18. Monitoring Water Quality

Driving Questions

Monitoring the quality of a natural body of water is an important part of good stewardship of the environment.

- How can you determine the quality of the water in a body of water?
- What is the quality of the water in a body of water in your area?
- How does water quality change in response to changes in the environment?

Background

Water quality is the suitability of water for a given use. Water in a natural ecosystem has to have the right balance of dissolved oxygen, nutrients, temperature, pH, salts, and light penetration to sustain a healthy aquatic ecosystem. Drinking water must have acceptable levels of contaminants to be deemed safe. Treated wastewater must also be of acceptable quality before it is released into the environment.

Natural bodies of water have many chemical and physical characteristics that can vary from one location to another. Water quality indicators can fluctuate depending on the characteristics of the surrounding watershed as well as from varying weather conditions. Water quality at a given point in a stream or river reflects the effects of upstream activities. We can measure different aspects of water quality at different locations to assess the health of a natural body of water and to locate possible sources of pollution.

Materials and Equipment

For each student or group:

- Turbidity sensor
- Weather sensor with GPS
- Dissolved oxygen sensor
- pH sensor
- Conductivity sensor
- Temperature sensor (optional)
- Buffer solution, pH 4, 25 mL
- Buffer solution, pH 10, 25 mL
- Wide-mouth sampling jar or small plastic bucket
- Long-handled sampling device
- Wading boots (optional)
- Duct tape and scissors
- Wash bottle containing distilled or deionized water

Safety

Add these important safety precautions to your normal laboratory procedures:

- Practice appropriate caution around bodies of water, steep terrain, and harmful plants or animals. Point out hazards you observe at the site.
- Use a buddy system and follow the established procedure in case of trouble.

Procedure

After you complete a step (or answer a question), place a check mark in the box (☐) next to that step.

Work with your teacher to find a good place to take your measurements.

Set Up

1. ☐ Start a new experiment on the data collection system.
2. ☐ Connect the weather/anemometer sensor to the data collection system.
3. ☐ Monitor live data without recording.
4. ☐ Determine the current barometric pressure and record below:

   Barometric pressure:_____.
5. ☐ Why is it necessary to determine the barometric pressure?
6. ☐ Connect the water quality sensor, using a sensor extension cable, to the data collection system.
7. ☐ Make sure the conductivity sensor is adjusted to measure the quality of fresh (not salt) water.
8. ☐ Calibrate the dissolved oxygen sensor.

Note: Determine the 100% saturation point for the dissolved oxygen sensor with the sensor's storage bottle submerged in the water you plan to monitor.

9. ☐ Why is it important to calibrate the dissolved oxygen sensor at the same temperature as the water you are testing?
10. ☐ Use pH 4 and pH 10 buffer solutions to calibrate the pH sensor.

11. ☐ Why is it necessary to calibrate the pH, dissolved oxygen, and turbidity sensors?

Note: Keep the file open that contains this calibration information. The sensor calibration remains with the file that was open when you performed the calibration.

12. ☐ Use duct tape to secure the data collection system and the sensor cables to the extension pole so the probes dangle from the end of the pole.

Collect Data – In situ

13. ☐ Start data recording, and gently lower the probes into the water at least 1 meter from the shoreline and to at least 1/3 meter below the surface of the water. If the water is stagnant, gently move the sensors back and forth for 1 minute.

14. ☐ Carefully remove the probes from the water, return them to the shore, and stop data recording.

    Write the run number here _____ .

15. ☐ Remove the sensors and recording device from the extension pole.

Collect Data – From a water sample

16. ☐ Use duct tape to attach a clean bucket or other container to the end of the extension pole.

17. ☐ Collect a sample of water from approximately the same spot that you just monitored with the sensors.

18. ☐ Test the quality of the water in the bucket (measure the temperature, pH, conductivity, and dissolved oxygen) using the same procedure used for the in situ sample.

    Record the run number here _____ .

19. ☐ Calibrate the turbidity sensor.

20. ☐ Stir the water in the bucket and measure the turbidity of the water.

    Record the run number here _____ .

21. ☐ Record the turbidity in Table 1.

22. ☐ (Optional) Test other water quality parameters as indicated by your teacher, using the water in the bucket as your sample.

23. ☐ (Optional) Record the GPS coordinates.

24. ☐ Find another site to monitor the water quality (Site 2), repeating the data collection procedure above.

Data Analysis

1. ☐ Show your first data run in a graph.

2. ☐ Complete Table 1 as follows:

   a. Use the graph tools to identify the value of each parameter that best represents the measured parameter.

   Note: This is a value in the area of the graph where the measurements have stabilized.

   b. Record these values in Table 1.

   c. Repeat this process for your second data run.

Table 1: Water quality measurements from two locations

Test	Temperature (°C)	pH	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
Site 1: In situ					
Site 1: Sample					
Site 2: In situ					
Site 1: Sample					

3. ☐ Describe the first test site. (For example, note the presence and types of surrounding vegetation, shade or full sun, signs of soil erosion, presence or absence of insects or other animals, and evidence of point-source pollution.

4. ☐ Describe the second test site.

Analysis Questions

1. **Was there a sizable difference between measurements made in situ and measurements of the water sample? Do you think it is worth the effort to take measurements in situ?**

2. **What do you think could be responsible for any differences you found between sites?**

3. **Dissolved oxygen levels below 3 mg/L indicate low water quality for many aquatic animals. Do you think the water you tested had enough dissolved oxygen to support most aquatic animals? Explain.**

4. **Dissolved oxygen levels above 9 mg/L indicate accelerated eutrophication and low water quality, due to rapid algae growth in nutrient-dense, warm water. These algal**

blooms are usually followed by very low dissolved oxygen levels. The algae die and are decomposed by bacteria, which consume the dissolved oxygen during aerobic cellular respiration. Does the body of water you investigated show evidence of accelerated eutrophication? Explain.

5. **Does the body of water show signs of acid rain or other acid deposition? Explain.**

6. **Conductivity is a measure of salts dissolved in the water. Conductivity levels above 200 to 300 µS/cm in a fresh-water surface body of water may indicate pollution by runoff from cities or agricultural regions. Does the body of water you investigated show signs of pollution? If so, what do you think might be contributing to this pollution?**

7. **In the United States, turbidity levels higher than 1 nephelometric turbidity unit (NTU) in drinking water are unlawful, and the World Health Organization recommends levels lower than 1 NTU for drinking water. If the body of water you investigated served as a drinking water source, would the water have to be filtered to remove suspended solids? Explain.**

Synthesis Questions

Use available resources to help you answer the following questions.

1. **Design an additional study to determine levels of pollutants in the body of water you tested. Use the evidence you collected in the field study to identify 3 additional tests you think would be useful to conduct, and explain why you picked these.**

2. **Design a water quality monitoring process to test whether point-source pollution is significantly affecting the body of water you investigated. If this body of water does not have an obvious point source for pollution, create a hypothetical one.**

(Examples of point-source pollution include heat from power plants; nitrogen-, phosphorous-, and phosphate-containing effluent from agricultural sources or runoff from cities; salt-containing effluent; and treated or untreated sewage.)