A "Hands-On" Experience in Water Quality Monitoring.

The Crystal Lake Watershed Fund, Inc. (CLWF) brings together local volunteers, resident experts, student interns, academic faculty, and governmental officials in cooperative environmental monitoring studies. The CLWF program is integrated with joint programs of the Benzie/Leelanau District Health Department, the Michigan DEQ, the U.S. EPA, the Michigan Lake and Stream Associations, the US Geological Survey (with the NPS), the Grand Traverse Regional Land Conservancy, Benzie County Central & Frankfort-Elberta Area Schools, and Interlochen Arts Academy. Many studies have been done in the Crystal Lake Watershed over the past 160 years in support of watershed management. Building on these past studies, the CLWF has continued to monitor levels and trends of various water quality parameters. As a cosponsor of the Crystal Lake ***"Walkabout"***, the CLWF emphasizes the importance of water quality monitoring and biomonitoring by describing significant parameters to be measured and the equipment used for measurement and sample collection to student participants and the general public.

Water Quality Monitoring.

PARAMETERS: Water quality monitoring is the measurement over time of physical, chemical, and biological parameters on samples of water and sediment, and microscopic plants and animals. Some are measured directly in the Lake; others require collection of samples and measurement in laboratories.

EQUIPMENT: Limnology (the study of lakes) requires special instruments to measure parameters and special tools to collect samples. The CLWF uses the instruments and tools described here.

Geographical Information System (GIS): Computers can map many features of the Crystal Lake Watershed. Just like making a deli sandwich, layers of data make up the map of the Crystal Lake Watershed. Each layer is different: watersheds, tributaries, wetlands, places, depths, heights, etc.

Global Positioning System (GPS): Satellites accurately locate positions (latitude, longitude, altitude) in the Crystal Lake Watershed and transmit the coordinates seen on hand-held GPS units. Sampling locations for environmental monitoring and other points of interest are placed on maps created by GIS.

Multiparameter Analyzer: This instrument (Hydrolab H20® Water Quality Multiprobe) measures seven parameters at once in the Lake (depth, temperature, dissolved oxygen, pH, conductivity, redox potential, and turbidity). Values for each parameter at different locations are logged in a computer and evaluated.

Temperature: Crystal Lake is warm in summer and cold in winter. In the Spring, light warm water (20°C = 68°F) at the surface forms a layer over heavy cold water (6°C = 43°F) near the bottom. A thermocline (zone of sharp temperature change) forms between these layers at depths of 30-50 feet. All water in the Lake "turns over" and completely mixes as it warms in the Spring, and again as it cools in the Fall.

Dissolved Oxygen: The amount of "Dissolved Oxygen" (DO) in lake water is important to fish and other aquatic life. A well-aerated lake like Crystal Lake may have 8-12 "ppm" (parts per million) of DO in summer, dips lower for a brief period in the fall, and rises again to 10-14 ppm in winter.

pH (Hydrogen Ion Concentration): pH is a measure of how much acidity or alkalinity is in water. A pH of 7 is neutral; a pH of 5 is 100 times more acidic; a pH of 9 is 100 times more alkaline. Some lakes like Crystal Lake (pH 8-9) are alkaline because of natural sediments of calcium carbonate (marl) that are very beneficial in controlling pH and phosphorus.

Conductivity: Conductivity is a measure of the dissolved salts (like table salt or road salt) in water. Water from Crystal Lake is like drinking water, and has much lower conductivity than seawater.

Redox Potential: Redox (reduction/oxidation) potential tells if the Lake can use more dissolved oxygen. Sediments that are anaerobic (no DO) have lower redox potential, are often black in color, and have unpleasant odors. Sediments that are aerobic (lots of DO) have higher redox potential and no odor. Deep water sediments from Crystal Lake have a slight seasonal demand for DO and no odor.

Turbidity: Turbidity (cloudiness) is due to suspended sediment, plankton (microscopic plants & animals), and bubbles. It is removed by Zebra mussels. In a very clear lake like Crystal Lake, turbidity is very low.

Secchi Disc: This is a circular weight painted in four black-and-white quadrants that is lowered into the water. Clarity of the water is measured as the depth at which the circle can no longer be seen. A deeper depth means clearer (less cloudy, less turbid) water. Secchi disc depths in Crystal Lake are 20-30 feet.

Phosphorus and Nitrogen: These two elements are nutrients (fertilizers) that are essential for green plants to grow. Phosphorus is often the nutrient that limits excessive plant growth. A lake can become eutrophic (over-fertilized) by too much phosphorus. This excess can produce algae blooms (rapid growths) that can reduce dissolved oxygen to levels, which may harm fish and other aquatic life. Phosphorus can enter a watershed from "point" sources (septic tank discharges), or "nonpoint" sources (fertilizer runoff, plant and animal debris, or airborne deposition). The excellent water quality of Crystal Lake is due to its oligotropic (under-fertilized) condition. Its diverse ecology includes a good fish population without excessive weeds.

Other Chemical Analyses: Some elements (calcium, magnesium) cause hardness (scale). Others (sodium) add to conductivity. Some (iron, manganese) may cause slight tastes. Still others (arsenic, copper, chromium, lead, zinc) are toxic but are usually not detected in lake water at significant levels.

Water Sampler: A tube with two open ends and "mouse-trap" covers is lowered in the Lake to the depth to be sampled. A small weight (messenger) is send down a rope to trigger the covers to close and capture a water sample for testing of different parameters in the laboratory.

Sediment Sampler: A long hollow tube is lowered near the bottom of the Lake. When it is dropped the rest of the way, it punches a hole in the bottom and fills with sediment. The sample is bottled and tested later. Sediment may be sand, marl, and/or muck in different proportions.

Plankton Sampler: A net of very fine cloth is towed behind a boat or lowered into the Lake. Very small plants (phytoplankton) and animals (zooplankton), either floating or suspended, are caught, washed into a bottle, preserved, and later identified.

Hester-Dendy Sampler: A series of hard wooden discs are threaded on a bolt and hung in the Lake. Various plants, insects, and microscopic organisms that attach and grow can be studied.

Aquatic Plant Sampler: Plants, with and without roots and stems, may grow on the bottom or in the Lake. They are sampled with a rake or with other samplers, mounted, and identified.

Lake & Stream Level Gauges: The levels of Crystal Lake and its tributaries rise and fall as rain and melted snow enter, and surface and ground waters leave. Winds and tides also change the levels. These changes in levels are measured automatically by the CLWF using very accurate level "sensors".

Other Programs: The CLWF helped to establish and currently supports enforcement of the ordinance to ensure that septic systems, esp. those near Crystal Lake comply with current standards. The CLWF also addresses sediment runoff from Cold Creek. The CLWF also encourages property owners to maintain "green-belts" to slow erosion and runoff, and to limit uses of fertilizers, herbicides, and pesticides.

Biomonitoring.

Biomonitoring or biosurvey is the assessment of impairments to aquatic life using biological methods. Assessments of ecological data and habitat evaluation are coupled with hydrology, chemical monitoring, and land use information. Benthic macroinvertebrates (bottom-dwelling, small organisms with no backbones) are collected in nearshore lake waters and wadeable streams, identified using taxonomic keys, and recorded on survey sheets. Streams are classified by Stream Order or Valley Segment Types (VSTs), using various parameters, e.g. channel characteristics, riparian zone features, total catchment area, hydrogeomorphic features (depth, velocity, flow, hydraulic gradient, erosive power), habitat (substrate, wetness), and water quality (temperature, dissolved oxygen, turbidity, nutrients).

The vegetative cover, bottom substrate (sediment), and stream morphology (shape) are determined for each sampling site. Benthic macroinvertebrates are collected by disturbing the bottom and washing the released sediment into a fine-mesh net. Samples are placed in flat trays to sort the macroinvertebrates from the sediment and detritus. Specimens are identified by taxonomy (size, shape, and unique anatomical features, e.g. legs, tails, antenna, mouth parts, etc.). Benthic microinvertebrates are assigned into sensitive, somewhat sensitive, and tolerant groups depending upon their resistance to adverse environmental conditions (temperature, pH, dissolved oxygen, trace pollutants, etc.). The Total Stream Quality Score (TSQS) is a comparative score of the diversity and numbers of benthic macroinvertebrates.

The question is, “What are the water quality goals for a watershed?” Physical and chemical parameters may indicate good water quality. Environmental conditions may suggest “improvements” in stream habitat for greater diversity and numbers of benthic invertebrates. Greater productivity through the food chain from plankton to benthic invertebrates to fish to humans, however, may run counter to high water quality expected for an extreme oligotrophic lake like Crystal Lake. Nutrient and sediment controls and good water flow management within reasonable limits are laudable goals. Water quality in Cold Creek and Crystal Lake are being addressed from the standpoint of use – fishable, swimable, drinkable, etc., but the “solution” of one “problem” may create a new ecological outcome that is unforeseen.