

Measurement of Water Quality

Grade Level:
6-8

Subject Areas:
Science

- Water quality
- Chemistry
- Data collection
- pH
- nutrients
- Scientific method

Duration:
45 minutes

Setting:
Classroom or field

Link to Washoe
County School
District Standards:
Science

- 4.8.2
- 15.8.4
- 15.8.2
- 15.8.4
- 16.8.1
- 16.8.2
- 16.8.3
- 16.8.4
- 16.8.5
- 19.8.1
- 19.8.4
- 23.8.6
- 24.8.4

PURPOSE: In this exercise the students learn to measure several water quality parameters in the classroom and how to record data.

SUMMARY: The exercise will introduce the student to methods used to measure the water quality parameters temperature, pH, nitrate and phosphorus. They will learn how to manage and graph the data. This exercise will prepare them for collection of data in the field.

BACKGROUND:

When someone is interested in maintaining aquatic ecosystem health they can investigate a multitude of environmental parameters. This is described as an assessment of "water quality." Typical water quality parameters that are good indicators of ecosystem health are temperature, pH, dissolved oxygen, nitrogen and phosphorus. The latter two are often described in general as "nutrients", for they are an important component of proteins and essential for life. Too much or too little of these items in an aquatic system can significantly affect ecosystem health.

ACIDITY

The pH of a water body can influence the types of organisms that inhabit a stream. PH is a measure of the activity of the hydrogen and hydroxyl ions, H^+ and OH^- . When there is more hydrogen ion activity a solution is acidic and when the hydroxyl radical is more active it is considered basic. The pH scale is from 1 to 14 with 7 being neutral and less than 7 acidic and greater than 7 basic. The pH scale is logarithmic so there is a 10-fold change between each number. Thus a pH difference of 2 reflects a 100-fold difference in pH. The pH in a water body can be influenced by the geology of an area, by the pH of rainfall, the presence of lakes and wetlands in the watershed, and by human activity. Air pollution can result in changing the pH of rainwater when it interacts with nitrogen and sulfur gases making nitric and sulfuric acid, respectively. Dry deposition of these gases from the atmosphere can also increase the acidity of water in a watershed. Table 1 shows the pH of common substances and the lethal limits for organisms.

TEMPERATURE

Temperature is a controlling factor for aquatic organisms: it controls their rate of metabolic activity, reproductive activity and life cycles. Most aquatic organisms are cold blooded which means their body temperature is regulated by their environment. Organisms are adapted to a temperature range so temperatures outside of that range and rapid fluctuations in temperature can impact organisms. It also affects the amount of oxygen that can be dissolved in water, the activity of parasites and diseases, and can affect the sensitivity of organisms to pollution.

Temperature will fluctuate seasonally and daily. Water quantity and velocity can also influence. One way that human activity can influence temperature is through releases of water from power plants and industry. Agriculture return flows, which are usually warmer than the stream, can influence temperature. Water releases from dams will also influence temperature.

NUTRIENTS

Nutrients that are often measured as water quality parameters are nitrogen and phosphorus. These are required by all organisms for growth, reproduction and living in general. Various chemical forms of nitrogen and phosphorus naturally occur in stream water.

If there are too many nutrients in the water they over stimulate growth of aquatic plants and algae. The vegetation can clog waterways. When the vegetation dies and is decomposed by bacteria the bacteria consume oxygen in the water. This can affect fish and aquatic invertebrates leading to a decrease in community diversity.

Nutrients are derived from fertilizers, sewage from septic systems and treatment plants, animal waste and detergents. Nitrogen can also come from atmospheric deposition.

Important forms of nitrogen in water are nitrate (NO_3^{2-}), nitrite (NO_2^{1-}), and ammonia (NH_4). Nitrate is the most common form analyzed. Nitrate and ammonia are taken up by plant plants and converted in to protein. Animals get nitrogen from plants and assimilate it and excrete it as waste. This is known as organic nitrogen, which can be converted to ammonia by bacteria. Not all is converted and some remains as nondigestible matter. Plants can take up the resulting ammonia but if there is excess it can be converted to nitrite. Nitrite may be oxidized by bacteria to nitrate. Under anaerobic (oxygen depleted) conditions nitrate and nitrite can be converted to nitrogen gas, which escapes to the atmosphere., Organic nitrogen is not available to plants and not really of concern. Nitrite is usually so low in concentration that it requires sophisticated methods of measurement. Nitrate is an appropriate form to analyze to check for water quality.

Phosphorus usually occurs as phosphate (PO_4^{3-}). This form is called inorganic phosphorus, orthophosphate, or reactive phosphorus. Phosphate that is bound to plant or animal tissue is organic phosphorus. Inorganic phosphorus is most likely derived from sewage leakage and fertilizers and detergents. Inorganic phosphorus is the form that is most available to plants and the easiest to measure.

MATERIALS

1. Temperature probe
2. Litmus paper
3. Clean tubes to put the water sample in
4. Container for water sample – sample bottle or beaker
5. Distilled water for rinsing between samples
6. Nitrate water testing kit www.hach.com
7. Phosphate testing kit www.hach.com or www.carolina.com
8. Wiffle or ping pong ball
9. Measuring tape
10. Stop watch
11. Latex gloves

Procedure

1. For a quality control check it is a good idea to try out the pH paper with solutions with known pH before heading to the field and to make sure everyone is interpreting the color scheme the same way.
2. In the field use gloves to collect the water samples into a beaker or jar. Rinse the beaker with the water to be sampled several times before filling it with water.
3. Collect samples from main current, away from banks and well underneath the surface of the water. This will help ensure a well- mixed representative sample.
4. Temperature and pH should be analyzed in the field immediately for both can change rapidly over time.
5. Do three replicates of each test.
6. Measure pH directly in the stream by inserting the paper and holding it there according to instructions.
7. Measure temperature in the water body at the same location you measure pH.
8. Nitrate and phosphate should be determined according to the directions on the test kits.
9. Record all values on the data sheet.
10. Velocity can be determined by placing something buoyant in the water like the wiffle ball and measuring the distance it travels over a certain amount of time. Measure off a distance parallel to the direction of flow. Drop the wiffle ball in the water and measure how long it takes for it to travel the distance. Calculate the velocity as follows:

$$\text{Velocity (feet/minute)} = \text{Distance traveled} / \text{Time}$$

Name _____
Date _____
Time _____

General information

Site description

Site location

Weather

Air temperature and recent weather trends

Water velocity

Quantitative Water Quality

PH 1. _____ 2. _____ 3 _____

Temperature 1 _____ 2 _____ 3 _____

Nitrate 1 _____ 2 _____ 3 _____

Phosphorus 1 _____ 2 _____ 3 _____

Qualitative water data

Water appearance

Stream bed coating

Odor

Scum

Orange to red

Rotten egg

Foam

Yellowish

Musky

Muddy

Black

Chlorine

Milky

Brown

None

Clear

None

Oily sheen

Brownish

Other _____

Other _____

Other _____

Resources

A world in our backyard: A wetlands educational and stewardship program. Video by Bill Nye www.envmedia.com/catalog/products/a_world_backyard.html. Printed material 144 pages with information and activities

Wow! The Wonders of Wetlands. Book with activities and handouts from Environmental Concern Inc. 201 Boundary Lane, P. O. Box P, St. Michaels, MD 21663
410-745-9620

Field manual for water quality monitoring: An environmental education program for schools (6th ed). 1992 Mitchell, Mark and William Stapp. This manual contains instructions for measuring eight chemical and physical water quality tests plus fecal coliforms and macroinvertebrates. Spiral bound 240 pgs with photos and illustrations. Available for \$9.95 from William G. Stapp, 2050 Delaware Drive, Ann Arbor, MI 48103. Make checks payable to William B. Stapp.

Water testing equipment

Hatch Chemical Co. www.hach.com

Carolina Biological Supply www.carolina.com

Vocabulary Words

wetland
hydric soil
nitrogen
phosphorus
pH
water velocity
water quality
water quantity