Cooperative
Lakes
Monitoring
Program

Dissolved Oxygen and Temperature

monitoring procedures

Dissolved oxygen and temperature are two of the fundamental variables in lake ecology. Measuring these parameters together provides valuable information for assessing the condition of a lake. The amount of dissolved oxygen in the water is an important indicator of overall lake health.

Water temperature serves as a driving force for many important lake processes. The temperature controls the length of the growing season in lakes, which influences the type and amount of biological activity. During the summer growing season, most lakes with significant depth (greater than 30 feet) are thermally stratified forming distinct layers of differing temperature and density. These layers are referred to as the epilimnion (warm surface layer) and hypolimnion (cold bottom layer), separated by a metalimnion (middle layer with decreasing temperature). The greatest changes in temperature occur at the thermocline in the metalimnion. Physical and chemical changes within these layers influence the cycling of nutrients and other elements within the lake system. Temperature also affects the level of dissolved oxygen in the water.

As temperature increases, the amount of atmospheric oxygen that can be dissolved in water decreases. Dissolved oxygen levels are also influenced by the time of day and by oxygen requirements of bacteria and other aquatic organisms. Photosynthesis during the daylight hours increases dissolved oxygen levels in the lake while dissolved oxygen is consumed by respiration at night. The bottom waters of many stratified lakes are susceptible to oxygen depletion, since atmospheric replenishment and photosynthetic production of oxygen are decreased at greater water depth and decomposition of organic matter in the bottom waters and sediment utilizes available oxygen. Low dissolved oxygen levels can result in the loss of susceptible organisms, such as trout and other coldwater fish, and the plant nutrient phosphorus can be released from the sediments when dissolved oxygen is depleted in the bottom waters of a lake.

Temperature and dissolved oxygen are typically measured as surface-to-bottom profiles, with measurements of both parameters collected at regular intervals. Temperature is easily measured with a thermometer or thermistor. Dissolved oxygen is either measured with an electronic meter or via a chemical test. Although most expensive, electronic dissolved oxygen/temperature meters provide the safest and most accurate means for volunteers to collect these data.

A. Equipment Checklist

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Program

SECCHI DISK TRANSPARENCY

monitoring procedures

Lakes with high water clarity or transparency are universally valued as exceptional quality resources. Lakes like Tahoe, Crater and Superior all evoke visions of crystal clear water, sandy beaches and no plants to hinder recreation. For almost 150 years a lake's clarity has been used to appraise its quality. In 1865, Professor Pietro A. Secchi lowered a painted disk into the water to measure the quality of Mediterranean bays around Italy. His disk has become a standard tool used by scientist around the world to generally assess the quality of lakes.

Dr. Secchi's disk has been standardized as a 20-centimeter (about eight inches) disk, with four alternating black and white quadrants painted on the surface. The disk is attached to a measured line and lowered into the lake until it disappears. The water depth at which the disk disappears is the Secchi disk depth or value for the lake. Obviously the deeper the disk is seen the clearer the water or the greater the transparency of the lake.

A lake's clarity or transparency is influenced by several factors, but for most lakes the amount of algae in the water is a major cause for changes in transparency. As more nutrients like phosphorus enter the lake from the watershed more algae are produced. As more algae are produced the clarity of the water decreases. In very clear lakes, Secchi disk values greater than 30 feet can be measured. On the other hand, in lakes with high nutrient inputs and abundant algae production the disk can disappear in two to three feet.

Unfortunately, the relationship between the Secchi disk value and algae as a measure of water quality is not so simple. Other factors can influence the Secchi disk value, reducing the usefulness of these measurements to appraise algae production directly. Other factors affecting Secchi disk values include: the angle of the sun in the sky, the roughness of the water surface, weather conditions (cloud cover, rain), the volunteer's eyesight, lakes shallower than their transparency, dissolved minerals in the water, suspended solids or soil particles in the water and the formation of lake marl or calcium carbonate. Consequently, Secchi disk values should only be considered as a measure of transparency and a very general indicator of algae levels. To more clearly define the levels of algae in the water, a parameter more directly measuring algae such as chlorophyll ***a*** must be used.

Despite these limitations, the Secchi disk value is still an important water quality measurement. When consistently done week-to-week and year-to-year, the

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Monitoring
Program

CHLOROPHYLL

monitoring procedures

Chlorophyll is the green photosynthetic pigment in the cells of plants. The relative amount of algae in a lake can be estimated by measuring the chlorophyll concentration in the water. The amount of chlorophyll in an algal cell varies among algae species as well as with changing light conditions at different depths within the lake. Changing seasons also create different light conditions that, in turn, affects chlorophyll production. To account for some of this variability, algal chlorophyll is monitored during five mid-month sampling events over the summer season (May through September) using a water column composite sampling technique.

The summer chlorophyll monitoring results, along with total phosphorus, and Secchi disk transparency measurements, provide an estimate of the level of productivity, or trophic state, of your lake. These results are used to calculate a set of trophic state indices (i.e. Carlson TSI) for the lake. These indices provide a quantitative means of describing the stage of lake aging, or eutrophication. Using Carlson's TSI, we classify lakes according to their trophic state (i.e. oligotrophic, mesotrophic, eutrophic, etc.).

A. Equipment Checklist

Chlorophyll Sampling Equipment
Equipment

boating safety equipment* and anchor*
chlorophyll monitoring procedures
chlorophyll data forms (2)
pencil* or indelible ink pen*
Secchi disk
composite sampler with measured line*
clothespin*
rectangular sample storage bottles (2)
magnesium carbonate (1% $MgCO_3$) solution
insulated cooler bag* and freezer ice pack*

Chlorophyll Filtering

60 cc plastic syringe
flexible plastic tube
filter holder
membrane filter disks (2)
tweezers and large safety pin*
coffee filter* or paper towel*
sample storage vials and caps (2)
chlorophyll sample labels (2)
fine tip permanent black marker*
aluminum foil*
zip-lock freezer bag*

*(provided by volunteer)

B. Safety

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PHOSPHORUS

monitoring procedures

Phosphorus is one of several essential nutrients that algae need to grow and reproduce. For most lakes in Michigan, phosphorus is the limiting factor for algal growth. The total amount of phosphorus in the water is used to predict the level of productivity and eutrophication in a lake. An increase in phosphorus over time is a measure of nutrient enrichment in a lake.

Phosphorus is a naturally occurring element that is found in rocks and soil. Humans use and dispose of phosphorus on a daily basis in common items such as fertilizers, foods, and cleaning agents. Lakes with developed watersheds often receive a portion of this human-generated phosphorus through runoff, septic leachate, and other sources.

Phosphorus is found in lakes in several forms that are in a constant state of flux as environmental conditions change and plants and animals live, die, and decompose in the lake. The various forms of phosphorus are constantly changing and are distributed in different locations of the lake with changing seasons. Because the forms of phosphorus are continuously changing and recycling, it is convenient to measure all of the forms of phosphorus together as total phosphorus.

The late summer phosphorus results, along with chlorophyll and Secchi disk transparency measurements, provide an estimate of the level of productivity, or trophic state, of your lake. These results are used to calculate a set of trophic state indices (i.e. Carlson TSI) for the lake. These indices provide a quantitative means of describing the stage of lake aging, or eutrophication. Using Carlson's TSI, we classify lakes according to their trophic state (i.e. oligotrophic, mesotrophic, eutrophic, etc.). Spring overturn, when the lake is generally well mixed from top to bottom, is an opportune time of the year to sample just the surface of the lake to obtain a representative sample for estimating the total amount of phosphorus in the lake. At other times of the year, more extensive water column sampling is needed to determine phosphorus levels in the lake.