The Menokin Foundation (www.menokin.org/lessonplans.htm)
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Nutrient Nuisance 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.
Math
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.
Language Arts
6.5 Reading– The student will read and demonstrate comprehension of a variety of informational selections.
6.6 Writing– The student will write narratives, descriptions, and explanations.

Setting
Classroom

Duration
2 – 45 minute classes (+2 weeks to grow algae)

Vocabulary
Algae, algal bloom, clarity, dissolved oxygen, nitrogen, nutrient, phosphorus, underwater grasses

Materials
Supplied by Educator:
3 clean 1-quart jars per group of 4-6 students (number dependent on how many groups you have if you divide the class into groups of 4-6 students. Use same groups as in Testing the Waters Activity).
Testing the Waters Activity jars or, if conducted as a stand-alone activity, one additional jar per group (no lids needed)
Fertilizer (any brand will work, but use a clear non-dye variety). You will need approximately ½ cup of fertilizer
Make copies of the *Experiment Worksheet*, and the *Nutrient Data Charts* (Weeks 1 and 2). Distribute one copy of each to each group.
Labels for each jar
Aluminum foil
Measuring cup
Measuring spoon
1 gallon untreated tap water

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Overview

Students conduct an experiment to demonstrate the impact of nutrients on algae growth. This activity is best conducted in conjunction with the Testing the Waters Activity.

Background

Excess nutrients (made up of mostly nitrogen and phosphorus) are a significant pollution problem for the Bay. 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, is carried in stormwater runoff to the Bay and its tributaries.

Excess nutrients in water cause the rapid growth of algae populations, known as algal blooms, which look like green slime or dense mats of brownish-green material floating in the water. As algae die and decompose, they deplete the oxygen supply in the water, leaving aquatic species to suffocate. In addition, the cloudy water caused by the bloom blocks sunlight to underwater grasses, which depend on sunlight for photosynthesis. As the underwater grasses die, critical habitat for juvenile crabs, fish, and other aquatic organisms is lost.

In this activity, students conduct a nutrient experiment that demonstrates the growth of algae. They will also consider ways to minimize their own nutrient contributions to the Bay.

Method

NOTE: Growing algae can be a hit or miss situation in which success depends on the light source, the conditions in your classroom, and the quality of the water sample. If you have time, do a practice run to find the best place to grow algae in your classroom. To shorten the activity, start growing the algae about a week before beginning the activity with students. When there is evidence of algae growth, allow students to record their observations on the *Nutrient Data Chart*.

If you do not want to attempt to grow algae, students can evaluate the effects of fertilizer on water quality by completing the exercise entitled "Hypothetical Nutrient Experiment."

1. Divide the class into their Testing the Waters groups (or groups of 4-6 students).

2. Distribute the materials to each group. If you have conducted the Testing the Waters Activity, give each group their respective pond water sample jars. Otherwise, include an additional jar for each group (4 jars/group)
3. Review the experimental procedure and the *Nutrient Data Chart* with students and have them record their predictions on their *Experiment Worksheet* page. The experimental procedure is as follows:
    a. Fill jar #1 with 500 ml (2c) of untreated tap water (control). Cover with foil and label "#1 TAP WATER – NO FERTILIZER ADDED."
    b. Label the Testing the Waters Activity or second jar "#2 UNTREATED POND WATER ONLY – NO FERTILIZER ADDED."
    c. In jar #3, mix 500 ml of pond water (utilizing the pond water collected in the gallon jug) and 1.25 ml (1/4 tsp) of fertilizer. Cover with foil and label "#3: 1.25 ML FERTILIZER."
    d. In jar #4, mix 500 ml of pond water and 0.625 ml (1/8 tsp) of fertilizer. Cover with foil and label "#4: 0.625 ML FERTILIZER."
    e. Put jars in a sunny place at room temperature and observe for approximately 2 weeks.
    f. Record daily observations on *Nutrient Data Chart*.
4. Ask students to identify the controls and variables in the experiment. Why have only tap water in jar #1 and only untreated pond water in jar #2? Vary the experiment by eliminating the tap water control and adding another variable. Try mixing ½ tsp (2.5 ml) or 1 tsp (5 ml) of fertilizer and water.
5. Once the experiment is complete, conduct the Testing the Waters procedures on water samples with fertilizer added (jars #3 or #4). This follow-up activity is conducted utilizing water testing materials obtained during the Refuge site visit. Water testing materials can also be obtained from a biological supply catalog.

Optional Activity

Prior to activity

- Make a copy of the *Nutrient Pollution* factsheet and the *Nutrient Pollution Worksheet* for each group.
- Make a transparency of (or copy for each student) the *Effects of Nutrients in the Bay* diagram.

1. Facilitate a discussion about the impact of excess nutrients on water quality in the Bay and the steps being taken to reduce nutrient levels. Show students the *Effects of Nutrients in the Bay* diagram and discuss its meaning.
2. Distribute the *Nutrient Pollution* factsheet and *Worksheet* to each group and allow students to complete the questions *Worksheet*.
3. Have each group share their response to question 4 (they are asked to brainstorm a list of ways to reduce the amount of nutrients entering the

Chesapeake Bay) and create a class list of their responses on the blackboard.

4. Finally, students are to create a public service announcement about the effect that excess nutrients have on the water quality of the Bay. Ask students to decide how best to distribute the announcement around the community to educate others.

ADDITIONAL SUGGESTIONS:

- Simplify this experiment by using fertilizer as the only variable (one jar with untreated water only and one jar with untreated water and fertilizer mix). Have students record their observations in the *Nutrient Data Chart*.
- Make this experiment more student directed by presenting the following investigation questions: "What causes algae to grow in water?" "What is the impact of algae growth?" or "What is the impact of excess nutrients on the water of the Bay and/or its tributaries?" With your guidance, students can then create their own experimental designs to answer these questions. This method challenges students to think like real scientists.

JOURNAL ENTRY:

You have learned what happens when too many nutrients enter the Bay! What happens when you ingest too much food or the wrong sort of food over along period of time? Explain how the Bay's problems resulting from too many nutrients are similar to or different from a person's problem with too much food.

EXTENSIONS:

- Have students read the labels of a variety of dishwashing and laundry detergents found in their homes. Ask them to provide a list of products that contain nitrogen or phosphorus. As a class, discuss alternatives to these products.
- Often, people over-fertilize in an effort to increase plant growth, but are actually harming the plants and soil and contributing to a high level of nutrient runoff! Discuss the importance of following manufacturer labels to insure proper use of fertilizer products and reduce nutrients entering the Bay. Then, conduct an experiment with grass seeds (or tomato plants) to see the impact of excess fertilizer on plants. Grow grass from seed in two small containers. As the appropriate amount of fertilizer to one container and water as usual. Add an excessive amount of fertilizer to a second container and water as usual. Observe the containers to detect what changes take place over time. After several weeks, record the nitrate level from the runoff of both plants (pour enough water in the plant container for it to "run off" into a pan underneath). Compare the results of each container.

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HYPOTHETICAL NUTRIENT EXPERIMENT

Procedure:

Preparation prior to activity

1. If students are unfamiliar with the concepts of dissolved oxygen and photosynthesis, review them with your class prior to beginning this exercise.
2. Make copies of the *Hypothetical Nutrient Experiment* for each group.
3. Pass out steps 1-3 of the *Hypothetical Nutrient Experiment* to each group.
4. When students have completed steps 1-3, pass out the remaining part (steps 4-6).

NOTE: Although changes in dissolved oxygen levels may be influenced by temperature changes and other fluctuations in the graph may result from the small sample size (one) used in the experiment, students should deduct from the graph that dissolved oxygen levels were constantly higher in the beaker *without* fertilizer.

Adapted with permission from *W.A.V.E. Watershed Action for Virginia's Environment*, Chesapeake Bay Foundation.

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HYPOTHETICAL NUTRIENT EXPERIMENT

PROCEDURE:

1. With your group, discuss and list below several ways fertilizers are used in your community.

   - _____
   - _____
   - _____

2. Study the methods below used in setting up the experiment.

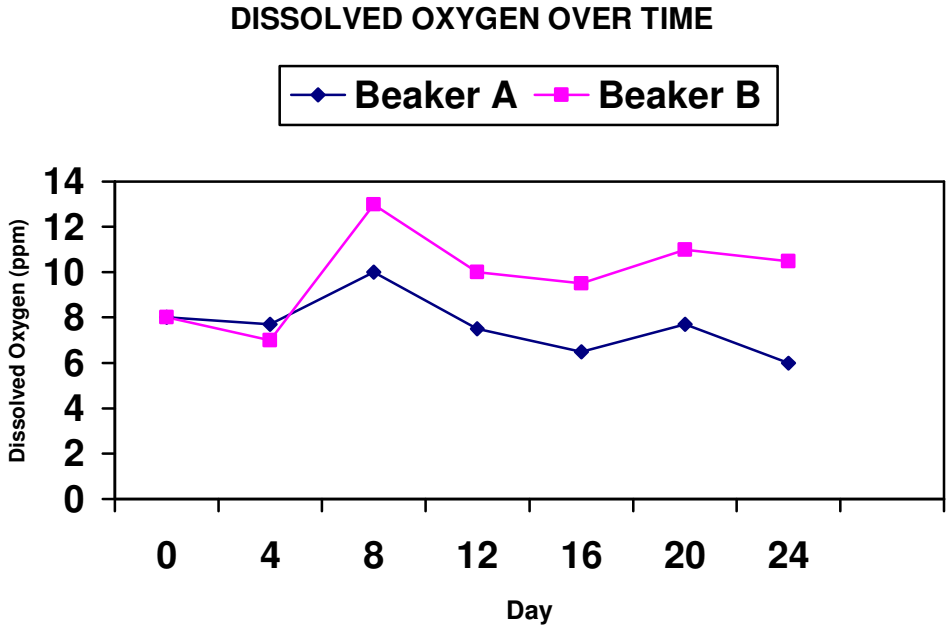
   The experiment:
   - Two beakers (A and B) were filled with equal amounts of Bay water (1 liter).
   - 15 ml of fertilizer was added to beaker A and stirred thoroughly until well mixed.
   - Nothing was added to beaker B (this was the "control").
   - The dissolved oxygen level and the water clarity were checked in each beaker daily.

3. Below, sketch two graphs showing generally how you think the dissolved oxygen levels in each beaker would change over 21 to 30 days. Label your axes.

4. Have one person in your group read "the results" of the experiment below aloud.

   The results:
   - After 10 days, beaker A became cloudy.
   - By 13 days, a yellowish coloring was observed in beaker A.
   - After 16 days, beaker A had a green thick, pea soup coloring.
   - Beaker B remained clear throughout the experiment.

5. Study the graph below showing the results of the dissolved oxygen tests.



6. Write a paragraph summarizing the results of the experiment using the methods of the experiment and the *Dissolved Oxygen Over Time* graph above. Your summary should include the answers to the following questions:

   - What question is this experiment trying to answer?
   - What causes the "pea soup" color in beaker A?
   - Which beaker would be better able t6o support aquatic life, such as crabs, fish, oysters, and underwater grasses?
   - What caused the differences in dissolved oxygen results between beaker A and beaker B?

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EXPERIMENT WORKSHEET

Part I:

1. Read the experimental procedure below.
    a. Fill jar #1 with 500 ml (2c) of untreated tap water (control). Cover with foil and label "#1 TAP WATER – NO FERTILIZER ADDED."
    b. Label the Testing the Waters Activity or second jar "#2 UNTREATED WATER ONLY – NO FERTILIZER ADDED."
    c. In jar #3, mix 500 ml of pond water and 1.25 ml (1/4 tsp) of fertilizer. Cover with foil and label "#3: 1.25 ML FERTILIZER."
    d. In jar #4, mix 500 ml of pond water and 0.625 ml (1/8 tsp) of fertilizer. Cover with foil and label "#4: 0.625 ML FERTILIZER."
    e. Put jars in a sunny place at room temperature.
    f. Observe for 2 weeks. Record your observations in the *Nutrient Data Chart* below.
2. In the space below, record predictions of what you think will happen in each jar after 2 weeks. This sort of prediction is often called a hypothesis.

    Jar 1:
    _____

    Jar 2:
    _____

    Jar 3:
    _____

    Jar 4:
    _____

3. Gather all the necessary materials to conduct the experiment and place them on the table.
4. Decide who will do each part of the experiment. Remember to assign someone to record the experimental information on the *Nutrient Data Chart* each day.
5. Conduct the experiment by following the experimental procedure. The experiment may take two or more weeks to show results.
6. Immediately after setting up the experiment, complete step 9a.
7. During the two weeks of the experiment record your daily observations in the *Nutrient Data Chart*.
8. When the experiment is finished, complete questions 9b, 10, and 11.

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9. a) Sketch the contents of Jar #4 on the FIRST day of the experiment in the top box.
   b) Sketch the contents of Jar #4 on the LAST day of the experiment in the bottom box.

FIRST DAY

LAST DAY

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NUTRIENT DATA CHART: WEEK 1

Directions: Record your daily observations in the chart below. Remember that you are recording the physical characteristics of your water sample (e.g., dark, light, cloudy, clear, etc.)

Week 1	Growth (of algae)	Color (of water)	Clarity (of water)	Other Observations
Day One				
Day Two				
Day Three				
Day Four				

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NUTRIENT DATA CHART: WEEK 2

Directions: Record your daily observations in the chart below. Remember that you are recording the physical characteristics of your water sample (e.g., dark, light, cloudy, clear, etc.)

Week 2	Growth (of algae)	Color (of water)	Clarity (of water)	Other Observations
Day One				
Day Two				
Day Three				
Day Four				

10. What happened in the experiment? Use the space below to summarize the results of the experiment. In your summary, include answers to the following questions:
    - Did you see an algal bloom in all four (4) jars? Why or why not?
    - Which jar(s) had the most algae growth and which had the least? Why?
    - Did any of the jars have no algae growth? Why or why not?
    - If you performed the Testing the Waters Activity, testing for temperature, dissolved oxygen, nitrates, or phosphates, describe how these levels changed over time in the four jars. Was there a connection between the algae growth and the chemical properties of the water?

11. Based on this experiment, which jar would be best able to support aquatic life, such as crabs, fish, oysters, and underwater grasses? Use the space below to support your answer.

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NUTRIENT POLLUTION WORKSHEET

1. Read the factsheet entitled *Nutrient Pollution*.
2. According to the factsheet, what are some of the sources of nutrients? List them below.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

3. Re-read the section of the *Nutrient Pollution* factsheet entitled, "What are the problems?" Using the information from this section, complete the *Sequence Diagram* on the next page to describe the sequence of events that occur when too many nutrients enter the water.
4. In 1987, in an attempt to reduce nutrients, Virginia's General Assembly passed a law banning the sale of any laundry detergents containing more than 0.5% phosphorus. The law also limited dishwashing detergent to 8.7% phosphorus. In the space below, brainstorm a list of several additional ways to reduce the amount of nutrients entering the Chesapeake Bay. Be specific. Share your list with the class.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

5. You now know a lot about nutrients, but most people don't know a thing! Create a public service announcement about the impact of excess nutrients on the water quality of the Bay. Distribute the completed announcement around the community or your school to educate others.