. Therefore, "spikes" in nitrogen levels usually correspond to runoff from storm events and floods in the Mississippi River watershed. The toxic effect of Un-ionized Ammonia Nitrogen is related to water temperature. The higher the water temperature, the lower of the level of Un-inionized Ammonia Nitrogen needed to be toxic to aquatic life.

FECAL COLIFORM

Category: Biological. The levels of fecal coliform are used to measure the impact of human and animal waste in water. The level is measured based on the number of fecal coliform colonies in 100 milliliters of water.

Sources: The main source of high levels of fecal coliform is sewage or animal waste getting into the water. Human wastes enter the water through waste treatment plants that are not operating properly.

Impacts: When this occurs, the water released from the plant may contain harmful bacteria and viruses. People can be exposed to these microorganisms by drinking the polluted water or through swimming, fishing or eating shellfish in polluted waters. High levels of animal wastes can enter waterbodies through unexpected flooding of barnyards or stock pens.

Factors Contributing to High Levels in Water Samples: The "quick" input of animal waste from storm events can suddenly increase the toxic effects of animal waste in water. Animal waste can also act as a fertilizer (for example, it contains nitrogen and phosphorus) and create damage by increasing nutrients. A primary source of fecal coliform from water treatment plants comes from unchlorinated wastewater. The current standard to meet swimmable water is <200 fecal coliform colonies/100 milliliters.

CHLOROPHYLL *a*

Category: Biological. Chlorophyll *a* is a major plant pigment that provides an index of algae biomass and a means to assess eutrophication. It is measured in micrograms per liter (ug/L).

Sources: Alga production on the river is influenced by water temperature and the presence of nutrients (nitrogen and phosphorous) needed for algae to grow.

Impacts: Some types of algae produce waste that can be toxic to aquatic organisms. However, to be toxic, the algae must be at very high concentrations.

Factors Contributing to High Levels in Water Samples: High levels of chlorophyll *a* are correlated with high levels of algae production in the Mississippi River. High numbers of algae are dependent on several factors including warm water temperature, high amounts of nutrients (nitrogen, phosphorus and silica) in the water, good water clarity and river discharge. Typically, chlorophyll *a* levels are highest when there are low flows on the Mississippi River, such as during a summer drought.

HEAVY METALS

Category: Chemical. Some of the heavy metals that occur in the Mississippi River are: lead, iron, mercury, cadmium and copper. Heavy metals are typically measured in micrograms per liter (ug/L).

Sources: Heavy metals occur naturally in the river. But high concentrations can occur due to burning of fossil fuels and domestic and industrial wastes. The USEPA estimates that 81 percent of the metals introduced into wastewater treatment plants come from various regulated industries that dispose of their wastes into municipal sewer systems and that about 19 percent comes from consumer households in the form of common household products.

Impacts: Trace amounts of many different metals are needed for proper development and growth in plants and animals. High levels of heavy metals can contaminate drinking, ground and surface waters, fish and food. The metals of greatest concern are: arsenic, cadmium, chromium, copper, lead, mercury, selenium and zinc. Heavy metals can affect human health by impacting reproduction, development, mental capacity and growth. Even low concentrations of some heavy metals can have toxic affects on the body. Several of these heavy metals can accumulate in body tissues over long periods of time, and are non-essential to human heath. Heavy metals can pose long-term environmental hazards if not properly disposed of because they do not readily breakdown in the environment and have the capability to biomagnify.

Factors Contributing to High Levels in Water Samples: Heavy metals are used in many industries and household products. The burning of fossil fuels (gas, oil, and coal) accounts for about 20% of the air-borne source of heavy metals. Heavy metal concentrations tend to be highest during periods of low flow on the Mississippi when there is less ability for the water in the river to dilute the concentration of metals.

POLYCHLORINATED BIPHENYLS (PCBs)

Category: Chemical. PCBs are a class of organic compounds produced commercially since 1929. The concentration of PCBs in the water is reported in nanograms per Liter (ng/L).

Sources: PCBs were used in electrical transformers, lubricants, hydraulic fluid and many other products. Environmental contamination with PCBs is worldwide due to its widespread use and ability to persist for long periods of time in the environment. Although banned in 1979, PCBs is still detected in air, soil and water. Recent surveys have found PCBs in every area of the country, even in areas remote from PCB manufacturers.

Impacts: PCBs can have harmful environmental and human impacts at very low concentrations. PCBs are highly soluble in fat tissue and accumulate dramatically in the food chain. The presence of PCBs in organisms has been shown to cause reproductive failures, birth defects, skin lesions, liver disorders, tumors and death.

Factors Contributing to High Levels in Water Samples: In aquatic environments, PCBs normally adhere to fine sediment particles, especially sediment with high organic carbon content. Disturbance of contaminated sediments, or improper disposal of items manufactured years ago, can reintroduce it back into the environment.

PHOSPHORUS

Category: Chemical. Measurements of phosphorus are taken in mg/L.

Sources: Phosphorus occurs naturally in the environment. Phosphorus is used for several industrial purposes, as a fertilizer and is found in wastewater from sewage treatment plants. In general, wastewater treatment plant discharges and urban and agricultural nonpoint source inputs are major sources of phosphorus. In particular, agricultural watersheds contributing high concentrations of sediment are especially important, since phosphorus is commonly bound to sediment particles.

Impacts: Phosphorus is an essential plant nutrient that occurs naturally in water and sediment. High levels of phosphorus can increase the production of algae and affect plant growth.

Factors Contributing to High Levels in Water Samples: Storm events that erode large amounts of topsoil in agricultural areas can cause short-term increases in phosphorus levels.

TEMPERATURE

Category: Physical. Temperature is most commonly measured in degrees Celsius.

Sources: Electric power plants along the Mississippi River use large quantities of water in their steam turbines. The heated water is often returned to the Mississippi River.

Impacts: Temperature is an important property of water that affects plants and animals. The temperature of water also affects the toxicity of some other variables of water quality (i.e. Un-ionized Ammonium Nitrogen and oxygen). For example, heat reduces the ability of water to hold dissolve oxygen in suspension. The higher temperatures allow the water to "release" the dissolved oxygen. With less oxygen in the water, fish and other aquatic life can be harmed.

Factors Contributing to High Levels in Water Samples: A factor causing increases in temperature is associated with industrial water use and power plants. Another process that can affect water temperature is sedimentation. As a backwater lake becomes shallower due to sedimentation, the water temperatures in that area can increase because light can reach the bottom and warm the sediment. With less volume of water in a backwater that has lost a lot of water depth because of sedimentation, water temperatures can increase.

PESTICIDES

Category: Chemical. The concentration of pesticides in the water is measured in micrograms per liter. Over 40 pesticide related chemicals were detected during 1987-1992 water sampling done on the Mississippi River.

Sources: Pesticides cover a broad range of agricultural chemicals designed to kill or limit the growth of life forms that have a negative impact on lawns or agricultural crops. Irrigation, ground water flow and natural runoff bring these toxic substances to rivers, streams, lake and oceans.

Impacts: High levels of pesticides can be harmful to aquatic life and cause illness in people. The impacts to aquatic life and humans can include: development problems (i.e. deformed frogs with missing or multiple appendages), mental impacts and reproduction. Some fish kills have also been linked to releases of pesticides into the water.

Factors Contributing to High Levels in Water Samples: High levels of pesticides may occur during storm events that cause increased runoff from agricultural areas.

DISSOLVED OXYGEN (DO)

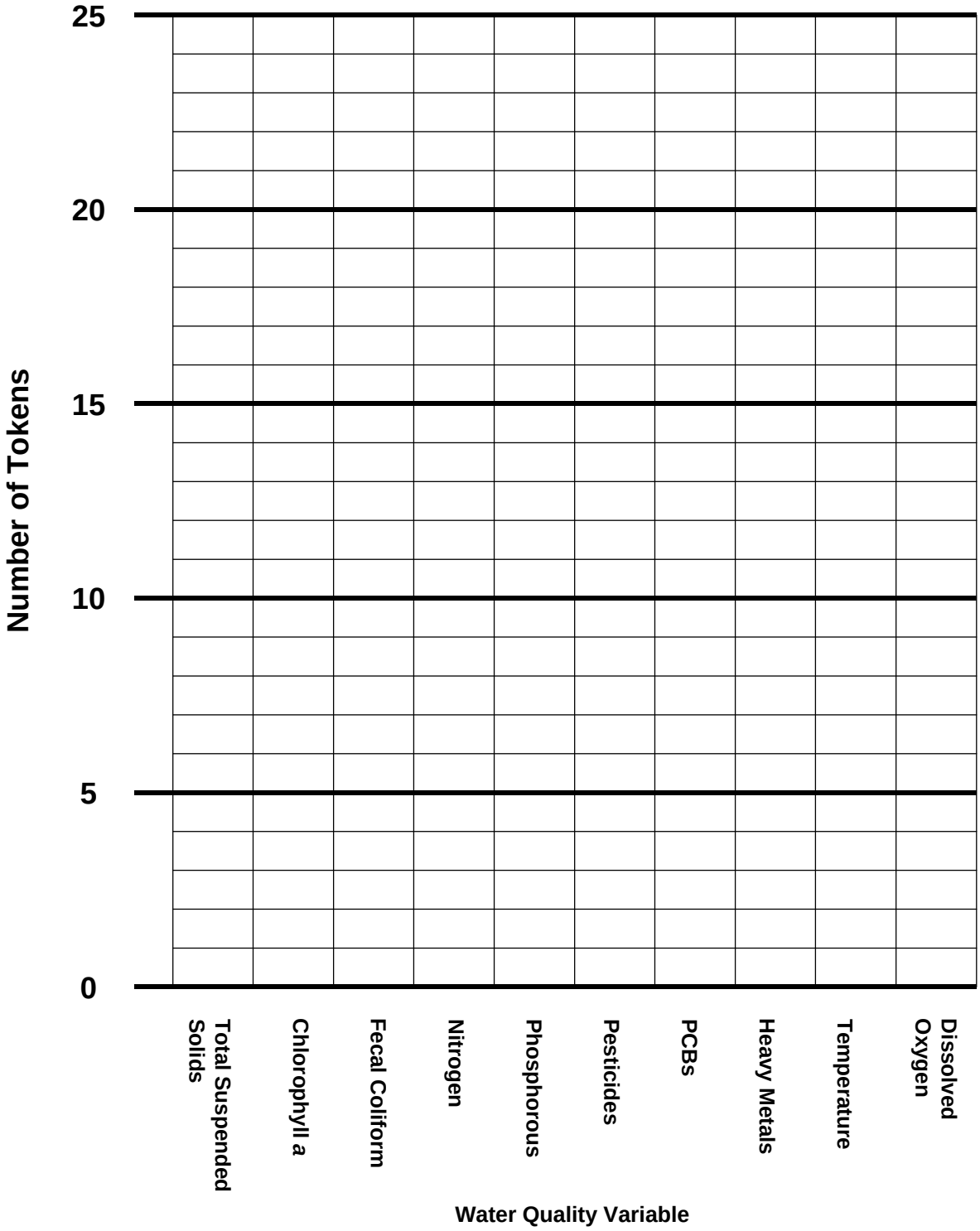
Category: Chemical. The amount of oxygen dissolved in water is measured in milligrams per liter, or parts per million (PPM). Five parts per million (PPM) dissolved oxygen is the common standard identified to support a balanced community of fish and aquatic life.

Sources: One of the main sources of low levels of dissolved oxygen is decomposition of organic material (plants, sewage and animal wastes). High amounts of animal waste can enter bodies due to runoff from manure piles or cattle feed lots. The water released from waste treatment plants can also be low in DO if it is not aerated before being placed back into the water.

Impacts: Low DO levels are often due to decomposition of organic material (i.e. plants or untreated wastewater). Low levels of dissolved oxygen can cause bad-smelling water and threaten fish survival. The smell comes from decomposition of the organic material switching from aerobic (oxygen based) to anaerobic (non-oxygen) processes. The byproduct gases given off during anaerobic decomposition have a unique smell sometimes similar to the sulfur that burns when a match is lit. Low level of DO can cause fish to suffocate.

Factors Contributing to Low Levels in Water Samples: The amount of dissolved oxygen water can "hold" is directly related to water temperature. The higher the water temperature, the less oxygen will be found dissolved in the water. Therefore, DO is usually highest during the winter when the water is coldest. However, the winter can also contribute to very low DO levels in areas protected from river currents. This is because ice and heavy snow cover can shade out the light plants need for photosynthesis. Without photosynthesis, there is no replacement of the oxygen being used as plants decompose.

Monitoring the Miss Bar Graph



WATER QUALITY: POSSIBLE SOLUTIONS

Water quality pollution and contamination can be reduced or eliminated through various actions. Long term monitoring of water quality variables can be used as a report card on how we have affected water quality through our actions. Below are the water quality variables and some actions people can take to reduce impacts to the waters of the Mississippi River. Many of these actions are in use today and have resulted in improved water quality.

Total Suspended Solids – One of the most common methods for reduction in the amount of suspended solids is to implement best land use management practices on agricultural lands. This includes strip cropping, rotational grazing and leaving a buffer of vegetation along stream banks. Erosion off construction sites can be reduced by using silt screens and carefully grading the sites to prevent steep slopes.

Nitrogen – The use of nitrogen as a fertilizer for row crops (i.e. corn) is a common practice. Application of the fertilizer should be when no precipitation is expected that could cause runoff into nearby streams. This loss of fertilizer can be expensive to the farmer. In urban areas, people should have the soil in their yard tested to see what type and quantity of fertilizer to apply. Studies have shown that most lawns are over fertilized. Nitrogen input from farm feed lots can be controlled through proper management of manure.

Fecal Coliform – The two main avenues for input of fecal coliform is from animal waste (manure) and sewage treatment plants that are not operating correctly. The impacts from farm feed lots can be controlled through proper management of manure. Sewage treatment impacts can be greatly reduced by keeping storm drain and sewage lines separate, maintaining existing plants in peak operating order or constructing a new sewage treatment plant if the present one is too small or expensive to repair.

Chlorophyll *a* – Concentrations of chlorophyll *a* are partially dependent on the presence of nutrients algae need to grow. Two of the main nutrients are nitrogen and phosphorus. Therefore, to reduce the levels of chlorophyll *a* reductions need to be made in inputs of nitrogen and phosphorus. (See nitrogen and phosphorus)

Heavy Metals – High concentrations of heavy metals are usually associated with inputs from industry and wastewater. Reductions in heavy metals can be obtained through better treatment of industrial wastes, less use of chemical cleaners in home and recycling batteries. Another source of heavy metals is from runoff from roads, streets and parking lots. This is because many of the fluids in vehicles have heavy metals present. One way to reduce the input of heavy metals is to repair any fluid leaks in vehicles.

PCBs – The manufacture of PCBs in the United States was banned in 1979 due to their affect on the environment. Many items constructed prior to the ban that are still in use. One is found in old power line transformers. Although most of the old transformers have been replaced, some are present. Another way that PCBs can be released into the environment is by disturbing areas contaminated with PCBs. Some areas of the Mississippi River have sediments that are contaminated with PCBs. This is because PCBs readily bind to silt and clay particles. They are released back into the environment when the sediments are disturbed by wave action or dredging (digging them up). Therefore, if an area is contaminated, the sediment should either be disposed of properly, or left undisturbed.

Phosphorus – Phosphorus is used as a fertilizer and for industrial purposes and can be released from sewage treatment plants that are not operating properly. Application of the fertilizer should be when no precipitation is expected that could cause runoff into nearby streams. This loss of fertilizer can be expensive to the farmer. Reducing the impact from sewage treatment plants requires keeping the plant in good operating condition.

Temperature – The water temperature of the Mississippi varies naturally. However, the human impacts to water temperature come from power plants and some industrial plants. The use of cooling towers to reduce the temperature of the water before it is released back into the river is one of the best ways to reduce the impact of high water temperatures.

Pesticides – Many different pesticides are used in agriculture. One method to reduce the impact of pesticides in the environment is to promote/encourage organic farming methods. Another method is to only use the amount and type of pesticide appropriate for the animal it is designed for, avoid spraying on windy days or days when precipitation is expected.

Dissolved Oxygen – The concentration of dissolved oxygen naturally varies within a twenty-four hour period and yearly. Low levels of dissolved oxygen that are caused by humans are associated with input of untreated sewage, runoff from feed lots, storm sewer runoff and some industry. Impacts from industry can be reduced by aerating the water before it is released back into the river. The impacts from storm sewers can be reduced by using storm water retention ponds to slow the input of runoff from storm events in urban areas. Proper treatment of sewage and management of feedlots can reduce the impacts of these practices on dissolve oxygen levels.

Monitoring the Miss
Water Quality Presentation Rubric

Group Member Names: _____

Water Quality Variable: _____

	5	3	1	Score
Presentation Team Work	Every member had a role in the presentation	Some members had a role in the presentation	Presentation by 1 person	
Accuracy of Information	All information presented was accurate	Most information presented was accurate	Information presented was inaccurate	
Poster Presentation	Poster was neat, visually appealing, uses text and graphics to convey message, was easy to understand, creative, included title	Poster was somewhat …	Poster was not …	
Thoroughness of Verbal Presentation	All required information was presented: • category of variable • source of pollution or contamination • effect on the environment (positive and negative) • causes of high levels of variable in the environment	Most required information was presented	Little required information was presented	
Possible Solutions	All information was accurate and visually appealing to the eye	Most information was accurate and somewhat visually appealing	Little of the information was accurate and was not visually appealing	

Total Score: _____/25 (23-25 Excellent, 22-20 Acceptable, 19 or less not Acceptable)

Comments: