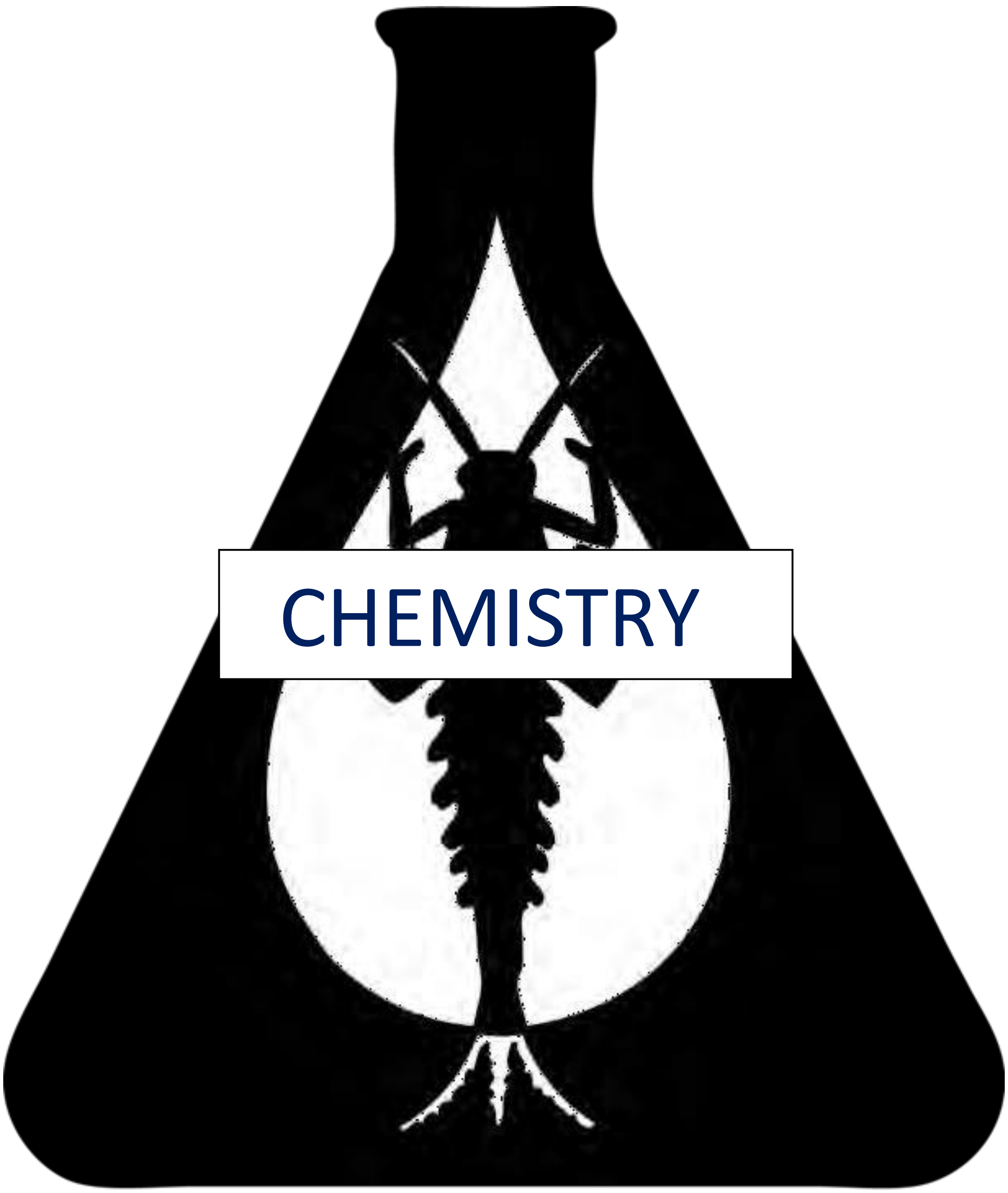
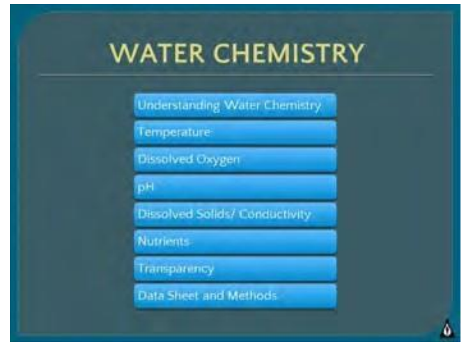
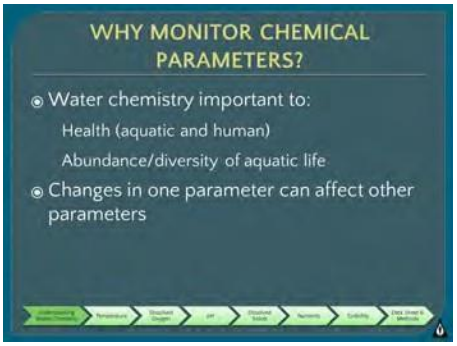

CHEMISTRY

Chemistry

We will discuss:

- Understanding Water Chemistry
- Temperature
- Dissolved Oxygen
- pH
- Dissolved Solids
- Nutrients
- Transparency



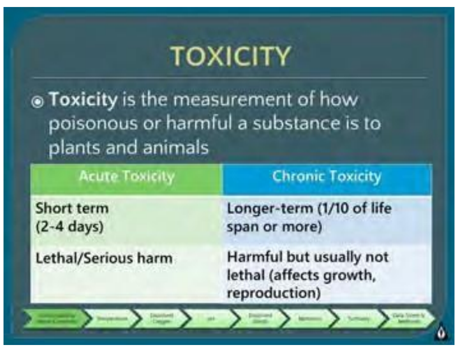


Why monitor chemical parameters?

Water carries needed nutrients and minerals to aquatic life and carries waste. Chemical parameters play an important role in:

- ***Health:*** of the stream
- ***Abundance:*** of aquatic insects
- ***Diversity:*** of aquatic organisms
- ***The life within the stream***

Remember that changes in many of the following parameters can affect other chemical parameters.

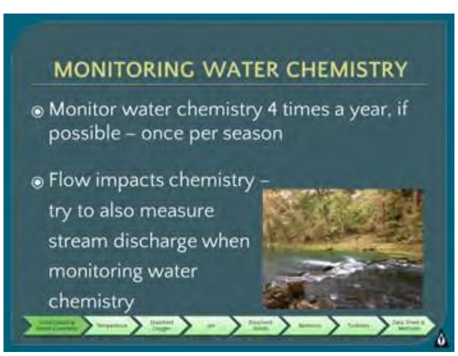


Toxicity Definitions

Toxicity: A measurement of how poisonous or harmful a substance is to plants an animals

Acute Toxicity	Chronic Toxicity
Short term (2-4 days)	Longer-term (1/10 of life span or more)
Lethal/Serious harm	Harmful but usually not lethal (affects growth, reproduction)

Water Quality Standards (WQS) are set to protect human health and animal life. These standards can be found on the Missouri Department of Natural Resources website.



Monitoring Water Chemistry

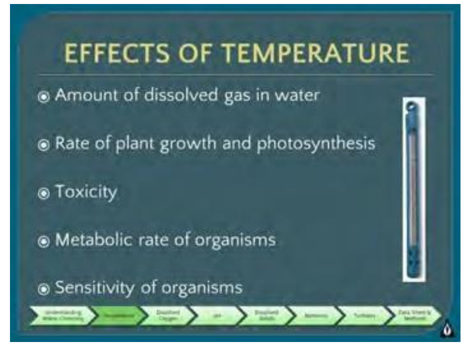
Water chemistry should be monitored at least four times per year, once every season. Some monitors may have specific project goals which require monitoring more frequently. Since stream flow affects water chemistry, also measure stream discharge while collecting water chemistry data.

Effects of Temperature

The ***amount of dissolved oxygen in the water, the rate of photosynthesis*** by algae and other aquatic plants, and the ***rate of plant growth*** are all affected by temperature. Plant growth increases with warmer temperatures. When plants die, they are decomposed by bacteria, which use up oxygen. Increased plant growth means more oxygen being removed from the water during the decomposition process.

The ***metabolic rates of organisms*** increase with higher temperatures. As respiration and digestion rates increase, fish, aquatic insects, and aerobic bacteria require more oxygen to survive.

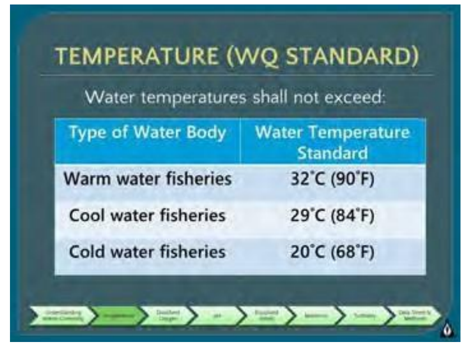
The ***sensitivity rates of organisms*** is also affected by temperature. Many organisms require a specific temperature range, and changing that range may eliminate some organisms from the ecosystem. Under temperature extremes, organisms may become stressed, which makes them more vulnerable to toxic wastes, parasites, and disease.



Water Quality Standard for Temperature

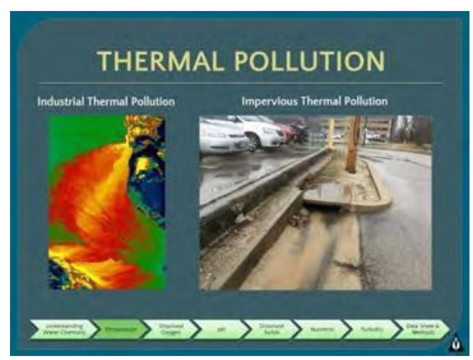
Water temperatures shall not exceed:

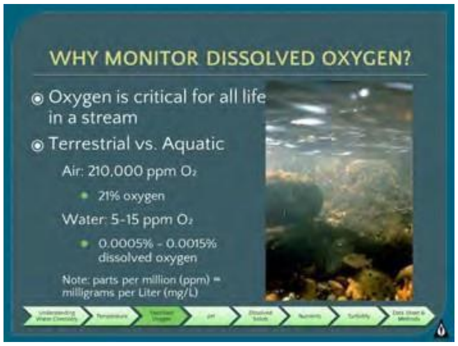
Type of Water Body	Water Temperature Standard
Warm water fisheries	32˚C (90˚F)
Cool water fisheries	29˚C (84˚F)
Cold water fisheries	20˚C (68˚F)

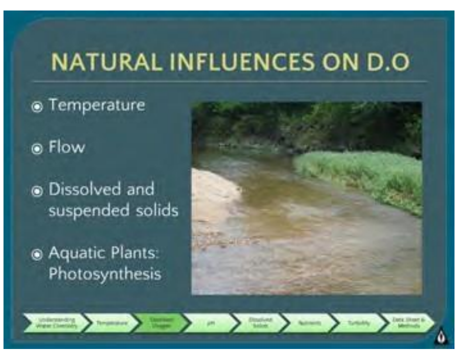


Effects on Temperature

- ***Riparian cover removal:*** What if the trees in the riparian zone were removed from a cold-water trout stream? It is likely that our cold-water stream would not remain cold as long, because there would no longer be any shade.
- ***Soil Erosion:*** increased turbidity
- ***Thermal Pollution:*** Sources of thermal pollution include warm or hot water from a power plant or industrial discharge and runoff from impervious surfaces such as parking lots and streets.
- ***Impervious Surfaces:*** Impervious surfaces are anything that does not absorb water such as concrete, asphalt, roof tops and compacted soils. Impervious surfaces get very hot in the summer and stormwater runoff from these surfaces can reach as much as 120° Fahrenheit.







Dissolved Oxygen

Dissolved oxygen (DO) is essential for the maintenance of healthy waterways. Aquatic life needs a certain level of dissolved oxygen for survival and a depletion of DO can cause a major shift in the organisms present in a stream. Dissolved oxygen comes from 3 major sources:

- ***Atmosphere:*** The air we breathe contains approximately 21% oxygen, which equates to 210,000 ppm oxygen. Some of this oxygen diffuses into streams. Most surface waters contain between 5 and 15 ppm dissolved oxygen.
- ***Aeration:*** Waves and tumbling saturate water with oxygen from the atmosphere like an aquarium aerator.
- ***Photosynthesis:*** Algae and other aquatic plants deliver oxygen to water.

Waters with consistently high D.O. are considered healthy and stable aquatic systems – a positive sign. Absence of D.O. is a sign of severe pollution.

Water Quality Standard for Dissolved Oxygen

The Water Quality Standard for D.O. is no less than 5 mg/L (5 ppm)

Dissolved oxygen fluctuates throughout the day. It is natural to be lowest just before sunrise and peak during the middle of the day. This is because algae and other aquatic plants switch from photosynthesis to respiration at night and are therefore using oxygen, not producing it.

Some of the factors that can cause extreme fluctuations in DO include:

- Removal of trees
- Excess nutrients

It's best to sample water quality first thing in the morning to measure the lowest dissolved oxygen for your stream.

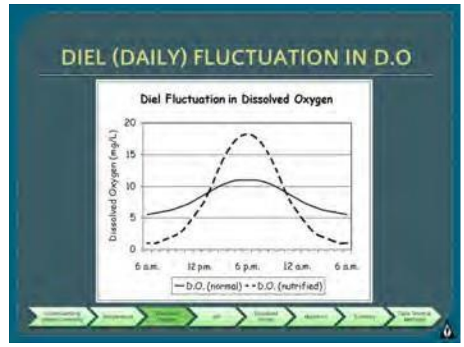
Dissolved Oxygen Percent Saturation

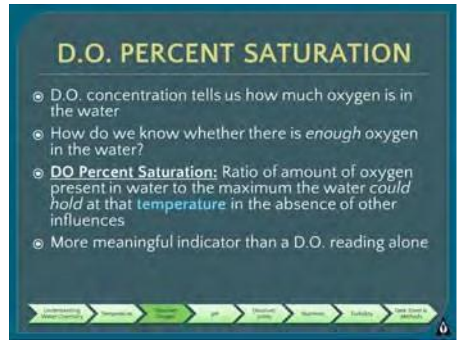
Dissolved Oxygen Saturation is the maximum level of dissolved oxygen that would be present in the water at a specific temperature, in the absence of other influences.

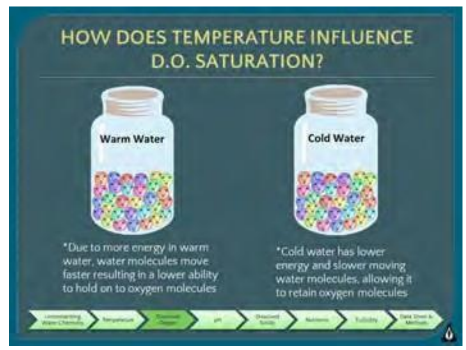
Percent Saturation is the percentage of dissolved oxygen concentration relative to that when completely saturated. This tells us whether a DO measurement is good or bad.

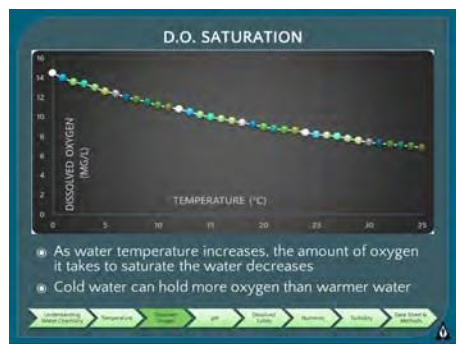
As water temperature increases, DO saturation decreases, and as water temperature decreases, DO saturation increases. Therefore, cold water will hold more DO than warm water.

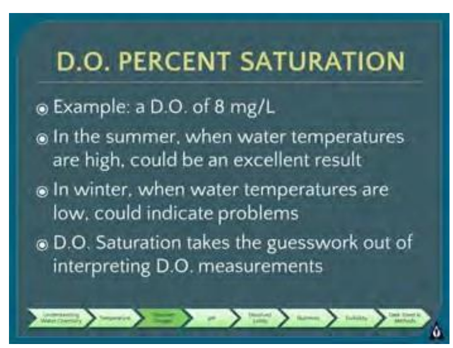
Acceptable D.O. Percent Saturation Levels	
Ozark Stream (high gradient, rocky bottom)	>80% D.O. Saturation
Prairie Streams (Low-gradient or slow moving)	>60% D. O. Saturation

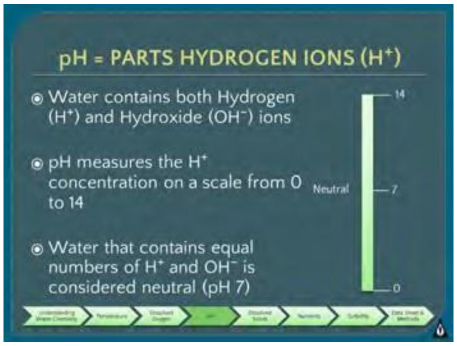


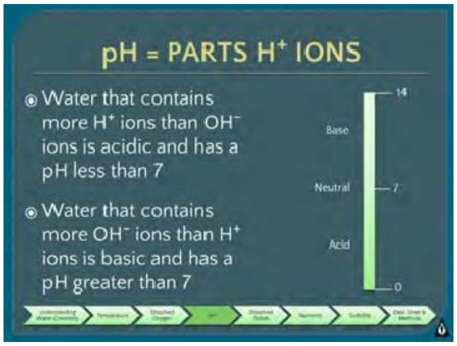


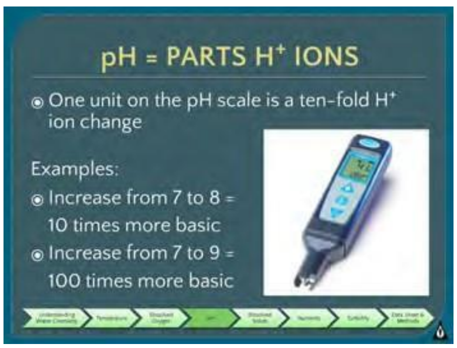


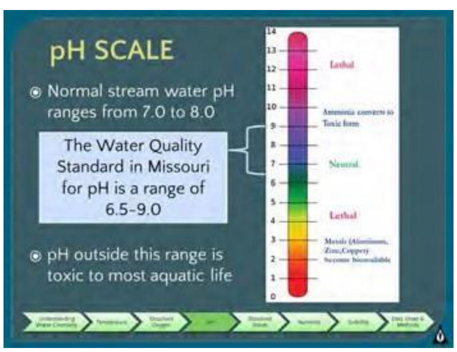












pH

Water contains both Hydrogen (H+) and Hydroxyl (OH-) ions. ***pH*** measures the H+ concentration on a scale from 0 to 14.

- ***neutral (pH 7)*** contains equal numbers of H+ and OH– ions
- ***acidic (pH < 7)*** contains more H+ than OH- ions
- ***basic (pH > 7)*** contains more OH– ions

The pH scale is logarithmic, meaning that every one-unit change on the pH scale is a ten-fold H+ ion change. A one-point pH change indicates the strength of the acid or base has increased or decreased tenfold. A two-point change indicates a 100-fold change.

- Increase from 7 to 8 = 10 times more basic
- Increase from 7 to 9 = 100 times more basic

pH Effects on aquatic life

Normal stream water pH ranges from 6.5 to 8.0. Most organisms have adapted to life in water of a specific pH and may die if that fluctuates even slightly. ***At extremely high or low pH values (11.0 or 4.5) the water becomes lethal to most organisms.***

Waters that are acidic can cause metals such as zinc, aluminum, and copper to be released into the water column and accumulate in the food chain. Copper and aluminum can accumulate on fish gills and cause deformities in young fish, reducing their chance of survival. Ammonia compounds convert to a toxic form in basic water. The more basic the water, the more toxic the ammonia that is present.

Water Quality Standard for Ph

The Water Quality Standard for pH is 6.5 – 9.0

Conductivity

Conductivity is a measure of the electrical current passing through water. It is a general indicator of water quality trends because it tells us the amount of dissolved solids are in the water. ***Conductivity measurements do not tell us which dissolved substances are in the water, only how much.*** Small amounts of certain dissolved solids, such as some metals, can cause significant changes in conductivity.

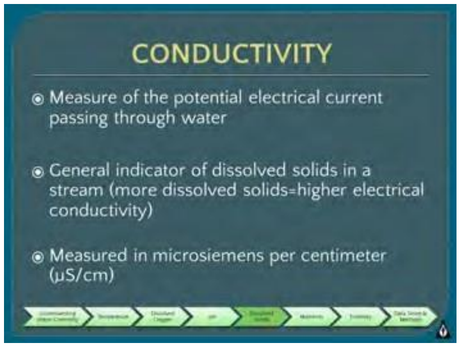
Common dissolved solids which influence conductivity:

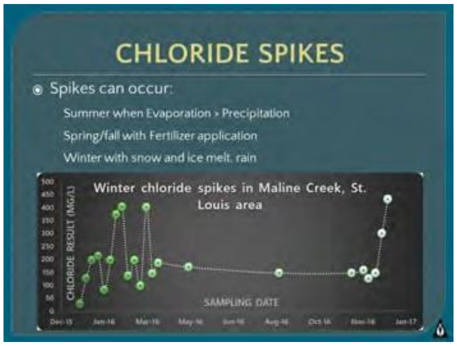
- Bicarbonate
- Calcium
- Magnesium
- Sulfate
- Chloride
- Sodium
- Potassium

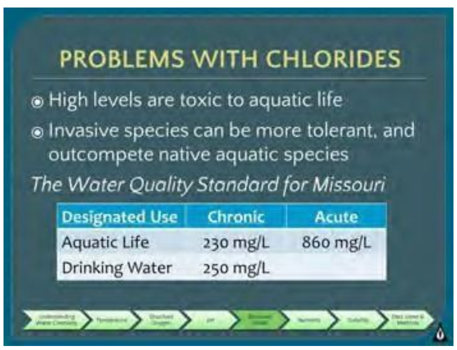
Sources of dissolved solids in streams include: rainfall, vegetation, rocks, soil, and groundwater. The three most abundant dissolved substances come from the dissolution of limestone and dolomite. The remaining one percent of dissolved solids can vary considerably, but can include nitrates, metals, ammonia, phosphorus, and manmade compounds such as pesticides and fuel.

Water Quality Standards for Conductivity

There is currently no Water Quality Standards for conductivity







Chlorides

Chlorides are salts resulting from the combination of chlorine gas and various metals. Most chlorides come from sodium chloride (NaCl) applied to roads and sidewalks to melt ice.

Application of these road salts has drastically increased since the 1970s. These salts can travel up to 130 ft from the roadway and often have heavy metal additives, so other harmful substances may be present.

High levels of chlorides are toxic to aquatic life. They interfere with osmoregulation in freshwater organisms and can lead to fish kills.

Some invasive species (e.g. Eurasian water milfoil) are more tolerant to chloride and can outcompete the native species of the area.

Spikes can occur during the summer during low flows and during the spring and fall after fertilizer applications.

Water Quality Standards for Chlorides

Designated Use	Chronic	Acute
Aquatic Life	230 mg/L	860 mg/L
Drinking Water	250 mg/L	

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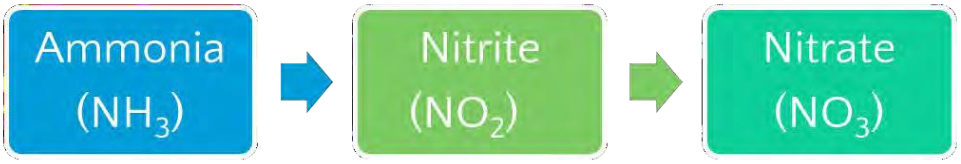
Nitrogen

Nitrogen is an essential plant nutrient required by all living plants and animals for building protein. All living, organic matter contains nitrogen***.*** As aquatic plants and animals die, bacteria break down the organic matter. Ammonia (NH_3) is oxidized (combined with oxygen) by bacteria to form nitrates (NO_2) and nitrates (NO_3).

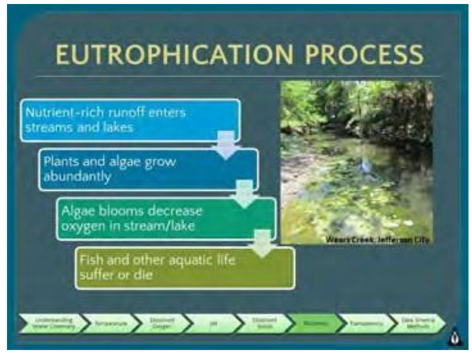


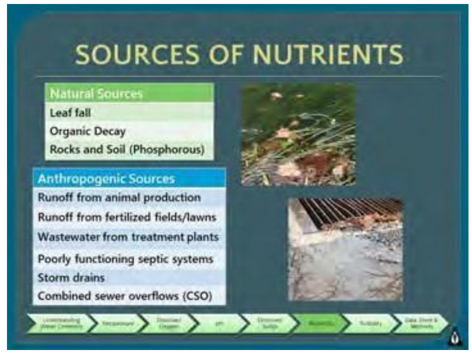
What affects nitrogen levels?

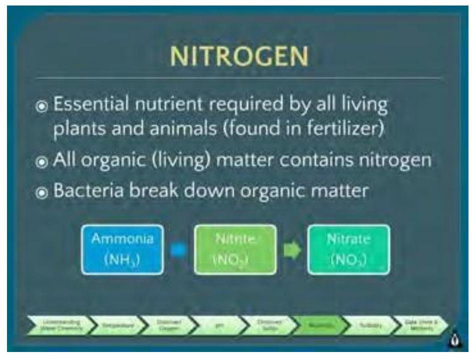
- Leaf fall
- Organic decay
- Anthropogenic impacts:
    - Poorly functioning septic systems
    - Wastewater from treatment plants
    - Runoff from animal production
    - Runoff from fields and lawns
    - Storm drains
    - Combined sewer overflows (CSO)

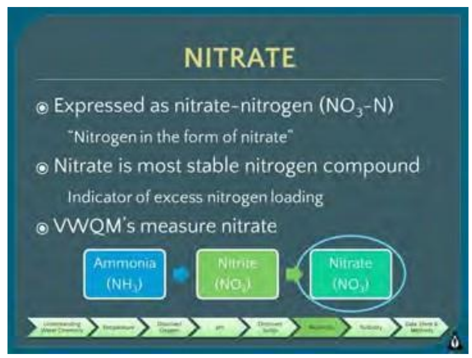
Water Quality Standard for Nitrate

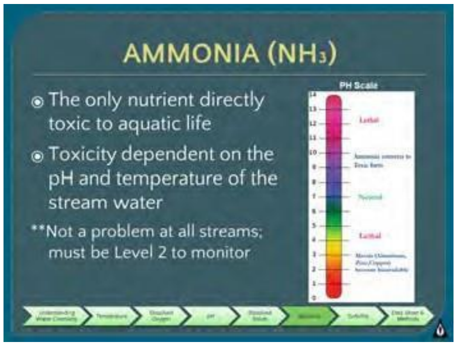
There is a nitrate Water Quality Standard criterion of **10 mg/L**











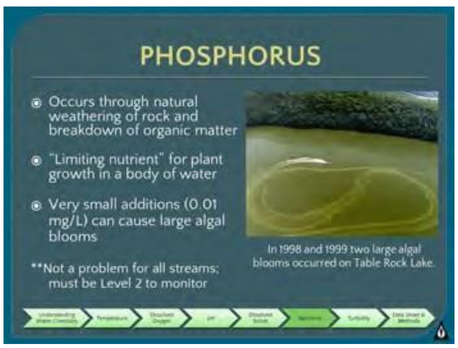
Ammonia

Ammonia (NH_3) is the only nutrient that is directly toxic to aquatic life. However, the toxicity of ammonia is dependent on the pH and the temperature of the water.

Ammonia levels are not usually a problem in most Pennsylvania Rivers and streams. Ammonia is only monitored when a need is determined.

Water Quality Standard for Ammonia

The Water Quality Standard for Ammonia Nitrogen is 0.5 mg/l



Phosphorus

Phosphorus is also a plant nutrient. It is most readily available to plants as ***orthophosphate,*** a reactive form of phosphorus commonly referred to as "phosphate" (PO_4). Phosphorus occurs naturally in rocks and enters the water column through the weathering of rock. When additional phosphorus enters an aquatic system, even very small amounts (0.01 mg/L) can cause large algal blooms.

Natural:

- ***Rocks and soil***
- ***Breakdown of organic matter***

Anthropogenic:

- ***Runoff from animal production:*** especially from poultry litter
- ***Wastewater from treatment plants***
- ***Poorly functioning septic systems***
- ***Runoff from fields and lawns:*** Many people fertilize their lawns in urban areas. Runoff from rainfall events following application can cause high phosphorus levels after storm events.
- ***Storm drains -*** Storm drains may carry waste from pets, lawn fertilizer, broken wastewater lines and septic systems.
- ***Combined sewer overflows (CSO)*** - These systems caused excessive algae blooms in Lake Erie in the 1960's. Starting in 2011, projects began to reduce the volume of discharges by CSOs around Lake Erie.
-

Water Quality Standard for Ammonia

- The EPA established a goal for total phosphorus concentration of 0.10 mg/L to limit cultural eutrophication of flowing water.

Transparency

Transparency is a measure of water clarity. It measures the depth in centimeters that light can penetrate the water. Suspended matter and plankton can cause cloudy, murky, or green water. A larger reading means the transparency is higher, thus the water is clearer.

Having a low transparency is detrimental to aquatic life. Sediment can block out light needed for vegetation, and it can bury fish eggs and benthic invertebrates. Suspended particles can also absorb heat and increase the water temperature.

Monitoring transparency can be particularly valuable:

- In areas being developed
- Agricultural areas not adopting best management practices to prevent soil erosion
- Downstream from quarries and gravel mining operations