Utah State University
WATER QUALITY EXTENSION

Understanding Your Watershed

pH

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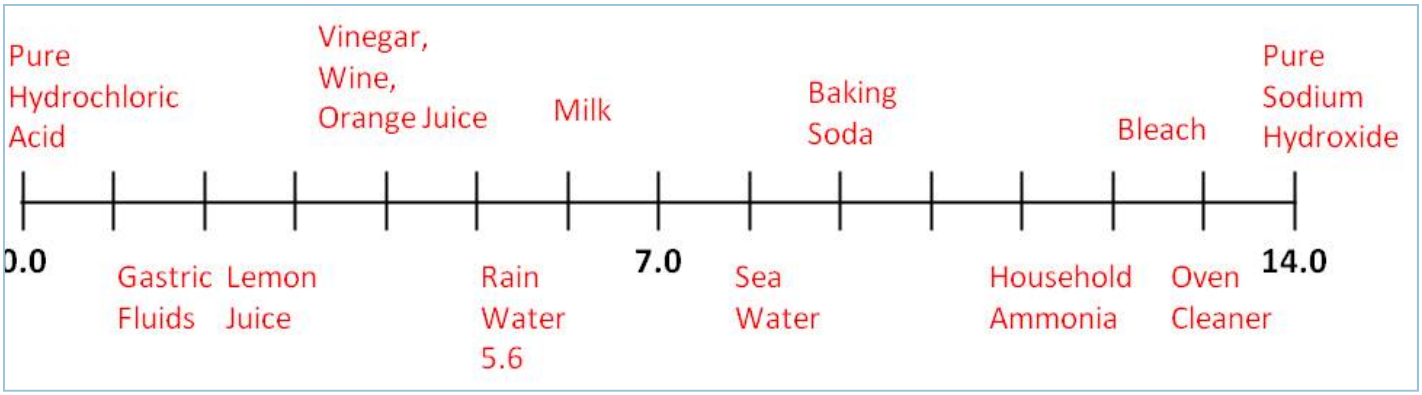
What is pH?

pH is a measurement of the *acidity* or *alkalinity* (base) of a solution. When substances dissolve in water they produce charged molecules called ions. Acidic water contains extra hydrogen ions (H+) and basic water contains extra hydroxyl (OH-) ions.

pH is measured on a scale of 0 to 14. Neutral water has a pH of 7. Acidic water has pH values less than 7, with 0 being the most acidic. Likewise, basic water has values greater than 7, with 14 being the most basic. A change of 1 unit on a pH scale represents a 10 fold change in the pH, so that water with pH of 6 is 10 times more acidic than water with a pH of 7, and water with a pH of 5 is 100 times more acidic than water with a pH of 7.

You might expect rainwater to be neutral, but it is actually somewhat acidic. As rain drops fall through the atmosphere, they dissolve gaseous carbon dioxide, creating a weak acid. Pure rainfall has a pH of about 5.6.

The figure below shows the pH of some common solutions. The pH of lakes and rivers in Utah typically falls between 6.5 and 9.0.



Why is the pH of water important?

Effects on animals and plants

Most aquatic animals and plants have adapted to life in water with a specific pH and may suffer from even a slight change.

- Even moderately acidic water (low pH) may reduce the hatching success of fish eggs, irritate fish and aquatic insect gills, and damage membranes.
- Water with extremely high or low pH is deadly. A pH below 4 or above 10 will kill most fish and very few animals can tolerate waters with a pH below 3 or above 11.
- Amphibians are particularly vulnerable to low pH, likely because their skin is so sensitive to pollutants. Some scientists believe the recent drop in amphibian numbers around the world is due to low pH levels caused by acid rain.

Effects on other chemicals in the water

- A change in the pH can alter the behavior of other chemicals in the water. The altered water chemistry may affect aquatic plants and animals. For example, ammonia is relatively harmless to fish in water that is neutral or acidic. However, as the water becomes more basic (the pH increases) ammonia becomes increasingly toxic.
- Heavy metals such as cadmium, lead, and chromium dissolve more easily in more acidic water (lower pH). This is important because many heavy metals also become much more toxic when dissolved in water.

How do natural influences affect the pH of a stream?

Watershed effects

- Certain dissolved minerals, such as calcium carbonate, can combine with the extra hydrogen or hydroxyl ions that alter the water's pH. When these minerals are present, the pH of the water doesn't change as much when acids or bases are added to the water. We call this *buffered water*. Many soils in our part of the West contain these minerals. When water percolates through these soils, the minerals dissolve and the buffering quality is passed along to the water. Some watersheds, such as areas in the northeast of the United States, contain rocks with few of these buffering minerals. These watersheds, therefore, will produce poorly buffered water and any additional acid will change the pH of these waters.
- If a watershed has pine or fir forests, streams within it may have a lower pH value. The decomposing needles of these trees add to the acidity of soils and also influence the acidity of nearby streams.

- Water that enters a stream from the water table has had a chance to percolate through soil. If the soil is buffered, and if ground water is the stream's main source of water, then pH may be somewhat higher (7-8).

Seasonal effects

- When precipitation falls through the air, it dissolves gases such as carbon dioxide and forms a weak acid. Natural, unpolluted rain and snow are slightly acidic—a pH between 5 and 6. When snow melts rapidly, the water may become runoff and not percolate through the soil before reaching the stream. This may not give the soil time to buffer the water, causing the pH to be slightly acidic.

Daily effects

- When aquatic plants convert sunlight to energy during photosynthesis, they remove carbon dioxide from the water. This can raise the pH of a stream. Since photosynthesis occurs only when light is present, the highest pH often occurs in the late afternoon. Likewise, lowest pH levels will occur just before sunrise.

How do human activities change the pH of a stream?

- Polluted precipitation, also known as "acid rain," increases the acidity of surface water near many industrial or large urban areas. The main contributors to acid rain are sulfuric acid (produced by coal burning industries) and nitric acid (produced by automobile engines). In Utah, our buffering soils help to decrease the effects of acid rain.

- Dumping industrial pollutants directly into waters—also known as point source pollution—can have intense and immediate effects on the pH of a stream.

- Mining may expose rocks to rain water and produce acidic runoff. Mine drainage can therefore introduce acidic water into streams. If the stream is poorly buffered, then pH may quickly reach toxic levels.

How is pH measured in a stream?

The pH of a stored water sample may change considerably compared to the actual pH level in the stream, so pH should be measured directly in the stream. Most scientists use a pH field meter.

A simple way to measure pH, however, is with colored litmus strips that are dipped in the water. The colors on the strips react with the water and change. The color change is compared to a chart to determine the water's pH. These strips can often be purchased in garden or science supply stores.

What do the results mean?

Natural pH levels typically fall between 6.5 and 9.0, depending on the surrounding soil and vegetation. If your pH value falls out of this range you may want to consider:

- Was the test performed correctly? Was the reading taken directly in the stream or was the sample handled correctly?
- Was the test performed during the summer in very productive waters (many aquatic plants)? Water containing many aquatic plants may have raised pH values on summer afternoons because of plant photosynthesis.
- Does the watershed contain a lot of granite-like rock, dense conifer forests, or acidic soil? If so, it will likely have relatively acidic waters.
- Was your sample taken during snow melt? Remember, snow melt may lower pH values.

If you answered "no" to these questions then take a look at your watershed. Are there land use practices that might be affecting the pH of your stream? Refer to the "Human Influences" section for possible sources of pH values outside the allowable range.

Aquatic life and recreational uses of lakes and streams are not affected when the pH varies between 6.5 and 9.0. For this reason, the state of Utah has established this as the allowable pH range for most surface waters.

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For more information, contact USU Water Quality Extension at 435-797-2580, or visit our website at http://extension.usu.edu/waterquality/