Water Temperature

The temperature of the water determines what can live there, because it is directly related to the amount of dissolved oxygen available to organisms for respiration. Cooler water has the capacity to hold more dissolved oxygen than warmer water. Water temperature also influences the metabolism of cold-blooded aquatic organisms. The warmer the water, the higher the metabolism of the organism and the more energy is required for survival. Conversely, the cooler the water, the lower the metabolism and less energy is required for survival. Cooler water habitats may allow more organisms to live in them. Additionally, each organism has a temperature range needed for survivorship and reproduction.

Measuring Water Temperature

1. Place the thermometer below the water's surface. If possible, obtain the temperature reading in the main streamflow.
2. Swirling gently, hold the thermometer in the water for approximately 2 minutes or until the reading stabilizes.
3. Record your reading in Celsius.
4. Repeat steps 1 – 3 in 2 more locations in the stream.
5. Calculate the average temperature in Celsius.
6. Describe the areas in the stream where you measured temperatures.
7. Make sure to record your data.

Interpreting Temperature

Forested environments with flowing water usually have little fluctuation in water temperature year round. This can be very good for the animals that live there since most are ectothermic (their body temperatures fluctuate with the temperature of the environment). They do not have to worry about freezing or releasing heat if the temperature is constant. Water temperatures often increase when tree cover is removed from stream banks or when sediment clouds the water, because sediments absorb and hold onto heat.

What was the average water temperature of the stream studied? If individual measurements differ, why do think this is? What else do you think could cause the stream temperature to increase?

Biotic Extension: How might the aquatic community change if the average stream temperature increased? When a stream ices over, how do you think it affects the organisms living there?

Sunlight

The amount of light in the system determines whether the energy base will be coming from live plants growing in the water or detritus (plant and animal matter falling into the water). The amount of light reaching the stream also influences the temperature of the water. Small streams are usually shaded by trees and therefore are cooler than larger streams.

Measuring Sunlight

1. Look up while in the stream. How much vegetation shades the stream at your site? 0% 25% 50% 75% 100%
2. Do you see any algae or aquatic plants growing in the stream? If so, are they attached to the ground and rocks or are they free floating?
3. Where are they located? (stream edge, main channel, on rocks)

Interpreting Sunlight

When the matter and energy flow for the system comes mostly from within the system, it is called autochthonous (A tock tha nus). This is when you see plants growing in and on the water. When the matter and energy flow for the system comes mostly from outside of the system, it is called allocthonous (A lock tha nus). The source of matter here is usually leaf litter. The type of matter feeding the system will determine what organisms live there, because they have specific adaptations related to their food source(s).

Where is the matter and energy flow (food) coming from in the stream? How might this affect the diversity of organisms that live there? Does sunlight reach the bottom of the stream? Does moving water absorb as much heat from the sun as still water?

Biotic Extension: What kinds of organisms did you find in the stream? Did you notice any micro-habitats in the stream? What food sources were available in this stream? (leaf litter, algae/moss, other organisms, etc.

Substrate

Substrate is the substance that makes up the bottom of the streambed. It can differ by composition (mineral to organic material), particle size, texture (smooth or rough), porosity (how much water runs through it) & stability.

Measuring Substrate

1. Take a look around the study area. What substances make up the majority of the streambed? Leaf Litter, Woody Debris (sticks, logs), Gravel (rocks smaller than your hand), Cobbles (rocks bigger than your hand that can be moved), Boulders (rocks that cannot be moved by hand, but are not attached to the bottom), Bedrock (a solid sheet of rock attached to the bottom).
2. Pick up a handful of loose substrate from the stream bottom. Squeeze it. Does it create a ball or does it fall apart? Is it smooth and slimy or rough and gritty? Silt/Clay/Mud (sticky, smooth, slimy, squish out of your hand when squeezed) or Sand (falls apart, rough, gritty).
3. Observe how water moves over different kinds of substrate. Does it slow down or speed up in specific areas? Does it look different?
4. Record your observations.

Interpreting Substrate

Substrate of a stream helps ecologists to determine the types of animals that will be found there. Substrate influences the speed in which water sheds off the land too. Bedrock sheds water quickly, while leaf litter and wood debris slows the water down. Rocky areas, leaf packs, and sandy pools all provide habitat for salamanders and macroinvertebrates. They also create riffles or areas where oxygen from the air mixes into the water column increasing the dissolved oxygen.

How many different types of substrate did you find in the stream? Was there a dominant substrate? Did you notice any differences in water movement or speed that you attribute to substrate?

Biotic extension: Identify micro-habitats based on substrate. Search for organisms in each micro-habitat. Collect, organize and identify what you find. Compare organisms based on micro-habitat. Do you notice any adaptations that are specific to the micro-habitat? Do you see any patterns? How does substrate diversity effect biotic diversity in a stream?

Current/Velocity

Velocity is the speed at which the water is moving in the stream channel. The speed affects the amount of sediments and debris moved downstream and exerts a force on the organisms in the stream. It also affects turbidity within the stream. Fast moving water tends to transport sediments and slow moving water tends to deposit them.

Measuring Velocity

1. Take a look at the study area. Are there areas where the water is moving faster than others? What do those areas look like?
2. Do you see any areas where sediment is being carried or deposited?
3. Record your observations. Draw a map of these areas and label them.
4. Measure the speed or velocity of the main channel of the stream.
    a. You will need a start point and end point, something that floats, a timer, and the measurement of length between the 2 points in meters
    b. Record each time trial (3x in same place)
    c. Calculate an average time (in sec)
    d. Record your data.
5. Describe what the area looks like where you collect data and add it to your map.
6. Calculate the velocity. Velocity = distance (m)/average time(s)

Interpreting Velocity

Fast currents bring suspended materials downstream and move oxygen over gills, but also exert a force. This force can dislodge smaller organisms from their hiding places which create energy sources for fish and other animals downstream. Slow moving water allows debris carried in the water column to settle and deposit in pools. These sandy areas create habitat for and bring nutrients to collectors (i.e. caddisflies) and sit and wait predators (i.e. dragonflies).

What was the average velocity of the main stream channel? Was it consistent throughout? How might velocity be affected if a huge rain storm comes through the area? What about a drought? Describe how volume of water effects velocity.

Biotic Extension: How many different micro-habitats can be identified based on velocity? Collect organisms from slow moving areas of the stream and fast moving areas of the stream. Take a close look at the organisms found in fast flowing water. Do you notice any adaptations that would help them stay in place? Take a close look at the organisms found in slow moving water (pools). Compare the two groups. Do you notice any patterns? How does velocity affect the biotic community found in this stream?

Riparian Zone

A riparian zone is the area adjacent to a stream and is one of the most important elements in determining the health of a stream. A high quality riparian zone should contain natural vegetation comprised of a community of trees, shrubs, and herbaceous plants.

Measuring the Riparian Zone

1. Looking upstream, record the presence or absence of the following vegetation types for the left and right banks of the stream:
    a. Evergreen trees
    b. Deciduous trees (shed leaves in winter)
    c. Bushes and shrubs (less than 15 ft high)
    d. herbaceous plants (grasses, ferns, vines, mosses)
    e. lawn (maintained grass)
    f. leaf litter
    g. bare soil, boulders, or pavement
2. Create a map of the riparian zone, labeling where the vegetation is located.
3. Observe the banks of the stream. Describe what it looks like where the land meets the water? Do you see any places where erosion is taking place?
4. Add these observations to your map.

Interpreting the Riparian Zone

Stream surroundings can affect the biotic community in many ways. Leaves shade the stream, keeping water temperatures cool which in turn affects the amount of dissolved oxygen in the water. Plants and leaf litter slow down and absorb run-off, filter out pollutants and prevent erosion of streambeds. Leaves and woody debris feed the stream when they fall. Decaying leaf litter is the main source of nitrogen and phosphorous input in forested headwater streams. Organisms need these nutrients to live.

What did you find surrounding the streams visited? Did you identify any areas where the riparian zone was eroding into the stream? If so, where was it located and how much erosion was happening? In what ways may your findings affect the stream community?

Biotic Extension: Take a look at the vegetation on the edges of the stream. Do you notice any insects or other organism using the vegetation as a home? Are any of the roots of the vegetation visible through the stream bank? If so, are there any organisms gripping onto the roots? Find an area where there is a leaf pack (leaf litter piled up in the stream). Collect the leaf pack in a strainer or bucket and search through it for living things. If you find anything, take a close look at them with a magnifying lens. Do you notice any adaptations that are useful for living and eating in a leaf pack? If you can, identify the organisms. Record your findings.

Dissolved Oxygen (DO)

Oxygen is as important to life in water as it is to life on land. Most aquatic plants and animals require oxygen for survival. Although oxygen atoms are present in the water molecule (H_2O), most aquatic life require oxygen in the free elemental state (O_2) as a dissolved gas. The amount of oxygen in water is called the dissolved oxygen (DO) concentration. Oxygen dissolves into the water from the atmosphere until the water is saturated. Aquatic plants, algae, and plankton also produce oxygen as a by-product of photosynthesis; which is why oxygen levels rise during the day and fall at night during respiration.

Measuring Dissolved Oxygen

1. Follow the instructions in the DO chemical kit carefully. Make sure to put on your safety equipment (goggles and gloves) before using the chemicals.
2. Record your findings.
3. Dispose of chemical waste in a bottle.
4. Describe the area where you took your water sample. Are there rocks or white water? Is the surface smooth or rough? Are there any plants growing in the water?
5. Record your observations.
6. Measure and record the temperature of the water where you measured DO.

Interpreting Dissolved Oxygen (DO)

DO is an important measure of stream health. Presence of oxygen in water is a positive sign, while absence of oxygen from water often indicates water pollution. While our atmosphere holds 21% (210,000 ppm) oxygen, water can hold at the most about 15 ppm. Aquatic organisms require different levels of DO.

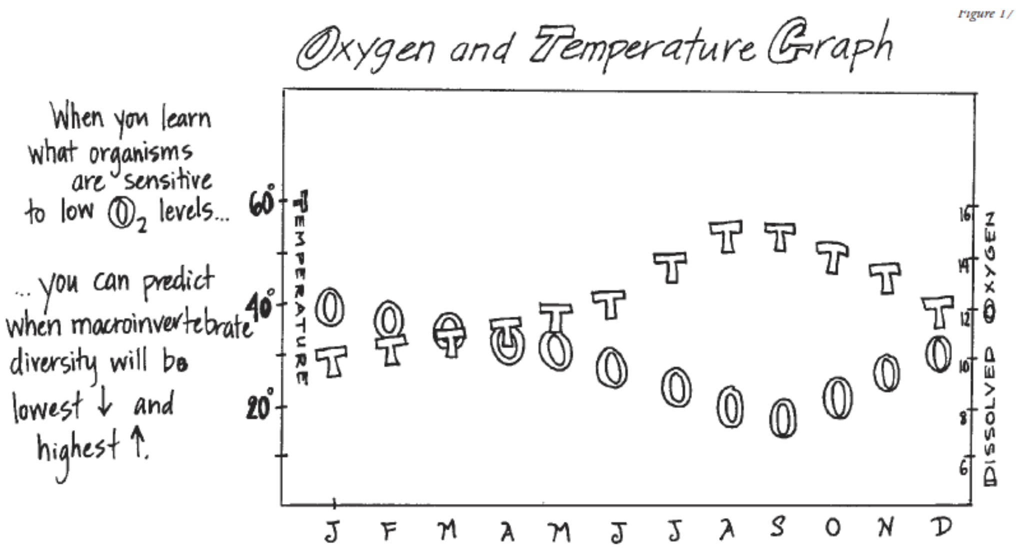
5 – 6 ppm is sufficient for most species
<3ppm is stressful to most aquatic species
<2ppm is fatal to most species.

Percent Saturation – In order to get a more accurate interpretation of DO, we will take into account water temperature. Use the scale provided to calculate the percent saturation.

80 to 120 percent are considered to be excellent
Between 60 and 79 percent are adequate
Above 125 percent and below 60 percent are poor

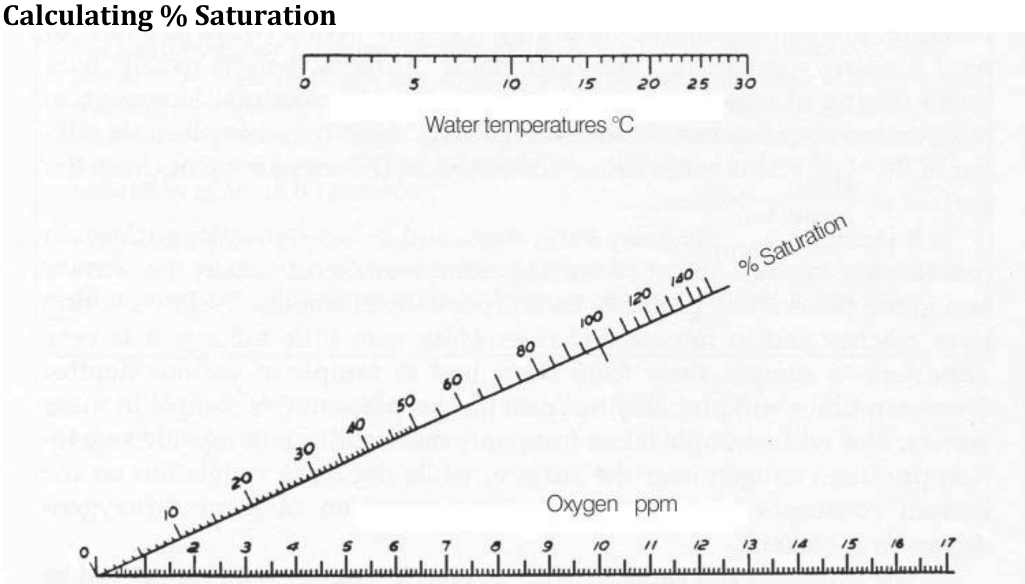
Biotic Extension: Some organisms are more sensitive to low levels of dissolved oxygen than others (i.e. some stoneflies) and can be used as biotic indicators. Their presence in the stream may indicate high levels of DO. What time of year do you expect the dissolved oxygen to be lowest? Highest? What kind of organisms would you expect to find in a stream with excellent dissolved oxygen levels?

Compare your results to this chart.



Cold water can hold more dissolved oxygen than warm water. The bottom scale is time in months. Temperature is measured on the left scale and with a T on the graph, while dissolved oxygen is measured on the right scale with an O on the graph.

Calculating % Saturation



Use a ruler to create a straight line from the DO measurement to the Water Temperature measurement. Read the percent saturation where the ruler crosses the middle scale.

Parts of Hydrogen (pH)

The pH test is one of the most common analyses in water testing. Water (H_2O) contains both hydrogen ions (H+) and hydroxide ions (OH-). The relative concentrations of these ions determine whether a solution is acidic or basic.

In pure water, pH is 7.0. Salts, acids, and bases are normal components of natural waters and will result in some deviation in pH. Changes in pH can influence the numbers and types of aquatic plants and animals which can live in the stream.

Measuring pH

1. To measure pH you will use a chemical kit.
2. Collect three pH measurements from different parts of the stream.
3. Calculate the average pH for the stream.
4. Dispose of the water sample in a waste bottle.
5. Record your data.

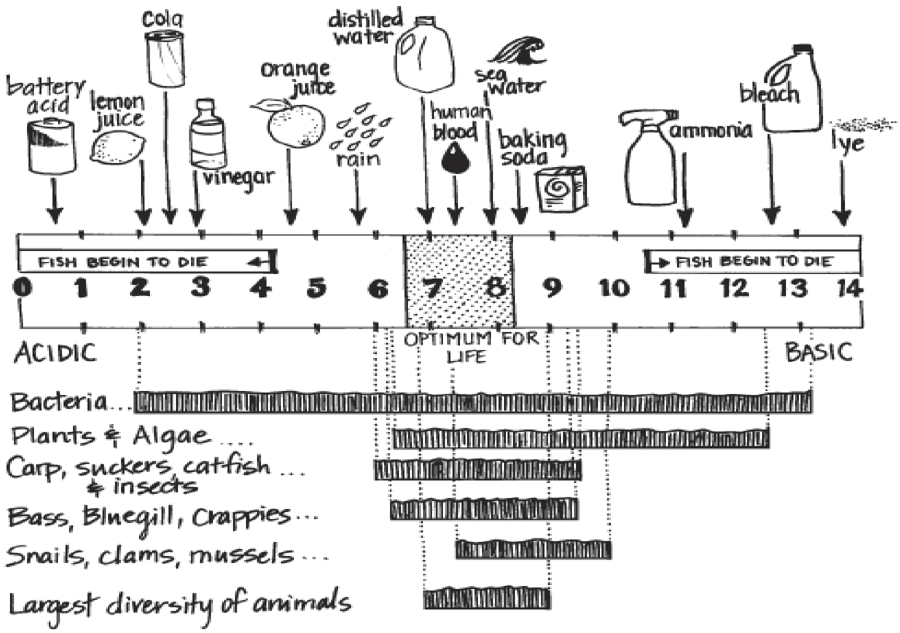
Interpreting pH or Parts of Hydrogen

pH is defined as the relative amount of free hydrogen or hydroxyl ions in the water. It is measured on a scale from 1 – 14 with 7 being neutral. Water that has more free hydrogen ions is acidic (any number below 7). Water with more hydroxyl ions is considered basic (any number above 7). pH is measured exponentially, meaning that number 6 on the scale is 10x more acidic than number 7. Distilled water is a 7 on the scale, while rain water is usually more acidic due to air pollution (acid rain) and can be as low as 5.5 on the scale. Battery acid is on the low side of the scale (1) and bleach is on the high side (13). Most organisms can survive in environments with a pH between 5 and 9, but some organisms are more sensitive. For example, trout do not survive well in water that has a pH below 6.0.

What is the pH of the streams we studied? Identify natural and manmade sources that may be affecting the acidity or alkalinity of the stream. (See additional list provided).

Biotic Extension: What was the pH of the stream studied? Compare it with the pH scale diagram provided. What might this mean for organisms living in the stream?

pH Scale Diagram



Natural and manmade processes that affect pH levels

Waterbodies with higher temperatures have slightly lower pH values. Also, algae blooms remove carbon dioxide (CO2) from the water during photo-synthesis, which may raise pH to 9 or more.

Runoff from abandoned mine lands can produce acid mine drainage which lowers pH. Lower pH values increase the solubility of some heavy metals, such as copper and aluminum, allowing them to dissolve into the water and become toxic to aquatic organisms.

Most natural waters have pH values of 5.0 - 8.5. Freshly fallen rainwater has a pH of 5.5 - 6.0 due to the presence of CO2 in the atmosphere, but air pollution due to automobiles and coal-burning power plants creates acid rain which is even more acidic.

Alkaline soils and minerals (limestone) buffer the effects of acid rain and may raise pH to 8.0 - 8.5.

Acidic soils and minerals can add to the acidity of streams. Decomposing evergreen needles can also add to the acidity of streams and soils.

Turbidity

Turbidity measures the amount of sediments traveling in the water column. Turbid water usually looks cloudy. Sediments are picked up and moved in areas with stronger currents. Sediments are deposited in areas where there is little or no current. Sediments in the water column are a natural part of the system, but excessive amounts of sediments can harm aquatic organisms. Turbid water may be the result of soil erosion, urban and agricultural runoff, algal blooms, or large storms.

Measuring Turbidity

1. Follow the instructions with the kit to get a turbidity reading.
2. Record your findings.
3. Describe what the area looks like where you tested the turbidity.
    a. Estimate how far it is away from the stream.
    b. Is the water moving fast, slow, or medium?
    c. What does the bottom of the stream look like?
4. Record your observations.

Interpreting Turbidity

Excessive amounts of sediments harm the biotic community. External gills and soft bodies on small animals can be destroyed by "rocks" rushing by them. Jellylike eggs on the bottom of the stream can be covered and the embryos suffocated when sediments are deposited. High turbidity can block sunlight from reaching life giving, oxygen producing plants. Sand absorbs heat more readily than water, so when many sediments are moving through the water column, it can increase the temperature, which also reduces dissolved oxygen.

What was the turbidity reading of the stream? How would we know if the turbidity had increased or decreased? What would it look like? What are some causes of increased turbidity in a stream? What are some ways we might decrease human caused turbidity in streams?

Biotic Extension: In what ways might high turbidity in a stream affect the aquatic community? What do organisms look like that live in the most turbid areas (riffles and runs)? Compare them to organisms in less turbid areas (pools).

Phosphates

Phosphorus (P) is essential to plant and animal life, and its presence in the environment is natural. Problems with phosphorus as a water pollutant result not from its presence, but from the addition of excessive amounts. Phosphorus enters surface waters in organic matter (dead plants and animals, animal waste), attached or adsorbed to soil particles, or in a number of manmade products (detergents, fertilizers, industry wastes). Phosphorus is an important nutrient in fertilizer because it increases plant growth. It increases aquatic plant growth (e.g. algae, weeds), as well.

Measuring Phosphates

1. Follow the instructions in the low range phosphates chemical kit carefully. Make sure to put on your safety equipment (goggles and gloves) before using the chemicals.
2. Record your findings.
3. Dispose of chemical waste in a bottle.
4. Observe the area where you took your sample. Do you notice any plants growing there? Are they in the water or out of the water? Are there just a few or are they growing everywhere? Is there any odor to the water?
5. Record your observations.

Interpreting Phosphates

Most fresh water has naturally low phosphate levels, and this limits algal growth. If excessive phosphates enter surface water, it can support rapid algal growth. When the algae die, their decomposition by bacteria uses up oxygen and may produce odors and algal toxins. The reaction of the aquatic system to an overloading of nutrients is known as eutrophication (U tra fi kay shun). Phosphorous remains in aquatic systems and cycles through different forms unless physically removed by dredging. Orthophosphate levels higher than 0.03ppm indicates potential for algal growth and eutrophication.

How much phosphorous was found in the stream studied? Is it more than or less than .003ppm? If it is more than .003pm, identify possible sources of excess phosphorous in the stream. What can humans do to decrease the amount of phosphorous entering the streams?

Biotic Extension: Do you notice any plants in or around the stream? Are they in the water or out of the water? Do they cover the surface or are they here and there? How do aquatic organisms use plants? If the number of plants in the stream increase, how might it effect the aquatic community?

Nitrogen

Nitrogen makes up about 80% of the air we breathe, and it is found in all living things. Nitrogen occurs in water as nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3). It enters the water from human and animal waste, decomposing organic matter, and runoff of fertilizer from lawns and crops. Nitrates are an essential nutrient for plant growth. Nitrogen is the most abundant nutrient in commercial fertilizers. Runoff from agriculture, golf courses, and lawns is high in nitrogen, especially if it rains soon after fertilization.

Measuring Nitrogen

1. Follow the instructions in the Nitrate Nitrogen Tablet kit carefully. Make sure to put on your safety equipment (goggles and gloves) before using the chemicals.
2. Record your data as nitrate nitrogen.
3. Dispose of chemical waste in a bottle.
4. Observe the area where you took your sample. Do you notice any plants growing there? Are they in the water or out of the water? Are there just a few or are they growing everywhere?
5. Record your observations.

Interpreting Nitrogen

Similar to phosphates, these are a main ingredient in fertilizers and can lead to increased aquatic plant growth and eutrophication (U tra fi kay shun). Nitrogen is readily converted into a gaseous form, so it doesn't stay in the system indefinitely like phosphorous. To interpret our results, you must first convert the nitrate nitrogen reading to Nitrate by multiplying the results by 4.4. Record as ppm Nitrate. The typical range for Nitrates (NO_3) is 0 – 36 ppm. Typical values for clean water are 0.3 to 5 ppm. Streams with >10 ppm are considered to have more of a potential for algal growth and eutrophication.

How much phosphorous was found in the stream studied? Is it more than or less than 10 ppm? If it is more than 10 ppm, identify possible sources of excess nitrogen in the stream. What can humans do to decrease the amount of nitrogen entering the streams?

Biotic Extension: Do you notice any plants in or around the stream? Are they in the water or out of the water? Do they cover the surface or are they here and there? How do aquatic organisms use plants? If the number of plants in the stream increase, how might it effect the aquatic community?

Alkalinity

Alkalinity is the water's capacity to resist changes in pH that would make the water more acidic. It is a measure of carbonates dissolved in groundwater. Carbonates like limestone can act as a buffer against acids in a system. They have the ability to neutralize acids, helping to keep the pH at a level that supports life.

Measuring Alkalinity

1. Follow the instructions in the Alkalinity kit carefully. Make sure to put on your safety equipment (goggles and gloves) before using the chemicals.
2. Dispose of chemical waste in a bottle.
3. Record your data as ppm $CaCO_3$.

Interpreting Alkalinity

Too many carbonates (>150 ppm $CaCO_3$) may result in a decrease in nutrients used for plant and animal growth. Too few carbonates (<30 ppm $CaCO_3$) can lead to no ability to buffer acids.

Biotic Extension: How many different kinds of organisms did you find during aquatic macroinvertebrate sampling? How might the diversity of organisms be affected by changes in alkalinity?