The Menokin Foundation (www.menokin.org/lessonplans.htm)
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Testing the Waters Lesson Plan

SOL Connections

Science
6.1 Scientific Investigation—the student will plan and conduct investigations.
6.7 Living Systems—the student will investigate and understand the natural processes and human interactions that affect watershed systems.
6.9 The student will investigate and understand public policy decisions relating to the environment.
6.10 Measurement—The student will estimate and then determine length, weight/mass, area, and liquid volume/capacity, using standard and nonstandard units of measure.

Setting

Refuge—Wilna Pond Outdoor Classroom Site

Duration

45 minutes

Overview

Students conduct water testing to demonstrate the impact of nutrients on algae growth.

Vocabulary

Groundwater, effluent, aquifers, surface water, dissolved oxygen, nitrate, phosphate.

Materials

NOTE: If you plan to follow this activity with Nutrient Nuisance, be sure to mention this when you make your Refuge visit reservation so that we can have follow-up dissolved oxygen test materials ready for you to take back to your classroom activity.

You need to bring:
(Collect the following containers or ask students to bring them from home. Wash containers thoroughly before use)

- 1-quart jars with lids (jars will have water samples in them on the return trip)—need 1 jar for every 4-6 students
- 3 1-gallon milk jugs
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- Copies of the % Saturation Chart/Ranking Test Results page and Water Quality Data Sheets for each group or student (make copies prior to your trip).
- 1 box for jars (to store the jars while in transport)

The Refuge will supply:
Water testing kits (includes thermometer, test tubes, and tests for dissolved oxygen, nitrates, and phosphates)
Microscopes
Slides
Eye droppers
Measuring cup
Eye protection
Latex gloves
Permanent marker

Background

Every part of our lives relies on water. Water makes up 80% of our total body weight. Most of the Earth's surface is covered by water. We use water daily for drinking, cooking, and washing. Water supports important food chains and the microscopic plant life responsible for much of the Earth's oxygen.

Most of the Earth's supply of available fresh water is found in underground rock formations called aquifers. Groundwater can be pumped to the surface through wells, may flow to the surface as a spring or seep underground into streams, ponds, wetlands, or rivers.

Streams, lakes, and ponds are examples of surface water. They provide drinking water, habitat for fish, water for industrial use, and for recreation. Their water sources include groundwater, rain, melted snow, surface runoff from surrounding land, and effluent-water returned to the environment after it has been used by people.

Water can dissolve and pick up all kinds of stuff as it moves through or over the ground, such as: minerals and organic matter from the soil; fertilizer placed on lawns and crops; chemicals placed on the sidewalks, roads, or driveways; and anything spilled on the ground. Some of these substances dissolved in water. Dissolved substances react with each other and with plants and animals

living in the water. Dissolved substances can be measured by chemical tests, which produce visible reactions, or with electronic instruments.

By testing some basic water quality parameters (dissolved oxygen, nitrates, phosphates, and temperature) it is possible to assess the general health of a water body and assess changes in the water quality.

Dissolved oxygen (DO) is important to the health of aquatic ecosystems. All aquatic animals need oxygen to survive. Natural waters with consistently high dissolved oxygen levels are most likely healthy and stable environments, and are capable of supporting a diversity of aquatic organisms. Natural and human-induced changes to the aquatic environment can affect the availability of dissolved oxygen. Dissolved oxygen % saturation is an important measurement of water quality. Cold water can hold more dissolved oxygen than warm water. For example, water at 28ºC will be 100% saturated with 8ppm dissolved oxygen. However, water at 8ºC can hold up to 12ppm of oxygen before it is 100% saturated. High levels of bacteria from sewage pollution or large amounts of rotting plants can cause the % saturation to decrease. This can cause large fluctuations in dissolved oxygen levels throughout the day, which can affect the ability of plants and animals to thrive.

Nitrate is a nutrient needed by all aquatic plants and animals to build protein. Excess nutrients like nitrate increase plant growth and decay, promote bacterial decomposition, and therefore, decrease the amount of oxygen available in the water. Although factories and sewage treatment plants are major "point sources" of this type of pollution, the average citizen is also to blame. Many of our seemingly innocent daily chores, such as driving, washing our cars, and doing laundry, can contribute nutrients to our waterways. In addition, nitrogen found in fertilizer from lawns and farms, as well as animal wastes from pets and livestock, are carried in storm water runoff to the Bay and its tributaries (including the Rappahannock River).

Phosphate is a nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions. High levels of this nutrient can lead to overgrowth of plants, increased bacterial activity, and decreased dissolved oxygen levels. Phosphate comes from several sources including human and animal waste, industrial pollution, and agricultural and lawn runoff.

Temperature is very important to water quality. Temperature affects the amount of dissolved oxygen in the water, the rate of photosynthesis by aquatic

plants, and the sensitivity of organisms to toxic wastes, parasites and disease. Thermal pollution, the discharge of heated water from industrial operations, for example, can cause temperature changes that threaten the balance of aquatic systems.

Method

Students will conduct water quality tests on pond water samples. This activity is best followed by Nutrient Nuisance, (a classroom experiment involving the addition of fertilizer and subsequent changes to the water samples and quality), but can be performed by itself.

SAFETY NOTE: Test Tabs® reagents used in this activity are designed with safety in mind. The single-unit, foil packaged TesTabs are easy to distribute and dispense. The single-test packaging minimizes the amount of material ever in the hands of an individual student. Only hand out the TesTabs when ready for immediate use. A single tablet, alone or reacted with a sample, is not a health hazard. However, as with any substance, ingesting large amounts can be harmful. Additional emergency information on all TestTabs is available 24 hours a day from the Poison Control Center at 1-800-222-1222.

On-Site

1. Divide the class into groups of 4-6 students and ask them to name their group.
2. If you plan to follow this activity with the Nutrient Nuisance Activity, fill the 3 one-gallon containers with untreated water from Wilna Pond. If this activity is being performed by itself, collect enough pond water to fill a 1-quart jar for each group.
3. Give each group one jar, a permanent marker, a water test kit, a pair of protective eyewear, and a pair of plastic gloves. Ask them to write their group name on the bottom of the jar.
4. Distribute 500 ml of your collected pond water into each of the group's 1-quart jars. *Retain the remaining water for the Nutrient Nuisance Activity, if conducted.*
5. Utilizing the refuge's water quality test kits, have students conduct water quality tests on the untreated pond water. Be sure they utilize protective eyewear and gloves during testing. Have students record their results in the "pre-experiment date" section of the *Water Quality Data Sheet.* Review Ranking Test Results page with the students.

a. Dissolved Oxygen Test *(If you have conducted or plan to conduct the Water Canaries Activity, you can conserve materials by performing this test once for both activities.)*
    1) Record the temperature of the water sample. Place the thermometer four inches below the water surface for one minute (in the 1 quart jar). Remove the thermometer from the water, read the temperature, and record the temperature as degrees Celsius.
    2) Submerge a test tube into the water sample. Carefully remove the tube from the water sample, keeping the tube full to the top.
    3) (Warn students that, during this next step, water will overflow when tablets are added and to hold it away from self and clothing.) Drop two Dissolved Oxygen Test Tabs® into the tube.
    4) Screw the cap on the tube. (More water will overflow as the cap is tightened.) Make sure no air bubbles are present in the sample.
    5) Mix by inverting the tube over and over until the tablets have disintegrated. This will take about 4 minutes.
    6) Wait 5 more minutes for the color to develop.
    7) Compare the color of the sample to the Dissolved Oxygen color chart. Record the result as ppm Dissolved Oxygen.
    8) Locate the temperature of the water sample on the % Saturation Chart. Locate the Dissolved Oxygen result of the water sample at the top of the chart. The % saturation of the water sample is where the temperature row and the Dissolved Oxygen column intersect.
    9) Set capped test tube aside.

b. Nitrate Test
    1) Fill another test tube to the 5mL line with the water sample.
    2) Add on Nitrate Wide Range CTA TesTab®.
    3) Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.
    4) Wait 5 minutes for the red color to develop. NOTE: If the sample does not develop a red color (sample is colorless or yellow), record the result as 0 ppm.

5) Compare the color of the sample to the Nitrate color chart. Record the result as ppm Nitrate.
6) Set capped test tube aside.

c. Phosphate Test
   1) Fill another test tube to the 10 ml line with the water sample.
   2) Add one Phosphorus TesTab.
   3) Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.
   4) Wait 5 minutes for the blue color to develop. NOTE: If the sample does not develop a blue color (sample is colorless), record the result as 0 ppm.
   5) Compare the color of the sample to the Phosphate color chart. Record the result as ppm Phosphate.
   6) Set capped test tube aside.

6. Distribute a microscope, eye dropper, and slide to each group and have them witness the life forms present in a drop of the pond water!
7. Ask the students to tightly cover their labeled pond water samples and put them in the box for transport back to the classroom.
8. Have each group take their capped test tubes into the Wilna Lodge. All test tubes should be emptied into the classroom sink and cleaned out. Have them keep them for the next steps.
9. Complete the *Nutrient Nuisance Activity*.
10. Repeat steps 5a – c, with the Nutrient Nuisance sample. Record the results in the "post-experiment data" section of the *Water Quality Data Sheet*. Compare the results of the pre and post data water quality tests. Which levels have changed? Discuss what the changes in DO, nitrate, phosphate, and temperature might mean to underwater grasses and aquatic species. Need to measure amount of water needed for tablets so educators can use their own containers. Can send extra TesTabs back with them for follow up. Also need to provide copy of color chart (in water test kits) and laminate.
11. Repeat step 8, and collect clean test tubes.

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% Saturation Chart

Temperature C	Dissolved Oxygen		
	0 ppm	4 ppm	8 ppm
2	0	29	58
4	0	31	61
6	0	32	64
8	0	34	68
10	0	35	71
12	0	37	74
14	0	39	78
16	0	41	81
18	0	42	84
20	0	44	88
22	0	46	92
24	0	48	95
26	0	49	99
28	0	51	102
30	0	53	106

Ranking Test Results

Test Factor	Result	Rank
Dissolved Oxygen	**91-110% Sat** **71-90% Sat** **51-70% Sat** **>50% Sat**	**4 (excellent)** **3 (good)** **2 (fair)** **1 (poor)**
Nitrate	**5 ppm** **20 ppm** **40 ppm**	**2 (fair)** **1 (poor)** **1 (poor)**
Phosphate	**1 ppm** **2 ppm** **4 ppm**	**4 (excellent)** **3 (good)** **2 (fair)**