Measuring Lake Quality *Lesson Plan*

Students practice for the FCAT while learning about lake quality and how humans impact it.

Topic: The Trophic State Index (TSI) is one factor used in determining lake water quality. Scientists also investigate a lake's dissolved oxygen and biotic factors, such as bacteria, plant, and animal species, to determine water quality. This activity focuses on TSI because there is a high correlation between water quality and the plant nutrients measured by the TSI. The following information from the Orange Water Atlas illustrates the relationships of nutrient scores and water quality.

To quote the Orange County Water Atlas:

> *"Trophic" means "relating to nutrition." To determine a waterbody's trophic state, the Trophic State Index (TSI) takes into account measurements of chlorophyll, nitrogen, and phosphorous, which are nutrients required by plant life. Florida waterbodies are classified into four trophic states: oligotrophic (lacking plant nutrients, the TSI is 0-49), mesotrophic (having a medium amount of plant nutrients, the TSI is 50-60), eutrophic (rich in plant nutrients, but often at the expense of dissolved oxygen; the TSI is 61-69), and hypereutrophic (extremely rich in plant nutrients, the TSI is greater than 69). The Florida Department of Environmental Protection (FDEP) uses this information to determine a good, fair or poor rating for the waterbody:*

Ratio	TSI Range	Use
GOOD	0-59	Fully supports designated use.
FAIR	60-69	Partially supports designated use.
POOR	70-100	Does not support designated use.

High levels of nutrients in lake water cause increased plant growth (hence greater levels of chlorophyll). As the levels of nutrients and chlorophyll increase, the TSI score also increases. Therefore, high TSI scores reflect poor lake quality. Yard fertilizers are one contributor to poor TSI. When these nutrients wash into lake water, they cause algae to grow at higher-than-normal rates. Algae add oxygen to lake water during photosynthesis, but it also uses oxygen during respiration. When the algae die, it is decomposed by bacteria that also use up oxygen. Between the algae growth and the bacteria, the oxygen level in poor quality lakes decreases. Very low oxygen levels can even lead to fish kills.
The Water Atlas website provides data that helps assess lake health. For example, the TSI Historic Range demonstrates how water quality has changed over the years. Lake managers can use this and other information to track down causes for and find solutions to water quality problems. On the Atlas, nutrients like nitrogen and phosphorous are measured in micrograms per liter of lake water (ug / liter). One gram equals one million (1,000,000) micrograms. Tracking nutrient levels can help scientists determine which nutrients affect plant growth and lake quality. In many Orange County lakes, phosphorous is listed as a "Limiting Nutrient." This means that if the amount of phosphorous were decreased, the number of problem plants in the lake would also decrease. As a result, some lake managers, wishing to restrict plant growth and improve lake quality, work to decrease lake

phosphorous levels. Other lakes in Orange County have nitrogen listed as a limiting nutrient. If a lake is listed as "balanced," neither phosphorous nor nitrogen are limiting factors, but equal in their effect on plant growth.

Grade Level: Middle

Performance Objectives:

References are to the Next Generation Sunshine State Standards.

Language Arts

LA.6.1.6.3	The student will use context clues to determine meanings of unfamiliar words.
LA.6.1.7.2	The student will analyze the author's purpose (e.g., to persuade, inform, entertain, or explain) and perspective in a variety of texts and understand how they affect meaning.
LA.6.1.7.3	The student will determine the main idea or essential message in grade-level text through inferring, paraphrasing, summarizing, and identifying relevant details.
LA.6.4.2.1	The student will write in a variety of informational/expository forms (e.g., summaries, procedures, instructions, experiments, rubrics, how-to manuals, assembly instructions).

Math

MA.8.A.6.1	The student will use exponents and scientific notation to write large and small numbers and vice versa and to solve problems.
MA.7.A.3.2	The student will add, subtract, multiply, and divide integers, fraction, and terminating decimals, and perform exponential operations with rational bases and whole number exponents including solving problems in everyday contexts.

Academic Outcomes/Lesson Objectives:

- Students will read a selection introducing them to methods for measuring lake quality.
- Students will respond to FCAT-type questions or prompts in Reading, Writing, and Math.

Time Allotted: One Instructional period (50 minutes)

References:

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

Trophic State: A Waterbody's Ability to Support Plant, Fish and Wildlife
2003. Florida LAKEWATCH.

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

Materials:

- Student handout: "Measuring Water Quality"
- Computer with internet access (optional)

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 µg 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.

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

Answer Key

Reading

1. b) LA.6.1.6.3, Bloom's Taxonomy Level One

2. Use the rubric for Extended Response Reading Questions – 4 points
   LA.6.1.7.2, Bloom's Taxonomy Level Two
   Example of a Top-Score Response:
   Human choices can impact lake quality both negatively and positively. When people choose to add extra nutrients to a lake, either by using too much fertilizer or by allowing pet waste to wash into them, this decreases the lake's quality. On the other hand, people can choose to measure lake quality and make decisions to help keep these water bodies healthy. They can choose to restrict the use of fertilizers and scoop up pet waste. In this way, human choices can both improve and decrease lake quality.

3. b) LA.6.1.7.3, Bloom's Taxonomy Level One
4. Use the rubric for Extended Response Reading Questions – 4 points
   LA.6.1.7.3, Bloom's Taxonomy Level One
   Example of a Top-Score Response:
   Lake Poinsett is a poor quality lake. Its TSI of 80 is greater than the TSI of the fair quality Lake Beauclair (TSI 64). The fair quality lake, in turn, has a greater TSI than good quality Palm Lake (TSI 13). In each case, the TSI increases as the phosphorus and nitrogen levels increase. This means that poor water quality often goes hand in hand with high nutrient levels (high TSI). Good water quality often goes along with low levels of nutrients (low TSI).

Writing

For All – Use the rubric for Florida Writes! – 6 points

1. LA.6.4.2.1
2. LA.6.4.2.1
3. LA.6.4.2.1
4. LA.6.4.2.1

Math

1. Use the rubric for Short Response Math Questions – 2 points MA.7.A.3.2

   Example of a Top-Score Response:
   Only Lake Poinsett has a TSI value closer to the low quality end of its range.

   For each lake, subtract the current value from the low quality end of the range. Then subtract the high quality value from the current TSI. If the difference is smaller between the current TSI and the low quality value, the Lake is included on the list of answers above.
   Example:
   Beauclair: 99 – 64 = 35 and 64 – 42 = 22 35 > 22 Closer to High Quality End

   Alternatively, compute the midpoint of the TSI range and determine on which side of the midpoint the current value falls.

Examples:

Beauclair:	((99 – 64) / 2] + 64 = 70.5	64 < 70.5	Closer to High Quality End
Poinsett:	(87 + 40) / 2 = 63.5	80 > 63.5	Closer to Low Quality End

A top score response will include a computation like one of the above for each lake in the table.

2. d) MA.7.A.3.2
3. a) MA.8.A.6.1
4. b) MA.7.A.3.2

The original version of this lesson was written by Kelley G. Weitzel for the Seminole County Water Atlas; it was adapted in 2011 by Water Atlas staff for use on the Orange County Water Atlas.

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