Station 2: Water Chemistry: Questions to stimulate discussion.

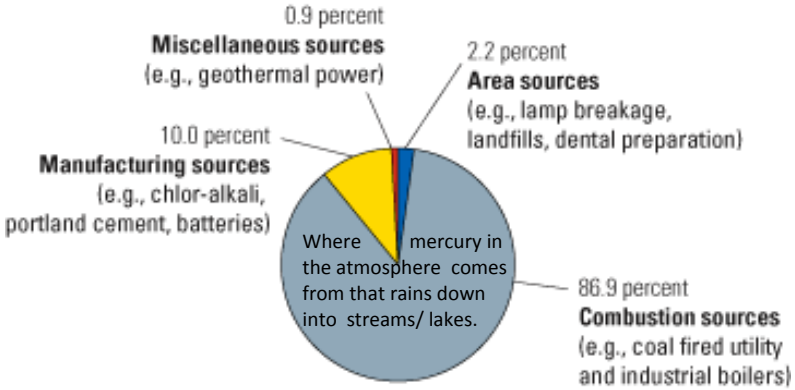
pH

1. What is pH?

Water is composed of hydrogen and oxygen atoms: **H_20**. There are also **hydrogen ions H^+,** and **hydroxide ions**, **OH^-** in the water. The number of H^+ or OH- ions is determined by the type of rocks and the soil that water is flowing over (e.g. limestone raises pH), the type of rainfall and other inputs into the system. The pH, in general means **the percentage of hydrogen ions** in the water. Acidic water has lots of hydrogen H^+ ions and basic or alkaline water has lots of hydroxide OH^- ions. Too many of either type is toxic to aquatic life. A neutral pH of 7 has equal number of both types of ions.

2. Why do we test the pH of the water?

Aquatic plants and animals have an optimal pH zone they prefer to live in. If the pH of the water is too high or too low, swimming speed can be decreased, eggs don't hatch, plant growth is slowed and death can occur. The rainfall is acidic in Northern Virginia because of all the pollution from vehicle emissions and coal fired power plants. This acidic rain lowers the pH of the water. If it gets below pH 5, toxic heavy metals like mercury in the sediment can be released having toxic effects of fish and other organisms. Chemicals spilled into the stream or lake can also lower or raise the pH.



The Environmental Protection Agency (1997)

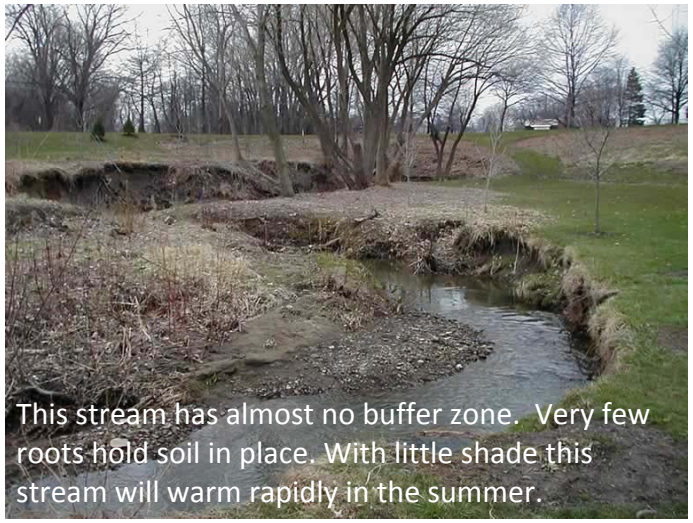
A measure of the concentration of hydrogen ions H^+	pH Scale: Acidic								Neutral			Basic								
Effects Observed	**0-2**	**3**	**3.5**	**4**	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**9.5**	**10**	**11**	**12**	**13**	**14**
Very little survival of living organisms																				
Fish survive just a few hours some plants & invertebrates survive																				
Deadly for all trout, salmon																				
All fish, most frogs and insects are not present																				
Most fish eggs won't hatch. Only invertebrates tolerant of acidic water present. Toxic metals in sediment released																				
Leaf litter,dead plant /animal materials accumulate because bottom-dwelling decomposing bacteria begin to die off.																				
pH of Acid Rain					*acid rain*															
Range for most aquatic organisms									Best range for aquatic organisms											
Unlikely to be harmful to fish, but chemical changes may occur																				
Harmful to perch, trout, salmon if prolonged exposure.																				
Prolonged exposure is lethal to carp and perch.																				
Lethal to all species of fish.																				

TEMPERATURE

1. Why is it important to measure the temperature of streams and lakes?

Water temperatures outside the "normal" range for a stream or river can cause harm to the aquatic organisms living there.

Cutting down trees surrounding a stream causes the water temperature to rise and accelerates the erosion of the stream bank which increases the amount of sediment in the water. It may also cause an increase in other kinds of pollutants entering the stream since tree roots help filter out certain pollutants before they enter the stream.



This stream has almost no buffer zone. Very few roots hold soil in place. With little shade this stream will warm rapidly in the summer.

2. Does colder or warmer water hold more dissolved oxygen?

Colder, because the molecules are closer together. **Warm water holds less dissolved oxygen**, thus it becomes a challenging environment to live in. When warm water washed off hot parking lots and blacktops into streams, the temperature may increase rapidly. Shallow streams warm faster.

Organism	Temperature range
 Caddisfly larvae	10 – 25°C
Mayfly larvae 	10 – 25°C
 Water Boatman	10 – 25°C
 Midge larvae	10 – 25°C
 Carp	10 – 25°C
 Rainbow Trout	5 – 20°C
 Small-mouth Bass	5 – 28°C

3. Does water temperature affect aquatic animals?

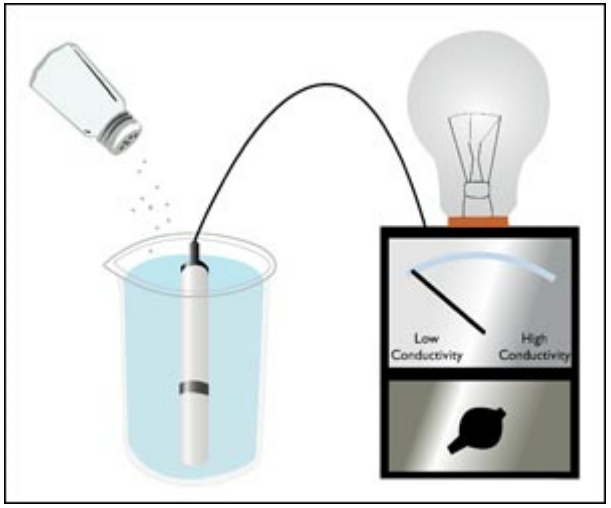
Yes! Water temperature determines how long each life stage lasts in aquatic insects. Warmer water (as long as food is available) speeds up growth and molting.

Each stage of this dragonfly nymph's life is called an instar.

This stream has a dense buffer zone. Roots hold bank in place. This shaded stream will not warm up as rapidly as the stream above.

Conductivity

1. What is conductivity?



Conductivity is the ability of the water to conduct an electrical current. Extremely pure water, like distilled water, has very few dissolved ions, and thus can't conduct a current. Electrical conductivity (EC) estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. Basically it tells you if you have a lot of 'stuff' dissolved or suspended in your water.

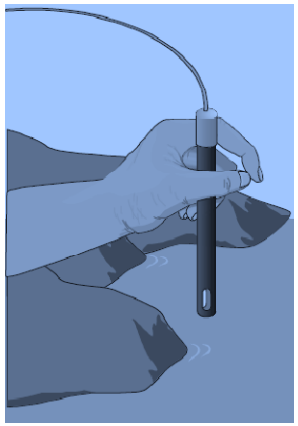
Suspended solids include silt, stirred-up bottom sediment, decaying plant matter, or sewage-treatment effluent. Electrical Conductivity is measured in microSiemens per centimeter (µS/cm).

To measure conductivity-- a sensor with two metal electrodes spaced exactly 1.0 cm apart is placed into the water. A constant voltage is applied across the electrodes. An electrical current flows through the water between these electrodes. The current is proportional to the concentration of dissolved ions in the water. Thus the more ions, the more conductive the water. (2000 µS = 1000 mg/L TDS).

2. Why is it important to measure the conductivity of streams and lakes?

When salts and other inorganic chemicals dissolve in water, they break into tiny, electrically charged particles called **ions**. These could indicate pollution. Aquatic animals and plants are adapted to tolerate a certain range of salinity and other ions.

Total Dissolved Solids is sometimes called a "watchdog" environmental test. Any change in the ionic composition between testing sites or different days can be detected using the conductivity probe. We expect there to be some dissolved solids in the water, we have to test further to know which ions are responsible for the conductivity in the stream or lake.



Man-made sources of ions that contribute to higher Total Dissolved Solids readings...

- Runoff from roads that have been salted in the winter.
- Fertilizer from fields & lawns adds ions
- The type of streambed, rocks that water flows over
- Organic matter from wastewater treatment plants may add nitrate or phosphate ions.
- If urban drinking water has been highly chlorinated, then runoff from irrigated lawns/gardens will have higher concentrations of sodium or chloride ions.
- Acidic rainwater, with dissolved gases like CO_2, NO_2, or SO_2, may have higer H^+ ion concentrations.
- Water flowing over limestone or clay soils will have higher conductivity

Nitrate


www.waterencyclopedia.com

1. What are nitrates?

Nitrate, NO^{3-} is a water-soluble molecule made up of nitrogen and oxygen. Nitrogen is a required element for plant growth (it helps plants in photosynthesis, builds proteins etc..). Even though Nitrogen (N_2) makes up about 78% of the earth's atmosphere, this nitrogen is unavailable to plants unless it gets transformed biologically (by microbes) or industrial processes (making fertilizer) into forms which are plant-available. As a result, modern agriculture is heavily dependent on commercial N fertilizer.

2. Why do we measure nitrate in the water?

Nitrate is highly mobile, which means that is it soluble in water. When it rains or fields/lawns are irrigated, nitrates easily mix with the water and are carried with the flow to streams and storm sewers (which empty into local streams). Once the nitrates are flowing in streams, algae rapidly uptake them and grow. Algae occur as tiny single-celled plants called phytoplankton or as larger seaweeds which look like "slime." If excess nutrients, like nitrates and phosphates flow into streams and the Bay, algae blooms result. The algae bloom can be so thick that it keeps light from getting through to the rooted underwater vegetation. As the algae dies and sinks to the bottom, decomposing bacteria feed on algae, using up all the dissolved oxygen in that area. This creates 'dead zones' in the Bay, areas with no dissolved oxygen.

3. During what time of year are algae blooms the most problematic?

Summer, because warm water holds less oxygen than cool water. Without oxygen, many organisms perish. Fish may be able to swim to an with more oxygen, but other species like clams, worms and small invertebrates are challenged to move long distances.

4. What can we do in Fairfax County to limit the amount of nitrates and phosphates in streams and the Bay?

* For lawn fertilizer, read the label so you don't over apply. If you must fertilize, only put down what the plant will use—nothing more so it doesn't wash off.
* Plant native plants. They are adapted to our soils and don't need additional fertilizer to grow. Add compost to your lawn so it needs less fertilizer and can soak up more stormwater.
* Plant a rain garden to soak up stormwater in your yard or schoolyard so less stormwater flows into local streams.
* Have your septic tank pumped out every three years.
* Keep lawn clippings and leaves out of streams and storm sewers

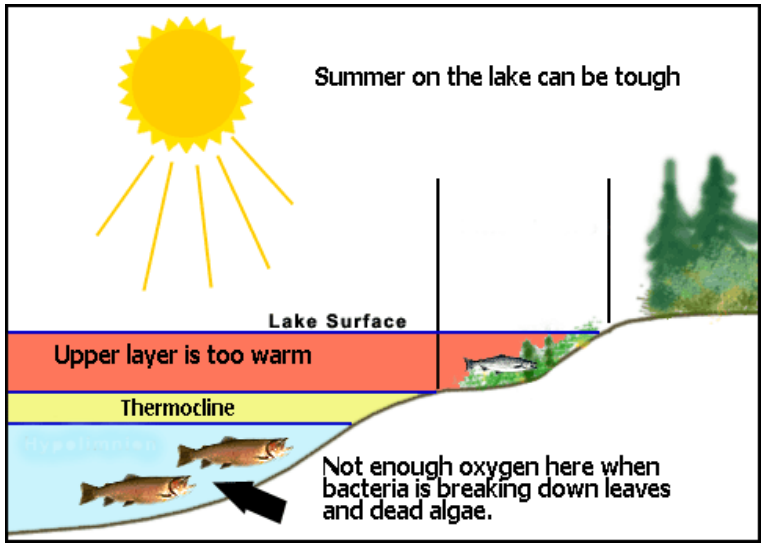
Dissolved Oxygen

1. What is dissolved oxygen?

It is the amount of oxygen in the water, which all organisms use to breathe. Low oxygen levels can seriously impair animal growth and impact the survival of aquatic organisms. The air we breathe contains about 21% oxygen. Water has significantly less than that, ranging from 0-18 parts per million (ppm) – or .0018%. Normal values are 5-6 ppm to support a healthy population of organisms.

2. Can you look at a stream or lake and predict the amount of Dissolved Oxygen?

Nope. Dissolved Oxygen is influenced by the water temperature, wind, the amount of algae producing oxygen, and nutrients (nitrates & phosphates). In streams, there is more DO in riffle areas than in calm areas.
If DO levels decrease, invertebrates, and other animals struggle to extract the oxygen they need to survive.

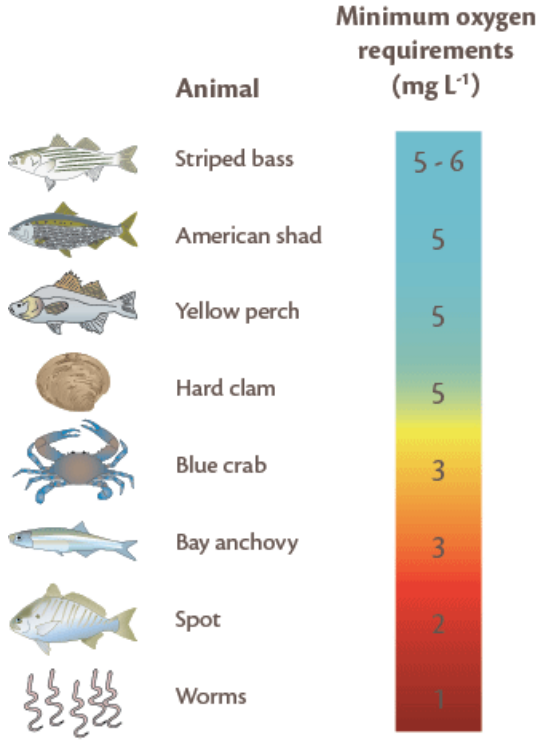


3. What causes Dissolved Oxygen levels to decrease?

Temperature. Warm water holds less DO than cold water. In shallow, slow streams that have few trees along the bank to shade the water, the water can heat up and DO decreases.

Decomposition of organic material like leaves, dead algae and plants. Bacteria feeding on these use up DO creating dead zones called anoxic areas. This is a BIG problem in the Chesapeake Bay during the summer months.

Excess nutrients from animal manure, fertilizer, wastewater treatment plants fuel these algae blooms.



'Minimum dissolved oxygen requirements for key organisms in Chesapeake Bay' www.eco-check.org

Turbidity

1. What is Turbidity?

When water is cloudy, it is called turbid. Turbid water, or **turbidity**, results when **sediment** (soil particles) and other materials are stirred up in the water. It is a measure of the degree to which light is scattered by suspended particulate material and soluble colored compounds in the water. It gives us an estimate of the muddiness or cloudiness of the water due to sediment, plankton and organic material.

2. What makes the water turbid?

In Northern Virginia, our soils have a high clay content. Clay soil particles are very fine and easily become suspended in water, during hard rains, where they are carried into local streams. Excess nutrients cause algae blooms which also increase turbidity.

3. How is turbidity different from water clarity?

Water clarity is a measure of how transparent the water is. Just like plants on land, aquatic plants need sunlight for growth. The amount of sunlight that reaches underwater plants depends on the clearness of the water, or **water clarity**. If sunlight can't reach the submerged aquatic plants, their growth is limited and animals like young crabs and fish have no hiding places from larger predators.

To measure water clarity, scientists use a **Secchi disk**. The line contains measurement markings. It is dropped into the water until it can't be seen, then pulled up until just visible. It is repeated, and the average of two depth measurements, is recorded as the Secchi depth.