What We Measure and Why

Lake level is a relative measure of the water level that is recorded daily using a staff plate installed on either a pole or a fixed height dock. These data can be used to look at the annual fluctuation of water levels in the lake, as well as response to increased water coming in due to storm event and the rate at which it drains. While most of the installed staff plates at lakes around the county are not surveyed to tie the data in with sea level, this could be done in the future to give actual elevations above sea level.

Daily **precipitation** is measured at the same time as lakelevel in order to relate the lake level to inputs from the watershed. These data are collected either through a plastic rain gauge provided by King County that can be emptied after reading each day or by a recording weather station if the volunteer chooses to purchase a reliable unit.

Secchi (pronounced "Seh-kee") transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a standardized black and white disk disappears from view when lowered from the water surface. Factors in the water that affect Secchi readings include the number and size of particles present, such as algae and silt, as well as water color from dissolved organic molecules. Other factors that affect the readings are the amount of glare, waves or choppiness of the water, shade from tall trees or the boat, as well as variation in the vision of the observers.

Level I volunteers measure Secchi depth and water temperature at a station in the middle of the lake weekly throughout the year. Level II volunteers measure 12 times between May and October when they collect water samples for laboratory analysis.

Water temperature is usually measured using an alcohol-based thermometer that holds a specific temperature long enough to allow the observer to read the value after retrieving the thermometer from the water.

Phosphorus and **nitrogen** are naturally occurring elements necessary for growth and reproduction in both plants and animals. However, many activities associated with human activities, such as residential development and agriculture can increase these nutrients in water beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is most often limited by the amount of available phosphorus. Increases in phosphorus can lead to more frequent and dense algae blooms – a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by cyanobacteria (bluegreen algae) that can produce toxins.

Total phosphorus (TP) and **total nitrogen (TN)** are both measured every time the Level II volunteers collect water at the 1m depth. More specific forms of nitrogen and phosphorus are measured twice during the sampling period, when water is collected from 3 depths at the station: at 1 m, the middle depth of the water column, and 1 m from the lake bottom. These include nitrate-nitrite, ammonia, and soluble reactive phosphorus (orthophosphate), and the data can be used to infer the amount of oxygen present in deep water, as well as the presence of internal loading of nutrients from the sediments back into the lake water.

The **ratio of total nitrogen to total phosphorus (N:P)** can be used to determine if nutrient conditions are favorable for the growth of cyanobacteria (bluegreen algae), which can negatively impact uses of the lake and potentially produce toxins. When N:P ratios are near or below 25, nitrogen is equally likely to

be the limiting nutrient as phosphorus. Cyanobacteria may then be able to dominate the algal community due to their ability to "fix" nitrogen (absorb nitrogen from air).

Chlorophyll-*a* concentrations indicate the abundance of phytoplankton (algae) in the lake. Although different species of algae contain varying amounts of chlorophyll, all algae must have some in order to complete the photosynthetic pathway by which they store energy. For example, some cyanobacteria have other light-catching pigments and thus have relatively little chlorophyll compared to their biovolume.

Pheophytin is a product of chlorophyll decomposition and is generally measured along with chlorophyll as an indicator of how reliable the chlorophyll measurement is for indicating the amount of living phytoplankton present. Bottom sediments will contain a large amount of pheophytin compared to chlorophyll, while samples with actively-growing algae from surface waters will have very little pheophytin present.

A common method of tracking water quality trends in lakes is by calculating the **Trophic State Index (TSI)**, developed and first presented by Robert Carlson (1977). TSI values predict the biological productivity of the lake based on three parameters that are easily measured: water clarity (Secchi), total phosphorus, and chlorophyll. The values are scaled from 0-100, which allow them to be used for comparisons of water quality over time and between lakes. If all of the operating assumptions about a lake ecosystem are met, the three TSI values should be very close together for a particular lake. When they are far apart in value, lake conditions and measurements should be examined to understand what special conditions exist at the lake or to evaluate the data for errors.

The index provides a quantitative way to separate three commonly used categories of productivity:

- *Oligotrophic*: low productivity (low in nutrient concentrations, small amount of algal growth), below 40 on the TSI scale.
- *Mesotrophic*: moderate productivity (moderate nutrient concentrations, moderate growth of algae), between 40 and 50 on the TSI scale.
- *Eutrophic:* high productivity (high nutrient concentrations, high level of algal growth), above 50 on the TSI scale.

A lake may fall into any of these categories naturally, depending on the conditions in the watershed, climate characteristics, vegetation, geology, as well as the shape and volume of the lake basin. Activities of people, such as land development, sanitary waste systems, and agricultural practices, can also increase productivity, which is known as "cultural eutrophication."