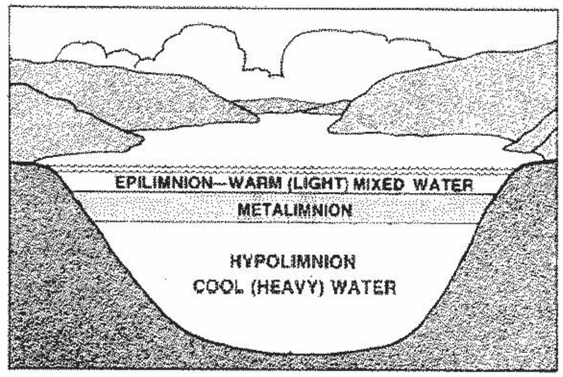
UNDERSTANDING LAKE ECOLOGY

■ *Lakes in Snohomish County* – Lakes are standing bodies of fresh water, usually more than an acre in size and deeper than 6 feet. There are about 60 lakes situated in the populated lowland portions of Snohomish County. Glaciers formed most of these lakes by gouging out holes in soil or bedrock or by depositing large blocks of ice whose melting created lake basins. These lowland lakes range in size from less than 10 acres to more than 1000 acres. Some of the lakes are more than 70 feet deep, while others are quite shallow. The average depth of a lake is often a good indicator of its biological activity. Shallow lakes tend to produce more algae and plants than deep lakes.

■ *Watersheds* – Every lake is a reflection of its watershed—the land area that drains into a lake. The watershed provides most of the water that flows into a lake through surface runoff or ground water. This water also brings nutrients, sediment, and other substances into the lake. These substances, in turn, affect the clarity of water, the amount and types of algae, and even the abundance of fish in a lake. Therefore, any activity in the watershed that contributes nutrients or sediment or affects water flow has the potential to change a lake's condition.

■ *Temperature and Stratification* – The temperature of water in a lake changes with the seasons and often varies with depth. During spring and summer, the sun warms the upper waters. Because warmer water is less dense, it floats above the cooler, more dense water below. The temperature and density differences tend to create distinct layers of water in the lake, and these layers do not mix easily. This process is known as stratification and occurs in all but the most shallow lakes.

The upper water layer, called the epilimnion, is warmer and receives more light than the lower layers. The colder, denser, darker bottom zone is called the hypolimnion. The metalimnion is the narrow band between the upper and lower waters where the temperature changes quickly with depth. The following illustration shows the pattern of thermal stratification in a typical lake.



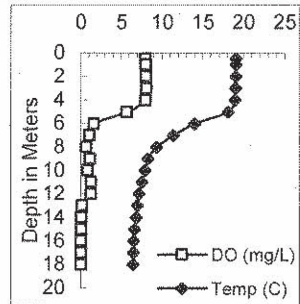
Lake Stratification
Adapted from *The Lake and Reservoir Restoration Guidance Manual*, North American Lake Management Society, 2nd Ed, 1990.

In the fall, as the upper waters cool, the temperature and density differences between the lake layers decrease. Eventually, wind and waves are able to overcome the forces separating the layers, and the entire lake mixes. This phenomenon is called fall turnover.

■ *Oxygen* – Oxygen dissolved in the water is essential for life in a lake. Most of the dissolved oxygen comes from the atmosphere, mainly from the mixing action of winds and waves. Like temperature, dissolved oxygen levels in a lake will vary over time and with depth. During the warm months, the epilimnion receives oxygen from the atmosphere, but the colder, denser bottom waters do not mix with the upper waters, so the hypolimnion is not re-supplied with oxygen. Also, the activity of bacteria that decompose organic matter in the lake bottom often consumes much of the oxygen in the hypolimnion. This summertime combination of oxygen depletion in the hypolimnion together with the warming of the epilimnion can create problems for fish.

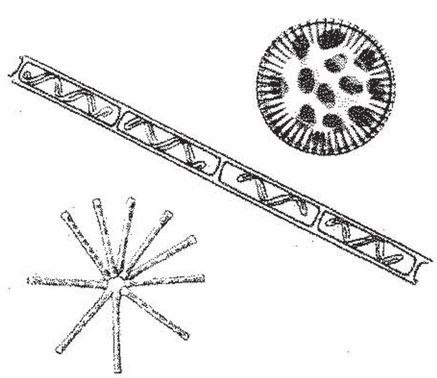
Typical Summer Dissolved Oxygen (DO) and Temperature Patterns in a Stratified Lake

(the lake surface is at the top of the graph)



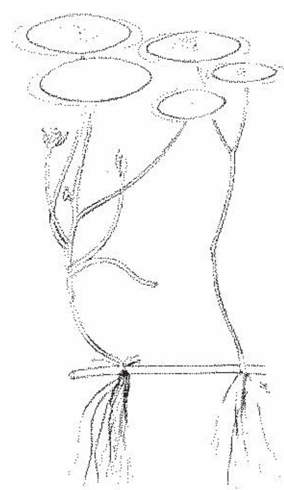
■ *Nutrients*–Nutrients, such as phosphorus and nitrogen, are essential for the growth of algae, fish, and aquatic plants in lakes. However, too many nutrients can enrich or pollute a lake. Unfortunately, human activities around the lake shore and throughout the watershed can contribute excess nutrients and other pollutants. Sources of nutrients include lawn and garden fertilizers, eroded soil, road runoff, poorly maintained septic systems, decomposing yard wastes, pet and animal wastes, and waterfowl droppings. Almost all lake protection efforts require actions to control nutrient runoff from the watershed. Phosphorus stored in lake bottom sediments can also be released into the lake water when dissolved oxygen levels drop during summer stratification. Sometimes in-lake action to control this source of nutrients is also necessary.

■ *Algae* – Algae are tiny plant-like organisms that are essential for a healthy lake. Fish and other aquatic life depend on algae as the basis for their food supply. However, excessive growths of algae, called algal blooms, can cloud the water, coat docks and pipes, deplete the oxygen, form unsightly scums, and sometimes release toxins. The main culprits causing these problems are a group called blue-green algae, which are actually bacteria that act like plants. If a lake experiences regular nuisance blue-green algal blooms, this is a strong indication that the lake is receiving excessive amounts of nutrients.



Examples of Freshwater Algae
Drawings by IFAS, Center for Aquatic Plants, University of Florida, 1990; and U.S. Soil Conservation Service, *Water Quality Indicators Guide: Surface Waters*, 1989.

■ *Aquatic Plants* – Aquatic plants are also important in a lake ecosystem. Aquatic plants provide food and shelter for fish and other aquatic animals, stabilize the shoreline and bottom sediments, and in some cases increase water clarity by out-competing algae for nutrients. Some plants grow entirely submersed under the water, some have leaves that float on the surface, and others have roots under the water with most of the plant standing above the water.



Watershield—A Native Aquatic Plant
Drawing by IFAS, Center for Aquatic Plants, University of Florida, 1990

Although aquatic plants are essential for lake health, excess growths of aquatic plants can interfere with swimming, boating, fishing, and wildlife habitat. In addition, invasion by non-native plant species can seriously damage a lake ecosystem. Non-native plants choke out native aquatic plants and form dense stands that are a nuisance to humans and wildlife.

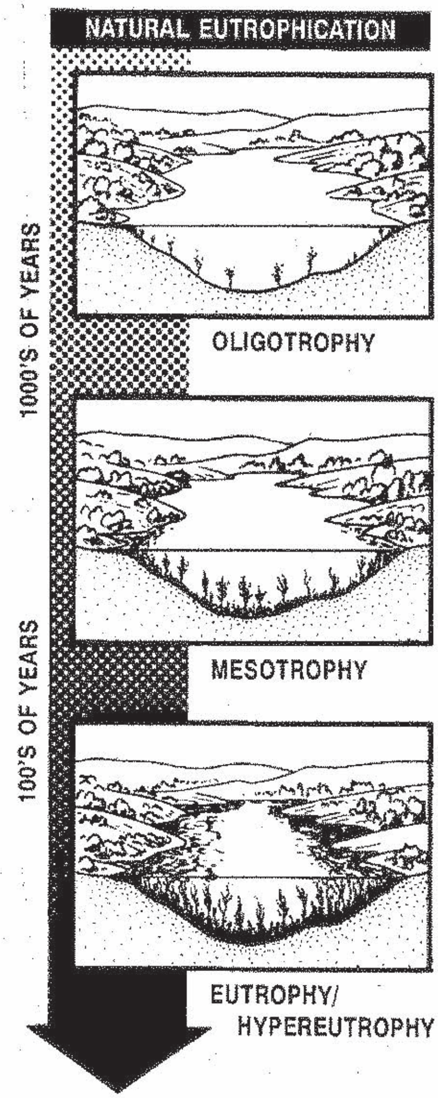
■ *Eutrophication and Trophic States* – All lakes go through a process of enrichment by nutrients and sediment. In this process, known as eutrophication, nutrients and sediment contribute to the ever-increasing growth of algae and aquatic plants. Over thousands of years, lakes will gradually fill up with organic matter and sediments.

Lakes are often classified by their degree of eutrophication—their trophic state. There are three primary trophic states for lakes—oligotrophic, mesotrophic, and eutrophic. Oligotrophic lakes are usually deep, with clear water, low nutrient concentrations, and few aquatic plants and algae. Mesotrophic lakes are richer in nutrients and produce more algae and aquatic plants. Eutrophic lakes are often shallow and characterized by abundant algae and plants, high nutrient concentrations, limited water clarity, and low dissolved oxygen in the bottom waters.

The trophic state of a lake can be determined in several ways. Three key factors are measurements of water clarity (how far down into the water one can see), total phosphorus concentrations, and chlorophyll *a* (a measure of the amount of algae in the water).

The trophic state classification of a lake does not necessarily indicate good or bad water quality because eutrophication is a natural process. It is possible for a lake that is shallow and naturally eutrophic to be considered in healthy condition if the fish are thriving and the algae and aquatic plants do not restrict lake users.

However, human activities that contribute sediment and excess nutrients to a lake can dramatically accelerate the eutrophication process. Therefore, a lake—even an oligotrophic one—may be considered at risk or impaired if it has more algae or aquatic plants than in the past. Increasing levels of aquatic plants and algae (especially blue-greens) are often signs of accelerated eutrophication.



The Natural Process of Eutrophication (Note: human activities can shorten this process to a matter of decades)

Illustration adapted from *Managing Lakes and Reservoirs*, The North American Lake Management Society, 3rd. Ed., 2001.