# An Introduction to Trophic States

## Southwest Region

Using Water Chemistry and Aquatic Plants to Estimate a Lake's Biological Productivity

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**Have you ever noticed** how different lakes are, throughout Florida? Some have crystal clear water and sandy bottom sediments while others are pea-soup green in color with lots of mucky sediments. Some lakes have reddish water with a few plants floating on the surface and others are so chalk full of plants, it seems we could walk across them. All of these characteristics provide clues about the waterbody's biological productivity – its ability to support life.

When faced with the challenge of trying to describe the various levels of biological productivity, scientists developed the **Trophic State Classification System**. Using this system, a waterbody can be grouped into one of four categories called **trophic states**. The adjectives used to denote each of these four trophic states, from the lowest level of biological productivity to the highest, are as follows:

**oligotrophic** (oh-lig-oh-TROH-fic) means scant or lacking nutrition.
**mesotrophic** (mes-oh-TROH-fic) means mid-range or medium nutrition.
**eutrophic** (you-TROH-fic) means abundant nutrition.
**hypereutrophic** (HI-per-you-troh-fic) means overabundant nutrition.

The ***Trophic State Classification System*** is useful for a number of reasons: It helps us understand why lakes differ so much and also provides a handy way to describe a lake or waterbody. For example, if a lake scientist (limnologist) in Spain uses the term "oligotrophic" while describing a lake to his colleague in Canada, the Canadian will be able to gain a general idea of the waterbody's productivity without even seeing it.

### Estimating the Biological Productivity of a Waterbody

There are several Trophic State Classification Systems used today. In this lesson, we'll be using a system developed by two scientists, Forsberg and Ryding. Their criteria for classifying lakes are based on the following four water chemistry parameters (see definitions below). *Note: These four parameters are used to estimate **biological** productivity, as it's simply not possible to measure every living thing in a lake or pond at any given time.*

**Chlorophyll** – is the dominant green pigment found in most algae. Since algae are a basic food source for many aquatic animals, we often measure the **total chlorophyll** (algal) concentrations found in collected water samples to help us estimate the biological productivity of a waterbody. Chlorophyll is the main parameter used to assess productivity in this trophic state classification system.

**Total phosphorus –** is a measure of all the forms of phosphorus found in a collected water sample. Phosphorus is an element (nutrient) necessary for the growth of all plants, including algae and aquatic plants. When this nutrient is in low supply, low biological productivity can be generally expected whereas highly productive waterbodies usually have an abundance of phosphorus.

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**Total nitrogen –** is a measure of all the forms of nitrogen found in a collected water sample. Nitrogen is also a necessary nutrient for the growth of plants, including algae and aquatic plants. When total nitrogen is in low supply, low biological productivity can generally be expected, along with clearer water.

**Secchi depth –** is a measurement that indicates water clarity, which is influenced by several factors including free-floating algae, dissolved organic compounds (tannins) and suspended particles.

**There are several other variables that impact this classification system – especially in Florida, where lakes often have an abundance of plants. For example:**

1) Nutrients are assimilated ("taken up") by aquatic plant tissues and, as a result, they may not be accurately represented in the water chemistry analysis;

2) Nutrients are "taken up" by algae that grow on submersed aquatic plants and other underwater structures; as a result, they may not be accurately represented in the water chemistry analysis.

3) Dense coverage of aquatic plants prevents wind and waves from stirring up bottom sediments; this keeps the nutrients "tied up" in the bottom sediments that might otherwise cause a planktonic algae bloom. As a result, the nutrients and/or chlorophyll may not be accurately represented in the water chemistry analysis.

4) In addition to algae, the overall abundance of larger plants in a lake is an important indicator of biological productivity. When assessing aquatic plant abundance/importance in a waterbody, scientists measure the percent of the bottom area that has aquatic plants growing on or over it; this is known as **PAC** or **"Percent Area Covered**."



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**The purpose of this activity is to gain a better understanding of the different levels of biological productivity found in lakes throughout Florida and the influence that aquatic plants may have on the overall "equation."**

**Directions:** Use the water chemistry data (below) and the attached Trophic State Classification handout to identify the trophic state of each lake.

| **Lake Name / County** | Total Chlorophyll Chl (ug/L) | Total Phosphorus TP (ug/L) | Total Nitrogen TN (ug/L) | Secchi Depth (feet) | Percent Area Coverage (% PAC)* | Trophic State |
|---|---|---|---|---|---|---|
| Little Lake Jackson, Highlands | 41.5 | 54 | 1007 | 3.3 | 11.0 | |
| Lake Alice, Hillsborough | 1.3 | 4 | 136 | 17.2 | 92 | |
| Mango, Hillsborough | 135.5 | 201 | 2417 | 1.2 | No data | |
| Lake Dinner, Highlands | 5.3 | 9 | 584 | 9.3 | No data | |
| Lake Istokpoga, Highlands | 38.1 | 55 | 1299 | 2.7 | 32.0 | |
| Lake Jackson, Highlands | 5.5 | 17 | 414 | 8.5 | No data | |
| Lake Crews, Pasco | 13.7 | 52 | 1157 | 2.7 | No data | |
| Lake Clear, Lake | 2.7 | 11 | 488 | 11.9 | 40.0 | |

Name: ________________________________________ Class Period:_____ Date:___________

**Questions**

1. Which characteristics were most helpful in determining the trophic state of each lake? Explain your answer.

2. Explain the relationship between each of the following:

    a. Secchi depth and trophic state –

    b. total phosphorus and trophic state –

    c. chlorophyll and trophic state –

3. If you were fishing for bass, which lake might you prefer and why?

4. If you wanted to go swimming, which trophic state category would you prefer for a lake? Why?

5. Using data in the table above, what relationship do you find between % PAC and trophic state of the lake? Explain.



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