Trophic State:
A Waterbody's Ability To Support Plants, Fish, and Wildlife

When faced with the challenge of trying to describe and organize what is known about the many varied and diverse waterbodies, scientists developed the Trophic State Classification System. It's one of the more commonly used systems worldwide and is used by Florida LAKEWATCH.

Using this system, waterbodies can be grouped into one of four categories, called "trophic states," based on their level of biological productivity.

Knowing what these terms mean and how they can be useful in managing your waterbody could come in handy someday. By reading this handout, you can learn:

- **how water chemistry is used to determine a waterbody's trophic state;**
- **what criteria are used to define the four trophic states;**
- **which trophic state category your waterbody fits into; and**
- **how the Trophic State Classification System can be useful.**

The names of the four trophic states, from the lowest level of biological productivity to the highest, are listed below:

Oligotrophic (oh-lig-oh-TROH-fic)

Mesotrophic (mes-oh-TROH-fic)

Eutrophic (you-TROH-fic)

Hypereutrophic (HI-per-you-troh-fic)

> The root word **trophic** means **"of or relating to nutrition**." The prefixes used in the Trophic State terminology (see words at left) provide clues to their meaning.
>
> **Oligo** means "scant or lacking."
> **Meso** means "mid-range."
> **Eu** means "good or sufficient."
> **Hyper** means "over abundant."

Using Water Chemistry To Determine a Waterbody's Trophic State

It's no coincidence that the Florida LAKEWATCH Program monitors the same four water chemistry parameters that scientists use to determine a waterbody's trophic state: total chlorophyll, total phosphorus, total nitrogen, and water clarity. These four parameters serve as indicators of a waterbody's biological productivity — its ability to support life. The word "indicator" is used here, because biological productivity is not something that can be measured directly. However, it can be estimated. Read on to find out how each parameter relates to the biological productivity of your waterbody and to its trophic state. (Continued on page 2.)

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Using Water Chemistry to Determine A Waterbody's Trophic State (continued from page 1)

Four Water Chemistry Parameters to Determine Trophic State:

Chlorophyll — is the dominant green pigment found in most algae (the microscopic plant-like organisms living in a waterbody). Chlorophyll enables algae to use sunlight to make food. In fact, most algae are so dependent upon chlorophyll pigments for survival that a measurement of the concentration of all the chlorophyll pigments found in a water sample (called *total* chlorophyll) can be used to estimate the amount of free floating algae in that waterbody. When large amounts of total chlorophyll are found in the sample, it generally means there are a lot of algae present.

Once we have an estimate of the amount of algae in a waterbody, we can take it a step further and use this information to estimate a trophic state. Since algae are a basic food source for many aquatic animals, their abundance is a crucial factor in how much life a waterbody can sustain. In general, when measurements of total chlorophyll are high (indicating lots of algae are present), the waterbody will be more biologically productive.

Phosphorus — is a nutrient necessary for the growth of algae and aquatic plants. It's found in many forms in waterbody sediments and dissolved in the water. LAKEWATCH uses a measurement called "total phosphorus" that includes all the various forms of phosphorus in a sample.

When this nutrient is in low supply (and all other factors necessary for plant and algae growth are present in sufficient amounts), low biological productivity can be expected. On the other end of the trophic state scale, highly productive waterbodies usually have an abundance of phosphorus.

In some waterbodies, phosphorus may be at a level that limits *further* growth of aquatic plants and/or algae. When this is true, scientists say phosphorus is the "limiting nutrient."

Nitrogen — is also a nutrient necessary for the growth of algae and aquatic plants. The LAKEWATCH measurement includes the sum of all forms of nitrogen called "total nitrogen." When total nitrogen is in low supply (and other factors necessary for plant and algae growth are present in sufficient amounts), low biological productivity can be expected. Like phosphorus, nitrogen can be a limiting nutrient.

Water clarity — refers to the clearness or transparency of water. Water clarity is determined by using an 8-inch diameter disk, called a Secchi (pronounced SEC-ee) disk. The maximum depth at which the Secchi disk can be seen when lowered into the water is measured. Several factors can affect water clarity in the following ways:

- free floating algae in the water can make waterbodies less clear;
- dissolved organic compounds (called tannins) can cause waterbodies to appear reddish or brown; and
- suspended solids (tiny particles stirred up from the waterbody's bottom or washed in from the watershed) can cause the water to be less clear.

Use Secchi Measurements With A Grain Of Salt

For waterbodies in which the presence of algae is the main factor that diminishes water clarity, the Secchi disk reading can be used to form an estimate of the waterbody's biological productivity. In this case, when the Secchi disk reading is a small number, it would indicate high levels of algae and therefore high biological productivity.

Basing an estimate of biological productivity on water clarity alone is an attractive option, because the measurement is inexpensive and simple. However, if dissolved organic compounds (tannins) or suspended solids are present in significant amounts, this method may be misleading — giving the impression the waterbody is more biologically productive than it actually is. LAKEWATCH measures both water clarity and total chlorophyll (algae) in order to get a more realistic picture.

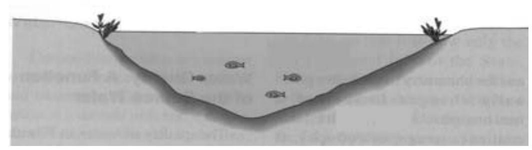
When the amount of algae in a lake is high, the Secchi disk disappears from view at a shallow depth.

Criteria Used to Define the Four Trophic States

There are several different Trophic State Classification Systems being used today. In 1980, two scientists, Forsberg and Ryding, developed criteria for classifying lakes into trophic states based on four water chemistry parameters (total chlorophyll, total phosphorus, total nitrogen, and water clarity). Although developed for Swedish lakes, their criteria work well for lakes in Florida and have been adopted by Florida LAKEWATCH. Definitions of the four trophic states, descriptions of typical waterbodies in each trophic state, and the Forsberg and Ryding criteria are listed below:

Oligotrophic waterbodies have the lowest level of biological productivity.

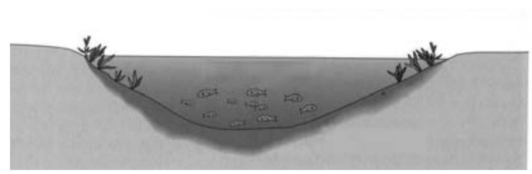
Criteria: total chlorophyll is less than 3 μg/L*
total phosphorus is less than 15 μg/L
total nitrogen is less than 400 μg/L
water clarity is greater than 13 feet



A typical oligotrophic waterbody will have clear water, few aquatic plants, few fish, not much wildlife, and a sandy bottom

Mesotrophic waterbodies have a moderate level of biological productivity.

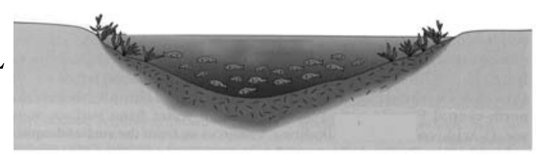
Criteria: total chlorophyll is between 3 and 7 μg/L
total phosphorus is between 15 and 25 μg/L
total nitrogen is between 400 and 600 μg/L
water clarity is between 8 and 13 feet



A typical mesotrophic waterbody will have moderately clear water and a moderate amount of aquatic plants.

Eutrophic waterbodies have a high level of biological productivity.

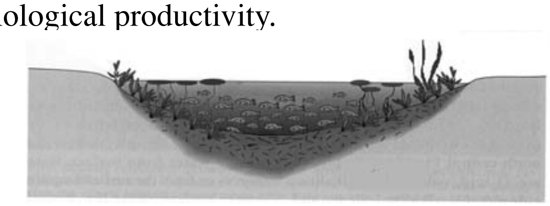
Criteria: total chlorophyll is between 7 and 40 μg/L
total phosphorus is between 25 and 100 μg/L
total nitrogen is between 600 and 1500 μg/L
water clarity is between 3 and 8 feet



A typical eutrophic waterbody will either have lots of aquatic plants and clear water; or it will have few aquatic plants and less clear water. In either case, it has the potential to support lots of fish and wildlife.

Hypereutrophic waterbodies have the highest level of biological productivity.

Criteria: total chlorophyll is greater than 40 μg/L
total phosphorus is greater than 100 μg/L
total nitrogen is greater than 1500 μg/L
water clarity is less than 3 feet



A typical hypereutrophic waterbody will have very low water clarity, the potential for lots of fish and wildlife, and it may have an abundance of aquatic plants.

* **The unit of measurement "micrograms per liter" is abbreviated "μg/L."**

How Trophic States Can Be Useful to You

➢ **You can reconcile your expectations with a waterbody's true potential.**

For example, oligotrophic waterbodies are often considered better suited for swimming than for fishing or watching wildlife. Because they typically have low levels of algae, the water is clear — an enticing feature for swimmers. However, the same clear water contains little food and habitat for supporting abundant fish and wildlife populations.

On the other end of the trophic spectrum, eutrophic or hypereutrophic waterbodies are often considered better suited for fishing and bird watching, because they typically have an abundance of food and habitat. Most swimmers, however, would not enjoy being in the less clear water, or disentangling themselves from the abundant plant growth that is generally characteristic of these highly productive waterbodies.

➢ **You can choose effective management strategies.**

Once you've defined management goals for your lake, you will have to choose among different management techniques to achieve them. Knowing your waterbody's trophic state can help you make an informed decision and improve your chances for success.

For example, if your waterbody were oligotrophic and more trophy bass were desired, it would be a mistake to merely stock more fish. There wouldn't be enough food to support them. A more effective management option might be to add nutrients to the waterbody, as is done by fisheries management agencies, to increase the amount of food (algae) and/or plants (habitat) in the water. In contrast, if your waterbody were eutrophic, a better choice of management options might be to impose restrictions on the size of bass that can be harvested from the waterbody (a slot limit), rather than adding nutrients.

➢ **You can communicate more effectively among citizens and water management professionals.**

Using the trophic state vocabulary allows us to describe a waterbody and its biological productivity in a single word. For example, to say a waterbody is oligotrophic should evoke a picture of crystal clear water, few aquatic plants, a sandy bottom, few fish, and scarce wildlife. Although some professionals debate the specifics, these descriptions are accurate enough to be extremely useful in water management communication.

➢ **You can monitor over the long term to see if your waterbody's trophic state changes.**

Many people are concerned about the impact of activities on their waterbody — factors like increasing population, nearby mining, drought, flooding, or others. However, some change is normal in living systems like waterbodies. How can you decide which changes are merely normal fluctuations and which are not? Many aquatic scientists view changes as being significant when they result in a waterbody moving from one trophic state to another. In this way the trophic state classification provides a useful yardstick for evaluating the seriousness of changes in your waterbody.

Aquatic plants play a major role in a waterbody's biological productivity by providing habitat for aquatic organisms and support for attached microorganisms like algae and small animals. Aquatic plant abundance also serves as an important indicator of a waterbody's trophic state. Consequently, some waterbodies may be classified into the wrong trophic state if the abundance of aquatic plants is not taken into account. For example, when submersed aquatic vegetation covers more than 50% of a waterbody's bottom, there will generally be less algae floating in the water.✪ The resulting low chlorophyll measurements may cause some waterbody managers to classify a waterbody as having a low level of biological productivity, even though the presence of large amounts of submersed aquatic plants clearly demonstrates that it is highly productive.

Unfortunately, it's expensive and time-consuming to perform a survey of aquatic plants, so these important data are often not available. In an effort to bridge the information gap, Florida LAKEWATCH staff and University of Florida students are conducting aquatic plant surveys on selected LAKEWATCH waterbodies during the summer months, as funding permits.

✪ *One explanation is that either the submersed plants, or perhaps the algae attached to them, use the available phosphorus in the water, depriving the free-floating algae of this necessary nutrient. Another explanation is that the submersed plants anchor the nutrient-rich bottom sediments in place — buffering the action of wind, waves, and human effects — depriving the free-floating algae of phosphorus contained in the muds that would otherwise be stirred up. Additionally, it's thought that algae will attach to underwater plants instead of floating in the water.*

The Trophic Classification System is just one way to group lakes. To discuss this handout or for more information, call our toll-free number 1-800-LAKEWATCH (1-800-525-3928). We welcome your questions, suggestions, and comments.