

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

**Lesson Summary:** This module focuses on the Trophic State Index of bodies of water, which estimates the biological productivity of a body of water by measuring the amount of the pigment chlorophyll a that it contains; chlorophyll a is a component of algae that is used in photosynthesis.

**Grade Level:** 6th – 8th

**Time Allotted:** Two class periods (approximately 50 minutes each).

### Performance Objectives

*References are to the Next Generation Sunshine State Standards (2007).*

#### Language Arts

- LA.A.1.3.2 The student uses a variety of strategies to analyze words and text, draw conclusions, use context and word structure clues, and recognize organizational patterns.
- LA.A.2.3.1 The student determines the main idea or essential message in a text and identifies relevant details and facts and patterns of organization.
- LA.A.2.3.2 The student identifies the author's purpose and/or point of view in a variety of texts and uses the information to construct meaning.
- LA.B.2.3.3 The student selects and uses appropriate formats for writing, including narrative, persuasive, and expository formats, according to the intended audience, purpose, and occasion.

#### Math

- MA.A.2.3.1 The student understands and uses exponential and scientific notation.
- MA.A.3.3.3 The student adds, subtracts, multiplies, and divides whole numbers, decimals, and fractions, including mixed numbers, to solve real-world problems, using appropriate methods of computing, such as mental mathematics, paper and pencil, and calculator.

#### Science

- SC.6.E.6.2: Recognize that there are a variety of different landforms on Earth's surface such as coastlines, dunes, rivers, mountains, glaciers, deltas, and lakes and relate these landforms as they apply to Florida.
- SC.6.L.14.3: Recognize and explore how cells of all organisms undergo similar processes to maintain homeostasis, including extracting energy from food, getting rid of waste, and reproducing.
- SC.6.N.1.5: Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

- SC.7.E.6.6: Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.
- SC.7.L.17.1: Explain and illustrate the roles of and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.
- SC.7.L.17.2: Compare and contrast the relationships among organisms such as mutualism, predation, parasitism, competition, and commensalism.
- SC.7.L.17.3: Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.
- SC.8.L.18.1: Describe and investigate the process of photosynthesis, such as the roles of light, carbon dioxide, water and chlorophyll; production of food; release of oxygen.

### Prior Knowledge

Students should have a basic idea of what might pollute water (though specific knowledge of algae blooms is not required).

**Topic Overview:** In assessing the health of water bodies, resource managers are concerned about chemical contaminants like lead, mercury, heavy metals, and other pollutants that come from automobiles and atmospheric deposition. But of perhaps greater concern is nutrient pollution. When lakes, streams, estuaries, and other bodies of water receive too many nutrients it can stimulate an overgrowth of plant material that starts a process called eutrophication, which can lead to algae blooms, weed-choked lakes, and water with such a low oxygen content that it cannot support fish, macroinvertebrates and other aquatic organisms.

Phosphorus and nitrogen are naturally-occurring elements that are necessary to support plant life and are only considered "pollutants" when they are overabundant. In a healthy aquatic ecosystem, they are present in moderate quantities and are in balance with one another, feeding existing plant life that, in turn, supports organisms further up the food chain. But when excess quantities of these nutrients are washed into a water body, the resulting explosion of algae and other plants can disrupt the biological functioning of the ecosystem and prevent people from using the water for drinking, recreation, or other purposes. Sources of nutrient pollution include runoff from residential lawns, farm fields and pastures, pet waste, discharges from septic tanks and feedlots, and emissions from combustion.

In freshwater systems, phosphorus and nitrogen serve as the limiting nutrients – the levels of these two nutrients determine the biological productivity of the lake, pond, or stream. A sharp increase in one or both of these elements can result in an "algal bloom" – a sudden population explosion of algae. There are several direct and indirect costs associated with algal blooms. As the algae population

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

proliferates, waters become increasingly more turbid. This turbidity is due in part to the single-celled algal organisms present in the water and in part to dead and decaying organic material. The turbidity coupled with the appearance of algal mats, which can sometimes reach from shore to shore, render eutrophic bodies of water unappealing to swimmers and boaters.

An algal bloom can also set off a chain of events whose effects are more far-reaching and more grave than these aesthetic considerations. As the algae begin to die, bacterial populations move in to decompose the organic matter. These aerobically respiring microbes can cause significant and sudden drops in the level of dissolved oxygen. During the daylight hours, there is a great deal of photosynthetic (oxygen-generating) activity in a eutrophic body of water, so this affect may not be apparent. At night, however, when photosynthesis ceases (but plant and animal respiration continues), the resulting net drop in dissolved oxygen can be devastating, sometimes leading to massive fish kills.

### Key Vocabulary

#### **Alga**

A simple, rootless plant that grows in sunlit water, giving the water a highly colored appearance, often green. Plural: algae

#### **Chlorophyll**

Any of a group of green pigments that are found in the chloroplasts of plants and in other photosynthetic organisms. "Chlorophyll a" is a specific form that is used by plants to carry out photosynthesis.

#### **Data**

Information (either facts or figures) from which conclusions can be drawn.

#### **Habitat**

The place where an organism, population, or community of animals, plants, or microorganisms lives, as well as its surroundings, both living and nonliving.

#### **Microgram**

One one-millionth (0.000001) of a gram. (May be abbreviated as  $\mu\text{g}$  or ug.)

#### **Nitrogen**

A chemical element that is also a biologically important nutrient essential to plant growth.

#### **Nutrient**

An element or compound essential as raw material for organism growth and development, such as carbon, nitrogen, or phosphorus. Nutrient pollution is primarily caused by urban or agricultural stormwater runoff containing fertilizers, or by runoff that contains animal manure.

#### **Phosphorous**

A chemical element that is also a biologically important nutrient essential to plant growth.

## Measuring Lake Quality Lesson Plan

Students learn how nutrients affect plant growth and water quality in water bodies.

### Trophic State

A measure of a lake's fertility, as determined by the quantities of the nutrients nitrogen and phosphorus in its water, as well as the pigment chlorophyll a.

### Materials

- Computer with internet access
- Two (2) fish bowls, ½ gallon to 1 gallon each
- Enough distilled water to fill the fish bowls
- Liquid plant fertilizer
- "Starter algae" taken from a nearby pond or fish tank
- Dissolved Oxygen test kit (optional)
- Classroom water testing kit for nitrogen and phosphorus (optional)
- Microscope (optional)

### References:

*The following documents are available in the Orange County Water Atlas Digital Library:*

[A Beginner's Guide to Water Management: Fish Communities and Trophic State in Florida Lakes.](#) 2007. Florida LAKEWATCH.

Glibert, Patricia, et al. [The Role of Eutrophication in the Global Proliferation of Harmful Algae Blooms.](#) 2005. Oceanography (Vol. 18, No. 2)

[Learn More: Trophic State Index \(TSI\).](#)

[Trophic State: A Waterbody's Ability to Support Plant, Fish and Wildlife.](#) 2003. Florida LAKEWATCH.

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

### Procedure – Day 1

#### Engage/Elicit

Present students with this problem: How exactly do we know if a lake or other body of water is polluted? What exactly is “pollution” anyway? Is it just toxic waste or oil spills in the water? Or can other things pollute water?

Get them to discuss and brainstorm ideas about pollution in small groups. Have them write down their ideas and circulate among the groups asking leading questions. Show them the photographs included in this lesson plan. Ask them whether they have seen lakes and streams covered in green or brown scum like that shown in the pictures. What do they think it is? What do they think causes it?

#### Explore

After brainstorming ideas and sharing what they have with the other groups, introduce the students to the FCAT worksheet with the reading material. Ask them if they have heard of “algae blooms” before and if they know anything about them. Let the students read the worksheet and answer the associated FCAT practice questions.

#### Explain

After completing the worksheet, go over the answers with the students. Help them understand what the correct answers were and try to identify areas where misconceptions or errors occurred. If possible in the time permitted today, have the students describe (either verbally or through a quick writing assignment) why they answered the way they did; if they had any difficulty, this could help identify why.

#### Extend

Hold up for the class the picture of the fertilizer bag included with this lesson. Point out the three numbers on the bag. Ask students if they know what they mean. Explain that fertilizers show their nutrient content with three numbers on the package. These numbers represent three different compounds: Nitrogen, Phosphorous, and Potash (Potassium), which are symbolized by the letters N-P-K. The three numbers listed on fertilizer labels correspond to the percentage of these materials found in the fertilizer.

Ask students to look for packages of fertilizer at their homes, and to write down the following information from the package and bring it to class to share:

1. The fertilizer's N-P-K formulation
2. What the fertilizer is used for (possible answers: general purpose, bloom booster (flowers), fruits and vegetables, orchids, roses, palms, African violets, lawns, etc.)

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

### Exchange/Evaluate

Check answers to FCAT practice questions. If necessary, assign a grade to the practice test.

### Procedure – Day 2

#### Engage/Elicit

Have students share the fertilizer package information they brought in with the class. Ask them why they think there are different relative amounts of N-P-K in the different kinds of fertilizer.

Make the observation that different kinds of plants have different nutritional needs, and that this is why different fertilizer formulations exist.

Explain the major roles of nitrogen, phosphorus and potassium in plant growth:

- Nitrogen helps plants to photosynthesize and promotes the growth of leaves.
- Phosphorus promotes the growth of roots, flowers and fruits.
- The role of potassium in plant growth is not well understood, but it seems to help plants metabolize nutrients and to resist disease.

Remind students about the algae blooms they saw in photographs and read about in the previous class and how they were an indication of pollution. Ask the students if they can recall any specific details and if they know why algae blooms can harm the environment.

#### Explore

Tell the students that one way scientists judge the health of a lake is to test whether certain substances are present, and in what amounts. Tell them that they are going to look at some of this data, and at the conclusions drawn from it.

Have the students go to the [Orange County Water Atlas](#) and from the **Topics** dropdown menu choose **Water Quality**. They should then click the link labeled **Overall Trophic State Index**. A list of lakes will be displayed. Allow the students time to explore the different lakes; remind them of which lakes they read about on Day 1 and encourage them to revisit those bodies of water so they can see where the information in Table 2 of the FCAT lesson came from.

After they have had a few minutes to familiarize themselves with the lake pages, have each student select four different lakes of their choice that were **\*NOT\*** in Day 1's reading assignment. (Note: they must choose lakes from the **Overall Trophic State Index** list produced as above; other lakes will not have data.) Ask them to create a table similar to Table 2 from the reading, finding and recording information for their four chosen lakes. The table can be created with a spreadsheet or word processing program, or freehand on paper, depending on your specific classroom goals.

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

Once the students have created their tables, have them form small groups of 4 or 5 and pool their data. Ask them to look for common elements within the data (For example: Do any of the lakes have the same limiting factors? Are the lakes from the same general areas? Etc.) They are trying to identify any patterns to the water quality of these bodies of water.

### Explain

1. Ask the students to share their group finding to the class. Did they notice any patterns? Did certain lakes, especially those near each other, tend to have similar readings and measurements? On the blackboard or other central area, you can begin making a list of the common elements found by the students. Can the students offer any explanation as to why these patterns exist?
2. Tell the students to imagine that they are building a house out of blocks, and that two colors of block are available, red and blue. The specifications for this particular house say no more than 6 red blocks can be used for every blue block. The block wholesaler delivers 900 red blocks and 90 blue blocks. How many blocks of each color can be used? How many are left over?

The answer is that because we can only use 6 red blocks for every blue one, so we could use no more than  $(6 \times 90) = 540$  of the red blocks, and there would be 360 left over. (If we had 60 more blue blocks, we could use up all of the remaining red ones.)

Explain that this is how the idea of a "limiting nutrient" works. Plants use nitrogen and phosphorus in a finite proportion to each other. There may be "extra" nitrogen in a lake, but plants can't use it because there isn't enough phosphorus, so phosphorus would be the limiting nutrient. However, if additional phosphorus were added, an increase in plant growth would result. (In a nitrogen-limited lake, the reverse would be true: there would be not enough nitrogen available for plants to use the existing phosphorus.) Where there is not "extra" nitrogen OR phosphorus, a lake is said to be "balanced".

### Extend

1. If time permits (or if you can extend the lesson an extra day), have the students use the [Advanced Mapping Tool](#) on the Orange County Water Atlas to locate the lakes they selected; you can either project the map from the Atlas up at the front of the classroom (if you have the equipment) or have the students draw an approximation of the map on a large piece of poster board so that they can all see the location of their bodies of water and their relative quality. If using the Advance Mapping Tool on a projection screen, show the students how you can identify Impaired and non-Impaired waters based on their color (the Impaired waters are Red and the non-Impaired are tan). This can let them see easily if bodies of water near each other are the same color and could be very useful in establishing a pattern of pollution.

## Measuring Lake Quality Lesson Plan

*Students learn how nutrients affect plant growth and water quality in water bodies.*

Is there any pattern to their location? Is there a common pollutant in certain areas identified in their tables? After creating map, brainstorm links and connections with class. Theorize how lakes became the way they are. Research actual causes for pollution at specific lakes.

2. Build the AquaTerra ecosystems and perform the experiment described in the **How Healthy Is Your Lake?** lesson in this curriculum. Or, come up with a new experiment. One possibility: Use several different fertilizer formulations in different ecosystems and compare the growth of the plants in the top of the ecosystem and the algae growth in the water below. Try to explain what happened and why.
3. Collect water from a nearby lake. Test samples of the water for its nitrogen and phosphorus content, using a classroom water testing kit. Examine drops of the water under a microscope; can you see algae in the water? Microorganisms? Identify what you observe. Does it provide any indication about whether the water quality is good or bad?

### Exchange/Evaluate

Verify information is correct on student generated tables. Reward/encourage discussion when generating map and discussing patterns.

Curriculum developed for Orange County Environmental Protection Division by USF's Florida Center for Community Design & Research. This material is based upon work supported by the Department of Energy under Award Number DE-EE0000791.

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.



*Photo credit: Florida Center for Community Design & Research, University of South Florida*



*Photo credit: Florida Center for Community Design & Research, University of South Florida*



*Photo credit: Florida Center for Community Design & Research, University of South Florida*

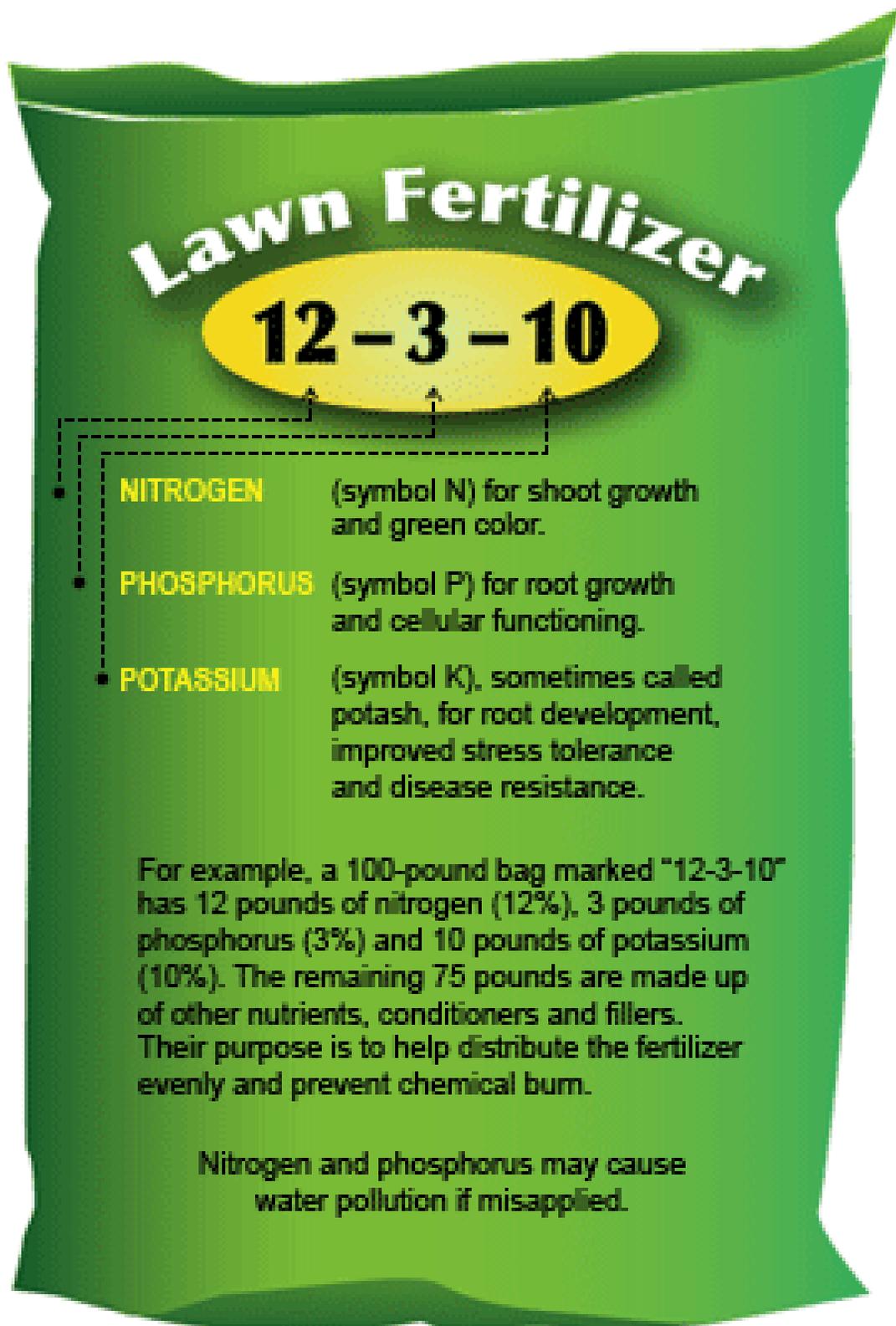


Image source: Southwest Florida Water Management District