pH

What is pH?
pH is a measurement of how acidic or alkaline (basic) the water is. pH is measured on a scale of 0 to 14, with 0 being the most acidic, and 14 being the most basic. Distilled water, which has no impurities, is neutral, and has a pH of 7.

Refer to Utah Stream Team manual for more information on the definition and importance of pH to fish and other aquatic life, and how natural and human activities affect the pH levels.

pH must be measured in the field. The pH will change if the water is collected and stored, and will not reflect the true value at the site.

Discussion Questions for pH:

1. Why does the pH of rainwater or snowmelt increase as the water moves over a landscape?

Soils in Utah contain acid neutralizing minerals, such as calcium and magnesium compounds, which are dissolved by the water as it moves through the soil and over the land. These minerals neutralize the acid in the rain. In some areas, the geology does not contain these minerals (for example the Adirondack Mountains in New York) and the acids in the water are not neutralized.

2. What is acid rain?

Acid rain is caused by air pollution such as sulfur and nitrogen oxides, which dissolve in rain water and form strong acids. Soils in Utah contain enough neutralizing compounds to buffer these acids (see #1), but in poorly buffered soils, lakes and streams can become so acidic that fish and other organisms cannot survive.

3. How does pH affect living organisms?

pH affects the function of membranes in living organisms. Therefore even moderately acidic waters may irritate the gills of fish and aquatic insects, and may reduce the hatching success of eggs. Many amphibians are particularly vulnerable because their skin is so sensitive to pollution.
Changes in pH may also affect the chemicals in the water. For example, ammonia is harmless to fish in water that isn't acidic, but becomes much more toxic in acidic water. Lower pH causes certain heavy metals to dissolve, resulting in toxic concentrations of these metals when the pH is low.

pH (continued)

Suggested sources of water samples, with expected results and explanation.

Source	Expected result	Explanation
rain water	low (~5.6-6.0)	Natural rainwater is slightly acidic because the rain dissolves atmospheric carbon dioxide, forming carbonic acid.
snowmelt	low (~5.6-6.0)	Like rain, snow is slightly acidic. During rapid snowmelt events, snowmelt may run directly into the streams with no buffering by contact with soils.
stream water	varies (6.5-9.0)	The results will vary depending on geography, location, season, and the time of day. See UST manual.
tap water	neutral (~7.0)	Dissolved calcium, magnesium and other compounds in most Utah surface and groundwater neutralizes the water.
groundwater	neutral to high (7.0-8.5)	Same as above, but may be more alkaline because the groundwater has more contact with buffering materials due to the longer storage time.
ponds/lakes (high productivity)	high (>9)	Will vary according to local geology and may vary during the day if many aquatic plants are present. Photosynthesis removes the carbonic acid from water, making the water more alkaline (increasing pH). This effect is strongest in the late afternoon of a sunny day.
sphagnum bogs	low (5-6)	Sphagnum and other mosses absorb calcium and magnesium, and release hydrogen ions into the water, lowering the pH.

Dissolved Oxygen (DO)

What is Dissolved Oxygen?
Dissolved oxygen (DO) measures the concentration of the O_2 molecules that are actually dissolved in water. This is the form of oxygen that fish and aquatic insects need.

Oxygen is not very soluble in water. At most, about 12 parts of oxygen can dissolve in a million parts of water (12 mg/liter). The maximum amount of oxygen that can dissolve in water is called its saturation concentration. The saturation concentration decreases as water temperature or elevation increases.

Refer to Utah Stream Team manual for more information on the definition and importance of DO to fish and other aquatic life, and how natural and human activities affect the DO levels.

DO must be measured in the field. The DO will change if the water is collected and stored, and will not reflect the true value at the site.

Discussion Questions for Dissolved Oxygen:

1. How does oxygen get into water?

   Oxygen is dissolved into water by contact with the atmosphere, or from aquatic plants that produce oxygen during photosynthesis. Therefore, oxygen will be higher in turbulent stream water (mixing with the atmosphere) or in water with many plants (but only during the day, when photosynthesis can occur).

2. How does oxygen get used up in water?

   The respiration of animals and plants uses oxygen. Bacterial decomposition of dead organic materials can be a major factor, and may cause the dissolved oxygen to be completely consumed in deep pools or lakes. Some chemical reactions (oxidation reactions) also require and consume oxygen.

3. How will dissolved oxygen concentrations be affected by the dumping of yard clippings or the runoff of animal manure?

   The decomposition of organic materials such as these may use all the available oxygen in the water. Secondary treatment by municipal treatment plants removes the organic material from the water for just this purpose. Before municipal wastewater was treated properly, many rivers and streams had fish kills and dead zones caused by low oxygen as this waste was decomposed.

Dissolved Oxygen (continued)

Suggested sources of water samples, with expected results and explanations.

Water Source	Expected Results	Explanation
Fast moving, cool stream	high (>10 mg/l)	Turbulence mixes atmospheric oxygen into the water. The water may even be supersaturated.
Still water (e.g., productive pond water)	may vary throughout the day: lower at night (<4 mg/l) and much higher in the late afternoon. (>10 mg/l)	No turbulence to mix the oxygen. Plants produce oxygen, but the plant respiration and decay may also use it up.
Warm water	low (<8 mg/l)	Warm water holds less oxygen than cold water.
Stream water in a closed jar without any plants	low to moderate (6-8 mg/l)	No plants to produce oxygen, no opportunity for mixing with atmospheric oxygen. Note: microscopic plants may complicate results.
Stream water in a closed jar with leaf litter (dead or decaying plants)	low (<6 mg/l)	Decaying plants/leaf litter use the oxygen in the water.

Turbidity

What is Turbidity?
Turbidity is a measure of how much suspended material is in the water. Turbidity may be caused by eroded sediment, organic debris, suspended minerals, or by microscopic plants growing in the water.

Refer to Utah Stream Team manual for more information on the definition and importance of turbidity to fish and other aquatic life, and how natural and human activities affect the turbidity levels.

The turbidity will change if the water is collected and stored, and will not reflect the true value at the site if the particles settle to the bottom. Make sure you shake a stored sample before measuring turbidity.

Discussion Questions for Turbidity:

1. Why does turbidity often increase in a stream when the flow increases?
   As the velocity of water increases, the increased energy of the water can carry more sediment. In very quiet waters the sediment will settle out. This is easily demonstrated by shaking a closed bottle with water and a little sand or silt. The sand stays suspended until the bottle is placed down, at which point the sand or silt will settle. Note that the heavier sand particles settle first.

2. How might different land uses (logging, agriculture, construction) affect turbidity of nearby streams?
   All of these activities may disturb the land and increase the potential for erosion. In all cases, turbidity might increase, especially during a rainstorm or if snowmelt runs off over these disturbed sites. Irrigation return flows may carry sediment directly from the field back to a stream.

3. Why does turbidity matter in a stream?
   In most streams, turbidity is a measurement of the amount of suspended sediment (silt, etc.) in the stream. Most streams can handle a certain amount of sediment (depending on the size and shape of the stream). However, if a major source of additional sediment occurs (from eroding banks or from changes in land uses) the stream may receive more sediment than it can transport. In these cases, the sediment will settle and may cover up important habitat for aquatic insects, or smother the eggs of fish.

Turbidity (continued)

Suggested sources of water samples, with expected results and explanation.

Water Source	Expected Results	Explanation
A river or stream in the mid-summer to early fall	low	Flows are generally lower in the early fall, so the water doesn't have as much energy to carry sediment.
A river or stream in the spring	high	Flows are generally higher in the spring, so there is more energy to carry sediment.
Productive pond	high	Algae and other plant matter (rather than inorganic sediment) will cause the water to be turbid.
NOTE: If you cannot sample during different seasons, or in a pond, use the following to demonstrate turbidity.		
Clear water / Tap water	low	Clear water has few suspended solids, so it will have the lowest turbidity.
Water with 2 g of silt per gallon	higher	Turbidity is a measurement of the suspended solids in the water so adding silt will cause the turbidity to be higher.
Water with 2 g of sand per gallon	moderate	Turbidity is a measurement of the number of suspended solids in the water (not the mass) so, 2 g of sand will be less turbid than 2 g of silt.

Temperature

What is Temperature?
Temperature is the measure of how much heat energy water contains. A stream's temperature is affected by the season, but also by the source of water, the geographic area of a stream, the shape of the channel and whether the stream is shaded. Most aquatic organisms require a specific temperature range, and many of our sport fish require cold water.

Refer to Utah Stream Team manual for more information on the definition and importance of temperature to fish and other aquatic life, and how natural and human activities affect the temperature levels.

Temperature must be measured in the field. The temperature will change if the water is collected and stored, and will not reflect the true value at the site.

Discussion Questions for Temperature:

1. Draw a graph of the temperature of a high mountain stream for an entire year. Draw another line on the graph to show how the temperature might change as you move further down the river.

Temperatures in streams can change beyond the obvious seasonal differences. Temperature in streams often start cold near the headwaters (snowmelt or shallow springs) and warm up from the sun as they move down through the watershed. Shading (riparian vegetation) and the width and depth of the stream will all affect a stream's temperature.

2. How will groundwater entering a stream affect its temperature?

Groundwater is usually colder than surface water and therefore would probably cool the stream. Some areas in Utah, however, have hot springs which introduce heat and minerals to a stream. Because the temperature of the groundwater doesn't fluctuate much throughout a year, a stream with a major groundwater component may show less seasonal variability than a stream fed entirely by surface runoff.

3. Discuss how different land uses (logging, road building, agriculture, urban uses) might affect temperature.

The major influences on temperature in a stream are exposure to the sun, and exposure to heated surfaces. Any activity that causes a stream to become shallower and wider (this can happen when too much sediment enters a stream) will cause the stream to heat more rapidly. When trees along the banks are removed, the loss of shading can cause the stream to heat up. Water that is diverted (such as for irrigation) and then returned to the stream usually heats up. Finally, streams with small flows will heat faster than streams with lots of water, so removing water from a stream can cause an increase in temperature.

Temperature (continued)

Suggested sources of water samples, with expected results and explanation.

Water Source	Expected Result	Explanation
A stream or river in the late summer / early fall	warmer	Warm air temperatures, plus no source of cold water (e.g., snowmelt) cause streams to be warmer in the later summer / early fall.
A stream or river in the spring or winter	cooler	Cold air temperatures plus snowmelt in the spring lower the temperatures of the water.
A stream near its headwaters	cool	The water source is snowmelt or groundwater. These streams are also usually shaded by trees and bushes.
A stream after it has traveled through a large valley or through a city.	warmer (compared to the headwater stream)	The water warms as it travels away from the headwaters due to solar radiation and heat transfer from the stream bed and banks. Areas with little riparian vegetation (no shading) will heat faster. Streams with concrete banks (e.g., urban areas) will absorb heat from these artificial banks.
Near a hot spring	warmer	Hot spring water will mix with the stream water, raising the temperature.