ENVIROTHON - AQUATICS

Ambient Stream Monitoring Program: This program has a network of 101 fixed stations located on main stem and tributary streams across the state, including six stations on the Missouri River. The program's primary objectives are to provide information on the status and trends of water quality in streams within each of the state's 13 river basins and link assessments of status and trends with natural and human factors that affect water quality. Ecoregion and land use considerations were used in selecting many of the stream locations. A representative number of State Resource Waters as well as streams within major urban areas were also selected. Samples are collected monthly and analyzed for traditional chemical and physical parameters and include nutrients, select herbicides and heavy metals.

Lake Monitoring: is currently conducted on 44 lakes across the state. Monitoring involves the collection of monthly water samples from May through September. These data are used to document existing water quality conditions, evaluate long-term trends, design watershed and lake restoration/protection projects, and evaluate project effectiveness. Monitoring focuses on nutrients, sediment, pesticides, heavy metals, dissolved oxygen, pH, temperature, conductivity, and water clarity.

Basin Rotation Monitoring Program: Targeting specific areas in the state each year improves NDEE's ability to identify and remediate water quality problems and allows resources to be focused where they can produce the greatest environmental results. During a six-year cycle, all 13 river basins in the state are intensively monitored. Monitoring data are used to document existing water quality conditions, assess the support of beneficial uses (such as aquatic life, recreation, and public drinking water supply), and prioritize water quality problems.

Public Beach Monitoring Program
Monitors public lakes with designated swimming beaches and/or a large amount of water based recreation. *E. coli* bacteria and toxic blue-green algae (microcystin toxin) are monitored weekly from May through September. Currently, 54 beaches on 51 different lakes are monitored with approximately 1200 samples assessed annually for each parameter. The ingestion of E. coli and/or the microcystin toxin can lead to serious illness in humans. Ingestion of the microcystin toxin by pets can lead to their death.

Stream Biological Monitoring Program
This program is used to evaluate the health of aquatic life populations and involves a unique randomized sample design that allows water quality status and trend assessments to be determined with a known level of confidence. Sampling is conducted in conjunction with the basin rotation monitoring strategy.

Dissolved Oxygen (DO):

This measures the amount of DO that is present in water. This is important because aquatic organisms breath the oxygen found in water through gills (fish, aquatic insects, mussels), through their skin (salamanders), while others are able to gulp air from the surface and hold air in a gas bladder.

Water Temperature:

Cold water holds more oxygen, so as water warms it has less potential to hold onto DO for aquatic life to breath. Some aquatic organisms are able to tolerate a lower O2 environment (like diptera – flies, midges – gnats, or fathead minnows). There are other types of organisms that must have high amounts of DO present (like ephemeroptera – mayflies, and salmonids – trout and salmon)

Temperature can also determine how toxic other substances are like ammonia. At certain temperatures (an pH) ammonia it can be difficult for some aquatic organisms to excrete ammonia causing toxic build up in tissues.

pH

pH is an expression of hydrogen ion concentration in water. Specifically, pH is the negative logarithm of hydrogen ion (H+) concentration (mol/L) in an aqueous solution:

The term is used to indicate basicity or acidity of a solution on a scale of 0 to 14, with pH 7 being neutral. As the concentration of H^+ ions in solution increases, acidity increases and pH gets lower, below 7 (see Figure 1). When pH is above 7, the solution is basic.

pH affects most chemical and biological processes in water. It is one of the most important environmental factors limiting species distributions in aquatic habitats. Different species flourish within different ranges of pH, with the optima for most aquatic organisms falling between pH 6.5-8. U.S. EPA water quality criteria for pH in freshwater suggest a range of 6.5 to 9.

Fluctuating pH or sustained pH outside this range physiologically stresses many species and can result in decreased reproduction, decreased growth, disease or death. This can ultimately lead to reduced biological diversity in streams.

Even small changes in pH can shift community composition in streams. This is because pH alters the chemical state of many pollutants (e.g., copper, ammonia), changing their solubility, transport and bioavailability. This can increase exposure to and toxicity of metals and nutrients to aquatic plants and animals.

Conductivity

Conductivity measures the ability of a solution to conduct electricity. Conductivity values depend on the ionic strength of the solution, the ions present, and the ion concentration.

As salts and other inorganic chemicals dissolve in water, they break down into ions. When ions and dissolved salts are present in the water, they increase the ability to conduct electricity, therefore as salinity increases in water, so does the electrical conductivity (EC). Pure (distilled) water is a good example of a poor conductor because it does not contain any dissolved salts that provide ions to conduct electricity.

As water temperatures fluctuate daily, so can the conductance level. When water becomes stratified due to temperature influencing the water density, the conductivity level in the stratified water can vary at different depths.

Changes in water flow from rivers and dams, and water levels from tidal stages and evaporation also affect water quality, as conductivity and salinity levels fluctuate.

As aforementioned, when conductivity increases in the water, so does the salinity. As salinity affects the solubility of dissolved oxygen (DO) it is critical to measure conductivity alongside salinity when determining the water quality. The higher the salinity and conductivity levels, the lower the DO levels in the water, which can cause issues for some aquatic plants and animals. Some aquatic life can tolerate salinity changes, however, most cannot, and will either die or become seriously sick.

Total suspended solids

The measure of solids suspended in the water column. Suspended solids can clog fish gills, either killing them or reducing their growth rate. They also reduce light penetration. This reduces the ability of algae to produce food and oxygen. When the water slows down, as when it enters a reservoir, the suspended sediment settles out and drops to the bottom, a process called siltation. This causes the water to clear, but as the silt or sediment settles it may change the bottom. The silt may smother bottom-dwelling organisms, cover breeding areas, and smother eggs.

Indirectly, the suspended solids affect other parameters such as temperature and dissolved oxygen. Because of the greater heat absorbency of the particulate matter, the surface water becomes warmer and this tends to stabilize the stratification (layering) in stream pools and reservoirs. This, in turn, interferes with mixing, decreasing the dispersion of oxygen and nutrients to deeper layers.

Can come from run off, turnover in the fall (after a stratified lake becomes one temperature again

Ammonia

Inorganic form of nitrogen (NH_3) When ammonia is present in water at high enough levels, it is difficult for aquatic organisms to sufficiently excrete the toxicant, leading to toxic buildup in internal tissues and blood, and potentially death. Environmental factors, such as pH and temperature, can affect ammonia toxicity to aquatic animals.

Nitrate-nitrite

Nitrate (NO_2^-) – Nitrite (NO_3^-) are needed by plants and animals to live. Nitrates are a form of nitrogen, which is found in several different forms in terrestrial and aquatic ecosystems. These forms of nitrogen include ammonia (NH_3), nitrates (NO_3), and nitrites (NO_2). Nitrates are essential plant nutrients, but in excess amounts they can cause significant water quality problems. Together with phosphorus, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the stream. This, in turn, affects dissolved oxygen, temperature, and other indicators. Excess nitrates can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blooded animals at higher concentrations (10 mg/L) or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/L); in the effluent of wastewater treatment plants, it can range up to 30 mg/L.

Sources of nitrates include wastewater treatment plants, runoff from fertilized lawns and cropland, failing on-site septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors.

Phosphorus

Phosphorus is an essential nutrient for plants and animals. However, excessive phosphorus in surface water can cause explosive growth of aquatic plants and algae. This can lead to a variety of water-quality problems, including low dissolved oxygen concentrations, which can cause fish kills and harm other aquatic life. Rivers connect our terrestrial landscape with downstream lakes, reservoirs, and coastal environments. High phosphorus concentrations and associated water-quality degradation are a key water-quality concern in many of our nation’s rivers and streams.

Alkalinity

Alkalinity is not a chemical in water, but, rather, it is a property of water that is dependent on the presence of certain chemicals in the water, such as bicarbonates, carbonates, and hydroxides. A definition of alkalinity would then be "the buffering capacity of a water body; a measure of the ability of the water body to neutralize acids and bases and thus maintain a fairly stable pH level". In more simple terms, water with a high alkalinity will experience less of a change in its own acidity, for instance, when acidic water, such as acid rain or a acid spill, is introduced into the water body.

Although you don't often hear about the alkalinity of your favorite lake in the news, alkalinity can be important to the health and welfare of a lake. The ecosystem and organisms that live in the lake evolved in water bodies that didn't change quickly. Before humans came along water bodies were not subjected to chemical spills and acid rain. Likely the pH and aquatic characteristics of a lake did not change much over the short term, which suited the fish in the lake just fine.

n a surface water body, such as a lake, the alkalinity in the water comes mostly from the rocks and land surrounding the lake. Precipitation falls in the watershed surrounding the lake and most of the water entering the lake comes from runoff over the landscape. If the landscape is in an area containing rocks such as limestone then the runoff picks up chemicals such as calcium carbonate ($CaCO_3$), which raises the pH and alkalinity of the water. In areas where the geology contains large amounts of granite, for instance, lakes will have a lower alkalinity. But, a pond in an suburban area, even in a granite-heavy area, could have a high alkalinity due to runoff from home lawns where limestone have been applied (used to raise the soil's pH to better grow lawns).

Chlorophyll a

Chlorophyll allows plants (including algae) to photosynthesize, i.e., use sunlight to convert simple molecules into organic compounds. Chlorophyll *a* is the predominant type of chlorophyll found in green plants and algae.

Chlorophyll *a* is a measure of the amount of algae growing in a waterbody. It can be used to classify the trophic condition of a waterbody. Although algae are a natural part of freshwater ecosystems, too much algae can cause aesthetic problems such as green scums and bad odors, and can result in decreased levels of dissolved oxygen. Some algae also produce toxins that can be of public health concern when they are found in high concentrations.

One of the symptoms of degraded water quality condition is the increase of algae biomass as measured by the concentration of chlorophyll *a*. Waters with high levels of nutrients from fertilizers, septic systems, sewage treatment plants and urban runoff may have high concentrations of chlorophyll *a* and excess amounts of algae.