

Abiotic:

Not alive; non-biological; for example, temperature and mixing are abiotic factors that influence the O₂ content of lake water whereas photosynthesis and respiration are biotic factors that affect O₂ solubility.

Acid:

A solution that is a proton (H⁺) donor and has a pH less than 7 on a scale of 0-14. The lower the pH the greater the acidity of the solution.

Acidity:

A measure of how acid a solution may be. A solution with a pH of less than 7.0 is considered acidic. Solutions with a pH of less than 4.5 contain mineral acidity (due to strong inorganic acids), while a solution having a pH greater than 8.3 contains no acidity.

Acid rain:

Precipitation having a pH lower than the natural range of ~5.2 - 5.6; caused by sulfur and nitrogen acids derived from anthropogenic emissions.

Acidification:

The process by which acids are added to a water body, causing a decrease in its buffering capacity (also referred to as *alkalinity* or *acid neutralizing capacity*), and ultimately a significant decrease in pH that may lead to the water body becoming acidic (pH < 7).

Adhesion:

The molecular force of attraction between unlike bodies that acts to hold them together.

Algae:

Simple single-celled, colonial, or multi-celled, aquatic plants. Aquatic algae are (mostly) microscopic plants that contain chlorophyll and grow by photosynthesis, and lack roots and stems ((non-vascular), and leaves. They absorb nutrients (carbon dioxide, nitrate, ammonium, phosphate and micronutrients) from the water or sediments, add oxygen to the water, and are usually the major source of organic matter at the base of the food web in lakes. Freely suspended forms are called *phytoplankton*; forms attached to rocks, stems, twigs, and bottom sediments are called periphyton.

Alkalinity:

Acid neutralizing or buffering capacity of water; a measure of the ability of water to resist changes in pH caused by the addition of acids or bases and therefore, the main indicator of susceptibility to acid rain; in natural waters it is due primarily to the presence of bicarbonates, carbonates and to a much lesser extent occasionally borates, silicates and phosphates. It is expressed in units of milligrams per liter (mg/l) of CaCO₃ (calcium carbonate) or as microequivalents per liter (ueq/l) where 20 ueq/l = 1 mg/l of CaCO₃. A solution having a pH below about 5 contains no alkalinity.

Anaerobic:

Technically this means "*without air*" but in limnology it is used synonymously with "*anoxic*."

Angle of incidence:

Angle between direction of motion of waves and a line perpendicular to surface the waves are striking.

Angle of reflection:

Angle between direction of motion of waves and a line perpendicular to surface the waves are reflected from.

Anions:

Negatively charged ions.

Anoxia:

Condition of being without dissolved oxygen (O₂).

Anoxic:

Completely lacking in oxygen.

Anthropogenic:

Human caused.

Aquatic respiration:

Refers to the use of oxygen in an aquatic system including the decomposition of organic matter and the use of oxygen by fish, algae, zooplankton, aquatic macrophytes, and microorganisms for metabolism.

Atmospheric (Barometric) Pressure:

Measure of the pressure of the earth's atmosphere per unit area. It is 760 mm Hg at sea level and decreases with increasing elevation.

Attenuation:

Decrease.

Aufwuchs:

The community of algae and other microorganisms that attach to surfaces such as rocks, twigs, and aquatic plants; essentially the same as "*periphyton*" that means "*attached algae*."

B Base:

A substance which accepts protons (H⁺) and has a pH greater than 7 on a scale of 0-14; also referred to as an alkaline substance.

Basin:

Geographic land area draining into a lake or river; also referred to as *drainage basin* or watershed.

Benthic:

Refers to being on the bottom of a lake.

Benthic zone:

Lake bottom sediment.

Bicarbonate:

The anion HCO_3^-

Bicarbonate Buffering Equilibrium Equation:

See [Carbonate Buffering System](#).

Bioaccumulation:

The increase in concentration of a chemical in organisms that reside in environments contaminated with low concentrations of various organic compounds. Also used to describe the progressive increase in the amount of a chemical in an organism resulting from rates of absorption of a substance in excess of its metabolism and excretion. Certain chemicals, such as pcbs, mercury, and some pesticides, can be concentrated from very low levels in the water to toxic levels in animals through this process.

Bioavailable:

Able to be assimilated (absorbed) by organisms.

Biochemical Oxygen Demand (BOD):

Sometimes referred to as *Biological Oxygen Demand (BOD)*. A measure of the amount of oxygen removed (respired) from aquatic environments by aerobic microorganisms either in the water column or in the sediments. The parameter BOD uses the maximum rate of O_2 consumption over a 5 day period in the dark at 20° to estimate the total amount of "biodegradable" organic matter in the system. Typically too insensitive to be useful for pristine lakes and so is used primarily for wastewater "streams" or systems impacted by organic pollution.

Bio-manipulation:

Reducing algal blooms by altering the fish community to reduce predation on certain zooplankton (cladocerans such as *daphnia*) that can most efficiently graze on algae.

Biomass:

The weight of a living organism or assemblage of organisms.

Biotic:

Referring to a live organism; see also [abiotic](#).

Birgean Heat Budget:

See [Heat Budget](#).

Buffer:

A substance which tends to keep pH levels fairly constant when acids or bases are added.

Buffering Capacity:

Ability of a solution to resist changes in pH when acids or bases are added; the buffering capacity of natural waters is mostly due to dissolved carbonate rocks in the basin; equivalent to acid neutralizing capacity (ANC). Typically considered to be exhausted.

C Calorie:

A basic measure of energy where 1 calorie is equal to the total amount of heat required to raise the temperature of 1 gram of water 1 degree Celsius.

Capillary Action:

The action by which water is drawn around soil particles (or any other solid substance like a small bore tube) because there is a stronger attraction between the soil or solid particles and the water molecules themselves.

Carbon Cycle:

The circulation of carbon atoms through the earth's whole ecosystem.

Carbon Dioxide:

A gas which is colorless and odorless; when dissolved in water it becomes carbonic acid; CO_2 is assimilated by plants for photosynthesis in the "dark" cycles of photosynthesis.

Carbonate ion:

The CO_3^{2-} ion in the Carbonate Buffer System the collective term for the natural inorganic chemical compounds related to carbon dioxide that exists in natural waterways. Combined with one proton, it becomes Bicarbonate, HCO_3^- and with two protons, Carbonic Acid. The carbonate ion forms a solid precipitant when combined with dissolved ions of calcium or magnesium.

Carbonate Buffering System:

The most important buffer system in natural surface waters and wastewater treatment, consisting of a carbon dioxide, water, carbonic acid, *Bicarbonate*, and *Carbonate* ion equilibrium that resists changes in the water's pH. If acid (hydrogen ions) is added to this buffer solution, the equilibrium is shifted and carbonate ions combine with the hydrogen ions to form bicarbonate. Subsequently, the bicarbonate then combines with hydrogen ions to form carbonic acid, which can dissociate into carbon dioxide and water. Thus the system pH is unaltered (buffered) even though acid was introduced.

Carnivores:

"Meat" eaters; organisms that eat other organisms.

Cations:

Positively charged ions.

Chemical Equilibrium:

Concentrations of reactants and products at which a reaction is in balance; there is no net exchange because the rate of the forward reaction is taking place at the same rate of the reverse reaction.

CHEMetrics Water Quality Test Kits:

CHEMetrics, Inc. (website: <http://www.chemetrics.com/>) is one of a number of companies that market a variety of test kits and field and lab instruments for water quality testing. Additional companies commonly cited are [Hach](#) and [LaMotte](#), and there are probably numerous others accessible to the reader through various educational resources or scientific lab products catalogues. *Water on the Web* does not endorse any particular company's products. Some test kits have been "approved" by state or federal agencies for certain types of tests in specific types of water or wastewater.

Chemocline:

Sharp gradient in chemical concentration; the boundary in a meromictic lake separating an upper layer of less-saline water that can mix completely at least once a year (mixolimnion) from a deeper, more saline (dense) layer (monimolimnion) that never is mixed into the overlying layer.

Chlorophyll:

Green pigment in plants that transforms light energy into chemical energy in photosynthesis.

Clarity:

Transparency; routinely estimated by the depth at which you can no longer see a sechi disk. The Secchi disk is a 20 cm (8 inch) diameter weighted metal plate with alternating quadrants painted black and white that is used to estimate water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi depth.

Coefficient of Heat Transfer:

The ratio of the temperature of an object to the temperature of its surroundings. The change in temperature of an object is directly proportional to the difference between its temperature and the temperature of its surroundings.

Cohesion:

The molecular force between particles within a substance that acts to unite them.

Cohesive Forces:

All the forces of attraction among particles of a liquid.

Conductivity (electrical conductivity and specific conductance):

Measures water's ability to conduct an electric current and is directly related to the total dissolved salts (ions) in the water. Called EC for electrical conductivity and is reported in micromhos per centimeter (umhos/cm) which has been recently renamed as uS/cm (microSiemens per centimeter). EC is temperature sensitive and increases with increasing temperature. Most modern probes automatically correct for temperature and standardize all readings to 25°C and then refer to the data as

specific EC.

Conduction:

Thermal conduction is the transfer of heat between two solid materials that are physically touching each other.

Consumers:

Organisms that must eat other organisms for their energy metabolism; organisms that cannot produce new organic matter by photosynthesis or chemosynthesis (producers).

Convection Currents:

Air or water movement caused by changes in density or thermal (temperature) gradients.

Covalent:

Refers to the chemical bond formed by the sharing of one or more electron pairs between two atoms.

Cyanobacteria:

Bluegreen algae; phylum or organisms that are biochemically bacterial in nature but perform plant photosynthesis.

D Decomposition:

The breakdown of organic matter by bacteria and fungi.

Denitrification:

Anaerobic bacterial process metabolism in which nitrate is used instead of oxygen during the oxidation of organic carbon compounds to yield energy (respiration). The process oxidizes organic carbon and (chemically) reduces nitrate to the gaseous end products N_2 (nitrogen gas) or N_2O (nitrous oxide). This is the major process used in wastewater treatment plants to ultimately convert *combined* nitrogen to a non-polluting state.

Density:

The mass of a substance or organism per unit volume (kg/cubic meter; grams/liter).

Density Stratification:

Creation of layers in a water body due to density differences; controlled by temperature, dissolved solids concentration and particle concentration.

Detritus:

Dead or decaying organic matter; technically called organic detritus to distinguish it from the mineral detritus classified by geologists.

Diatom:

Group of algae characterized by glass (silica) cell wall, beautifully ornamented; often the brown stuff attached to rock surfaces.

Diel:

A 24 hour period of time.

Diffusion:

The movement of a substance from an area of high concentration to an area of low concentration. Turbulent diffusion, or mixing, results from atmospheric motions (wind) diffusing water, vapor, heat, and other chemical components by exchanging parcels called eddies between regions in space in apparent random fashion. Molecular diffusion, which operates in stagnant zones, such as at the bottom sediment-water boundary in a deep lake, occurs much, much more slowly and so is important only on a very small scale such as right at the bottom.

Dimictic:

Having two mixing periods, typically in spring and fall.

Dipole:

A molecule that has two opposite electrical poles, or regions, separated by a distance.

Dipole - Dipole Forces:

Intermolecular attraction between the oppositely charged poles of nearby molecules.

Dipole - Induced Dipole Forces:

Very weak forces between a dipole and non-polar molecule that acts like a dipole in the presence of a dipole molecule.

Dipteran:

True flies.

Dissolved Oxygen (DO or O₂):

The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation. Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms and the prevention of offensive odors. DO levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life. Levels above 5 milligrams per liter (mg O₂/L) are considered optimal and most fish cannot survive for prolonged periods at levels below 3 mg O₂/L. Levels below 1 mg O₂/L are often referred to as *hypoxic* and when O₂ is totally absent *anoxic* (often called anaerobic which technically means *without air*). Secondary and advanced wastewater treatment systems are generally designed to degrade organic matter to ensure adequate dissolved oxygen in waste-receiving waters (from North American Lake Management Society).

Dissolved Oxygen Profile:

A graph of the amount of dissolved oxygen per unit depth; where the depth is on the z (vertical) axis and dissolved oxygen is on the x (horizontal) axis. Limnologists plot graphs this way but be sure to note that the depth (z) axis is really for the independent variable and the horizontal (x) axis is really for the dependent variable.

Dissolved Solids Concentration:

The total mass of dissolved mineral constituents or chemical compounds in water; they form the residue that remains after evaporation and drying. Often referred to as the *total dissolved salts* (TDS) concentration or dissolved ion concentration. In seawater or brackish water this is approximated by the *salinity* of the water. All of these parameters are estimated by the electrical conductivity (EC).

Drainage lakes:

Lakes having a defined surface inlet and outlet.

Dry deposition:

Fine particulate matter and aerosols settling from the atmosphere onto lake and land surfaces during periods with no precipitation.

[TOP](#)

E Ecological pyramid:

Conceptual scheme whereby the amount of biomass or energy at each level of the food "chain" decreases as you move from primary producers through the different levels of consumers.

Ecoregion:

An environmental area characterized by specific land uses, soil types, surface form, and potential natural vegetation.

Ecosystem:

All of the interacting organisms in a defined space in association with their interrelated physical and chemical environment.

Electrical Conductivity (EC):

See [Conductivity](#).

Electromagnetic Radiation:

Radiation that travels through space at the speed of light that includes light, radio waves, x-rays, and gamma rays.

Endothermic Reaction:

A reaction which absorbs heat; see also [exothermic reaction](#).

Epilimnion:

The upper, wind-mixed layer of a thermally stratified lake. This water is turbulently mixed throughout at least some portion of the day and because of its exposure, can freely exchange dissolved gases (such as O₂ and CO₂) with the atmosphere.

Equilibrium:

See [Chemical Equilibrium](#).

Euphotic zone:

Layer of water where sunlight is sufficient for photosynthesis to occur.

Eutrophic Lake:

A very *biologically productive* type of lake due to relatively high rates of nutrient input. See [Eutrophication](#).

Eutrophication:

The process by which lakes and streams are enriched by nutrients (usually phosphorus and nitrogen) which leads to excessive plant growth - algae in the open water, periphyton (*attached* algae) along the shoreline, and macrophytes (the higher plants we often call *weeds*) in the nearshore zone. See the [Lake Ecology Primer Biology](#) section for more information about this problem; it remains the biggest pollution problem for Minnesota's (and in fact for the rest of our country as well) lakes. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile). The less productive a lake is naturally, the more sensitive it is to increased nutrient loads from human-caused disturbances in the watershed.

Evaporation:

The process of converting liquid to vapor.

Excel:

Refers to Microsoft's Excel spreadsheet software.

Exothermic Reaction:

A reaction which gives off heat; see also [endothermic reaction](#).

Export rates:

Amount of a particular nutrient or contaminant annually transported from its source to a lake or stream; usually related to land uses and expressed per unit area per year.

F Fetch:

Distance the wind blows over water without appreciable change in direction; relates to intensity of turbulent mixing.

Fix:

Convert CO₂ to carbohydrate or N₂ to NH₄⁺ (carbon fixation and nitrogen fixation);

Flagella:

Whiplike structure that enables motility in certain groups of algae.

Flow Rate:

The rate at which water moves by a given point; in rivers it is usually measured in cubic meters per second (m³/sec) or cubic feet per second (cfs).

Flushing Rate:

The retention time (turnover rate or flushing rate), the average length of time water resides in a lake, ranging from several days in small impoundments to many years in large seepage lakes. Retention time is important in determining the impact of nutrient

inputs. Long retention times result in recycling and greater nutrient retention in most lakes. Calculate retention time by dividing the volume of water passing through the lake per year by the lake volume.

Food Chain:

The transfer of food energy from plants through herbivores to carnivores. An example: insect-fish-bear or the sequence of algae being eaten by zooplankton (grazers; herbivores) which in turn are eaten by small fish (planktivores; predators) which are then eaten by larger fish (piscivores; fish eating predators) and eventually by people or other predators (fish-eating birds, mammals, and reptiles).

Food Web:

Food chains hooked together into a complex interconnected web.

G Gas Solubility:

The ability of a gas to dissolve into another substance.

Geographic Information System (GIS):

A computer system which allows for input and manipulation of geographic data to allow researchers to manipulate, analyze and display the information in a map format.

Grazers:

Herbivores; zooplankton in the open water zone.

H Hach Water Quality Test Kits:

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Hardwater:

Lakes that have a high buffering capacity and are not generally sensitive to acid deposition. These lakes have dissolved salt concentrations greater than 120 mg/L.

Heat:

Energy that is transferred from one body to another because of a difference in temperature.

Heat Budget:

The amount of heat energy required annually to raise the temperature of a water body from its winter minimum to its summer maximum.

Heat Energy:

An energy form proportional to and associated with molecular motion. Conduction, convection or radiation can transfer heat from one mass of matter to another.

Heat Reflection:

The return of radiant heat energy by a reflecting surface.

Heat of Transformation:

See [Latent Heat](#).

Heat of Vaporization:

The heat required to convert a substance from the liquid to the gaseous state with no temperature change. This is also called the latent heat of vaporization.

Henry's Law:

States that at a given temperature the solubility of a gas is directly proportional to the pressure of the gas directly above the liquid.

Herbivores:

Plant eaters.

Heterogeneous:

Not uniform; patchy.

Holomictic:

Typically mixes completely throughout the water column at least once a year.

Hydrogen:

Colorless, odorless and tasteless gas; combines with oxygen to form water.

Hydrogen Bond:

A type of chemical bond caused by electromagnetic forces, occurring when the positive pole of one molecule (e.g., water) is attracted to and forms a bond with the negative pole of another molecule (e.g., another water molecule).

Hydrogen Ion:

An individual atom of hydrogen which is not attached to a molecule and therefore has a positive (+) charge.

Hydrology:

The study of water's properties, distribution and circulation on Earth.

Hydrostatic Pressure:

Pressure exerted in a column of water.

Hypolimnetic Oxygen Depletion:

A condition where the dissolved oxygen in the bottom layer (hypolimnion) of a water body is gradually consumed through respiration and decomposition faster than it can

be replaced over the course of the summer. A similar phenomenon may occur in the winter under ice cover. The rate at which O_2 is depleted is a measure of the productivity of the system.

Hypolimnion:

The bottom, and most dense layer of a stratified lake. It is typically the coldest layer in the summer and warmest in the winter. It is isolated from wind mixing and typically too dark for much plant photosynthesis to occur.

I Ice-out:

Date when lake thaws.

Impervious surfaces:

Land surfaces such as roads, parking lots, buildings, etc that prevent rainwater from soaking into the soil. The water increases in velocity causing more erosion; it warms causing potential heat stress for downstream trout; it picks up roadway contaminants; and the loss of vegetation removes a "sink" for dissolved nutrients - plant uptake.

Inflow:

Water flowing into a lake.

Inorganic:

Substances of mineral, not carbon origin.

Ion:

An electrically charged particle.

Isothermal:

Constant in temperature.

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L Lake Profile:

A graph of a lake variable per depth; where the depth is on the z-axis and the variable is on the x-axis. Depth is the independent variable and the x-axis is the dependent variable.

LaMotte Water Quality Testing Kits:

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Landuse:

The primary or primary and secondary uses of land, such as cropland, woodland, pastureland, forest, water (lakes, wetlands, streams), etc. The description of a particular landuse should convey the dominant character of a geographic area and establish the dominant types of human activities which are prevalent in each region.

Landscape:

All the natural geographical features, such as fields, hills, forests, and water that distinguish one part of the earth's surface from another part. These characteristics are a result not only of natural forces but of human use of the land as well.

Latent Heat (Energy):

The amount of heat (energy) released from or absorbed by a substance when it undergoes a change of state; also known as Heat of Transformation.

Le Chatelier's Principle:

A principle of equilibrium; states that in a balanced equilibrium, if one or more factors changes, the system will readjust to reach equilibrium.

Leach:

To remove soluble or other constituents from a medium by the action of a percolating liquid, as in leaching salts from the soil by the application of water.

Limnetic zone:

Open water zone.

Littoral:

Nearshore out from shore to the depth of the euphotic zone where it is too dark on the bottom for macrophytes to grow.

Loading Rates:

The rate at which materials (typically suspended sediment, nutrients [N and P], or contaminants) are transported into a water body.

Loricas:

Glass cell covering.

M Macrophytes:

Higher aquatic plants; in the sense of "higher" evolutionarily than algae and having roots and differentiated tissues; may be emergent (cattails, bulrushes, reeds, wild rice), submergent (water milfoil, bladderwort) or floating (duckweed, lily pads).

Marl:

Encrustation of calcium carbonate that forms on plants in high pH/alkalinity lakes and on your faucet from the precipitation of calcium carbonate.

Meromictic:

Describing a lake that doesn't mix completely ([see chemocline](#)).

Mesotrophic:

Moderately productive; relating to the moderate fertility of a lake in terms of its algal biomass.

Mean Depth:

The average depth of a water body; determined by dividing lake volume by the surface area (also called z mean).

Metabolism:

The chemical and physical processes continually going on in living organisms and cells, by which the energy is provided for cellular processes and activities, and new material is assimilated to repair waste.

Metalimnion:

The middle or transitional zone between the well mixed epilimnion and the colder hypolimnion layers in a stratified lake. This layer contains the [thermocline](#), but is loosely defined depending on the shape of the temperature profile.

Micronutrient:

Trace nutrients required by microorganisms or zooplankton such as molybdenum and cobalt; nitrogen and phosphorus are considered to be macronutrients.

Mixolimnion:

The upper layer of less-saline water that can mix completely at least once a year in a meromictic lake ([see chemocline](#)).

Mixture

An aggregate of two or more substances that are not chemically united.

Monimolimnion:

Bottom layer of stagnant water in a meromictic lake that never is completely mixed ([see chemocline](#)).

Morphoedaphic Index:

A measure of the potential yield of fishery from a lake; computed by taking the concentration of total dissolved solids (TDS) divided by the mean depth of the lake; it assumes that increasing dissolved salt content reflects increased nutrient content due to increased contact of precipitation with the soil prior to entering a lake.

Morphometry:

Relating to the shape of a lake basin; includes parameters needed to describe the shape of the lake such as volume, surface area, mean depth, maximum depth, maximum length and width, shoreline length, shoreline development (length of the perimeter, or shoreline divided by the calculated diameter of a circle of equivalent area [how convoluted the shoreline is]), depth versus volume and surface area curves.

Motile:

Able to move at will.

N Neuston:

(1) The collection of minute or microscopic organisms that inhabit the surface layer of a body of water. (2) Organisms resting or swimming on the surface of still bodies of water.

Nitrification:

Bacterial metabolism in which ammonium ion (NH_4^+) is oxidized to nitrite (NO_2^-) and then to nitrate (NO_3^-) in order to yield chemical energy that is used to *fix* carbon dioxide into organic carbon. The process is a type of chemosynthesis which is comparable to photosynthesis except that chemical energy rather than light energy is used. These bacteria are aerobic and so require dissolved oxygen in order to survive.

Nitrogen Fixation:

The conversion of elemental nitrogen in the atmosphere (N_2) to a form (e.g., ammonia) that can be used as a nitrogen source by organisms. Biological nitrogen fixation is carried out by a variety of organisms; however, those responsible for most of the fixation in lakes are certain species of bluegreen algae.

Non-motile:

Not able to move at will.

Non-polar Molecule:

A molecule that does not have electrically charged areas (poles).

Non-polar Gas:

A gas that is electrically neutral.

Nonpoint source:

Diffuse source of pollutant(s); not discharged from a pipe; associated with land use such as agriculture or contaminated groundwater flow or on-site septic systems.

Nuisance blooms:

Referring to obnoxious and excessive growths of algae caused by excessive nutrient loading; often due to scum forming cyanobacteria (bluegreen algae) that can regulate their buoyancy to float high in the water column to obtain sunlight.

Nutrient loading:

Discharging of nutrients from the watershed (basin) into a receiving water body (lake, stream, wetland); expressed usually as mass per unit area per unit time (kg/ha/yr or lbs/acre/year).

O Oligotrophic:

Very unproductive; lakes low in nutrients and algae, usually very transparent with abundant hypolimnetic oxygen if stratified.

Omnivorous:

Capable of eating plants, fungi and animals.

Organic:

Substances which contain carbon atoms and carbon-carbon bonds.

Outflow:

Water flowing out of a lake.

Outliers:

Data points that lie outside of the normal range of data. Ideally, outliers must be determined by a statistical test before they can be removed from a data set.

Oxygen:

An odorless, colorless gas; combines to form water; essential for aerobic respiration.

Oxygen Solubility:

The ability of oxygen gas to dissolve into water.

P Paleolimnology:

The study of the history of lakes via the analysis of organisms and chemistry of lake bottom sediments.

Parameter:

Whatever it is you measure; a particular physical, chemical, or biological property that is being measured.

Partial Pressure:

The pressure exhibited by a single gas in a gas mixture.

Periphyton:

Attached algae; the green slime that attaches shoreline and bottom vegetation and the brown stuff attached to rock surfaces.

Petri dish:

A shallow, round glass dish + lid used for culturing microorganisms.

pH

A measure of the concentration of hydrogen ions.

pH Profile:

A graph of the pH level per depth; where the depth is on the z-axis and pH level is on the x-axis. Depth is the independent variable and the x-axis is the dependent variable.

pH Scale:

A scale used to determine the alkaline or acidic nature of a substance. The scale ranges from 1-14 with 1 being the most acidic and 14 the most basic. Pure water is neutral with a pH of 7.

Phosphorus:

Key nutrient influencing plant growth in lakes. Soluble reactive phosphorus (PO_4^{-3}) is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

Photosynthesis:

The process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugars and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base, and is an important source of oxygen for many lakes.

Photosynthesizers:

Organisms that produce their energy via photosynthesis.

Phytoplankton:

Microscopic floating plants, mainly algae, that live suspended in bodies of water and that drift about because they cannot move by themselves or because they are too small or too weak to swim effectively against a current.

Planktivores:

Animals that eat plankton; usually refers to fish that feed on zooplankton but can also refer to fish that graze on algae; includes invertebrate predators, such as the phantom midge.

Polarity:

An unsymmetrical distribution of electron density found in a covalent bond.

Polar gas:

A gas which is made up of molecules that have electrically charged areas (poles).

Polar molecule:

A molecule in which one structural end (an atom or atoms) possesses a slight negative charge and another structural end possesses a slight positive charge but the charges do not cancel one another out but rather create two separate poles.

Polymictic:

Mixes completely intermittently.

Ppb:

Part-per-billion; equivalent to a microgram per liter (ug/l).

Ppm:

Part-per-million; equivalent to a milligram per liter (mg/l).

Pressure (p):

The force exerted per unit area.

Primary consumers:

First level of consumers according to the ecological pyramid concept; organisms that eat herbivorous grazers.

Primary producers:

Organisms that convert CO_2 to biomass. Usually refers to photosynthesizers, but also includes the chemosynthetic bacteria that use chemical instead of light energy to **fix** CO_2 to biomass.

Primary Productivity:

The productivity of the photosynthesizers at the base of the food chain in ecosystems. This refers to the yield of new biomass (plant) growth during a specified time period. The entire year's accumulation is termed annual production. In the open water of lakes it is typically estimated by measured growth rates of phytoplankton (algae), either via O_2 accumulation in light relative to dark bottles of lake water or by the uptake of added radioactive carbon dioxide in sealed bottles of lake water.

Productivity:

The time rate of production of biomass for a given group of organisms; essentially the net growth rate of organisms.

Profile:

A vertical, depth by depth characterization of a water column, usually at the deepest part of a lake.

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R Radiation:

The movement of energy through any medium via heat, light or radio waves.

Radioisotopes:

Radioactive isotopes; radioactive forms of carbon, phosphorus, and other nutrients are used to measure rates of their absorption into biological communities; radioisotopes derived from fallout from atmospheric nuclear weapons testing are used to date layers of lake sediments

Relative depth:

A measure of how deep a lake is relative to its surface area, "*high*" being associated with "*small but deep*" $z_r = [88.6 * z_{max}] / \theta\%$ for maximum depth and area.

Respiration:

The metabolic process by which organic carbon molecules are oxidized to carbon dioxide and water with a net release of energy. Aerobic respiration requires, and therefore consumes, molecular oxygen (algae, *weeds*, zooplankton, benthic invertebrates, fish, many bacteria, people). Certain bacteria can use nitrate in place of oxygen (denitrifiers) or sulfate (sulfate reducers), but only under anaerobic (anoxic) conditions - typically present only in the sediments or in the hypolimnion after prolonged oxygen depletion has occurred.

S Saturation:

The point at which a substance has the maximum amount of another substance at a given temperature and pressure; also see supersaturation.

Secchi Disk:

A disk with a 4-6 inch radius that is divided into 4 equal quadrates of alternating black and white colors. It is lowered into a section of shaded water until it can no longer be seen and then lifted back up until it can be seen once again. Averaging the two depths gives the clarity of the water; see also [clarity](#).

Secondary consumers:

Consumers such as plankton eating fish or predaceous zooplankton that eat other zooplankton.

Sedimentation:

The removal, transport, and deposition of detached soil particles by flowing water or wind. Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, precipitated calcium carbonate (marl), and soil and organic matter eroded from the lake's watershed.

Seepage lakes:

Lake having an inlet or an outlet but not both; primary water inputs are precipitation and groundwater.

Sewage sludge:

The solid portion of sewage that contains organic matter, and a whole community of algae, fungi, bacteria and protozoans that consume it. The terms Biosolids, Sludge, and sewage sludge can be used interchangeably.

Shoreline:

The zone where lake and land meet. Shorelands are defined as the lands 1000 ft from the ordinary high water level.

Softwater lakes:

Lakes with low buffering capacity (alkalinity) that are most sensitive to acid deposition inputs.

Solubility:

The ability of a substance to dissolve into another; also see gas solubility.

Solute:

A substance which can be dissolved into another substance.

Solution:

A homogenous mixture of two substances.

Solvent:

A substance which has the ability to dissolve another; also see [Universal Solvent](#).

Specific conductance:

A measure of the ability of water to conduct an electrical current as measured using a 1-cm cell and expressed in units of electrical conductance (EC), i.e. siemens (uS or mS) at 25 C.

Specific Heat:

The amount of heat required to raise the temperature of one gram of substance one degree Celsius.

Spring turnover:

Period of complete or nearly complete vertical mixing in the spring after ice-out and prior to thermal stratification.

States of Matter:

The three basic forms (or states) which a substance can take: solid, liquid, or gas; a fourth form, called a plasma (an ionized gas), is also possible but only at extremely high temperatures.

Stormwater discharge:

Precipitation and snowmelt runoff from roadways, parking lots, roof drains that is collected in gutters and drains; a major source of nonpoint source pollution to water bodies and a major headache to sewage treatment plants in municipalities where the stormwater is combined with the flow of domestic wastewater (sewage) before entering the wastewater treatment plant.

Stratification:

An effect where a substance or material is broken into distinct horizontal layers due to different characteristics such as density or temperature.

Stratified:

Separated into distinct layers.

Stratigraphic:

Relating to stratigraphy, the branch of geology which treats the formation, composition, sequence and correlation of the layered rocks as parts of the earth's crust.

Substrate:

Attachment surface or bottom material in which organisms can attach or live-within; such as rock substrate or sand or muck substrate or woody debris or living macrophytes.

Supersaturation:

When a substance is more highly concentrated (more saturated) in another substance than is normally possible under normal temperature and pressure.

Surface Tension:

A phenomenon caused by a strong attraction towards the interior of the liquid action on liquid molecules in or near the surface in such a way to reduce the surface area.

Suspended Sediment (SS or Total SS[TSS]):

Very small particles which remain distributed throughout the water column due to turbulent mixing exceeding gravitational sinking; also see [turbidity](#).

Suspension:

A heterogeneous mixture in which solute-like particles settle out of solvent-like phase some time after their introduction.

T TDS:

Total dissolved salts or solids in a volume of water; usually in mg/l; estimated by EC (electrical conductivity).

Temperate:

Refers to lakes located in a climate where the summers are warm and the winters moderately cold. The Temperate Zone is between the Tropic of Cancer and the Arctic Circle.

Temperature:

A measure of whether a substance is hot or cold.

Temperature Profile:

A graph of the temperature per depth; where the depth is on the z-axis and temperature is on the x-axis.

Tertiary consumers:

Larger consumers in the fourth trophic level like adult northern pike, ospreys and humans that eat fish.

Thermal stratification:

Existence of a turbulently mixed layer of warm water (epilimnion) overlying a colder mass of relatively stagnant water (hypolimnion) in a water body due to cold water being denser than warm water coupled with the damping effect of water depth on the intensity of wind mixing.

Thermocline:

The depth at which the temperature gradient is steepest during the summer; usually this gradient must be at least 1°C per meter of depth.

Topography:

Configuration of physical surface of land; includes relief imprints and locations of all man-made and natural features.

Total Dissolved Solids (TDS):

The amount of dissolved substances, such as salts or minerals, in water remaining after evaporating the water and weighing the residue.

Tributary:

Feeder stream.

Trophic State:

Eutrophication is the process by which lakes are enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification or state: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Trophic webs:

Conceptual model of the interconnections of species of organisms according to their different feeding groups.

Turbidity:

A measure of the degree to which light is scattered by suspended particulate material and soluble colored compounds in the water. It provides an estimate of the the muddiness or cloudiness of the water due to clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, and microscopic organisms.

Turnover:

Fall cooling and spring warming of surface water act to make density uniform throughout the water column. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the water's oxygen content. However, warming may occur too rapidly in the spring for mixing to be effective, especially in small sheltered kettle lakes.

Two story fishery:

An upper warm water fishery overlying a deeper coldwater salmonid (trout or salmon) fishery; typically these are relatively deep and unproductive lakes that maintain oxygen >5 ppm in much of the hypolimnion throughout the summer.

U Universal Solvent:

A substance that has the ability to dissolve both bases and acids, such as water.

V Vertical extinction coefficient:

A measure of the ability of a particular water sample to exponentially attenuate(decrease) light shining on it. It is the constant **k** in the equation $i(z) = i(0) \cdot \exp(-k \cdot z)$ where z is any depth in meters, and "**exp**" refers to the base "**e**" the for the exponential.

W Water column:

A conceptual column of water from lake surface to bottom sediments.

Water Density:

The ratio of water's mass to its volume; water is the most dense at four degrees Celsius.

Watershed:

All land and water areas that drain toward a river or lake; also called Drainage Basin or Water Basin.

Watershed area: lake surface area ratio:

A_w/a_0 ; a measure relating to how much land area is there relative to lake area in a given watershed.

Weathering:

The mechanical and chemical breakdown and dissolution of rocks.

Wet deposition:

Precipitation of all kinds.

Winkler Titration Kit:

A "wet" chemistry analytical procedure used to determine the oxygen content of water via the Winkler reaction.

Winterkill:

A sudden and dramatic mass fish death caused by insufficient oxygen in a frozen lake.

X

Y

Z Zooplankton:

The animal portion of the living particles in water that freely float in open water, eat bacteria, algae, detritus and sometimes other zooplankton and are in turn eaten by

planktivorous fish.

CONVERSION TABLES

LENGTH		
Metric	Metric	English
Kilometer	1,000 meters	0.621 miles
Meter	1 meters	39.4 inches 3.28 feet
Centimeter	0.01 meters	0.394 inches
Millimeter	0.001 meters	0.0394 inches 39.4 mils
Micron	0.001 millimeters	0.0000394 inches 0.0394 mils
Angstrom	0.1 microns	0.00000394 inches

AREA		
Metric	Metric	English
Hectare (ha)	10,000 m ²	2.471 acres
Section	259 hectares	640 acres 1 mile ²

VOLUME		
Metric	Metric	United States
1,000 liters	1 cubic meter	1.308 cubic yard
1000 milliliters	1 liter	1.057 quart

1 milliliter (mL)	1 cubic centimeter (cc)	----
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WEIGHT			
Metric	Metric	Comparable Water Volume	English (U.S.)
Metric ton (tonne)	1,000 kilograms	1 cubic meter	2205 lb = 2.2 tons
Kilogram	1,000 grams	1 liter	2.205 lb
Gram	1000 milligrams	1 mL or cc	--
Milligram	1000 micrograms	1 uL (microliter)	--

CONCENTRATIONS	
1 gram/Liter	‰ (part per thousand)
1 milligram/Liter	1 ppm (part per million)
1 microgram/Liter	1 ppb (part per billion)
1 nanogram/Liter	1 ppt (part per trillion)