Alkalinity

1. Explain what alkalinity is.

2. What chemical is "responsible" for alkalinity?

3. Explain the alkalinity buffering reaction

4. Apply these ideas to what we studied about Lake Erie.

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Alkalinity

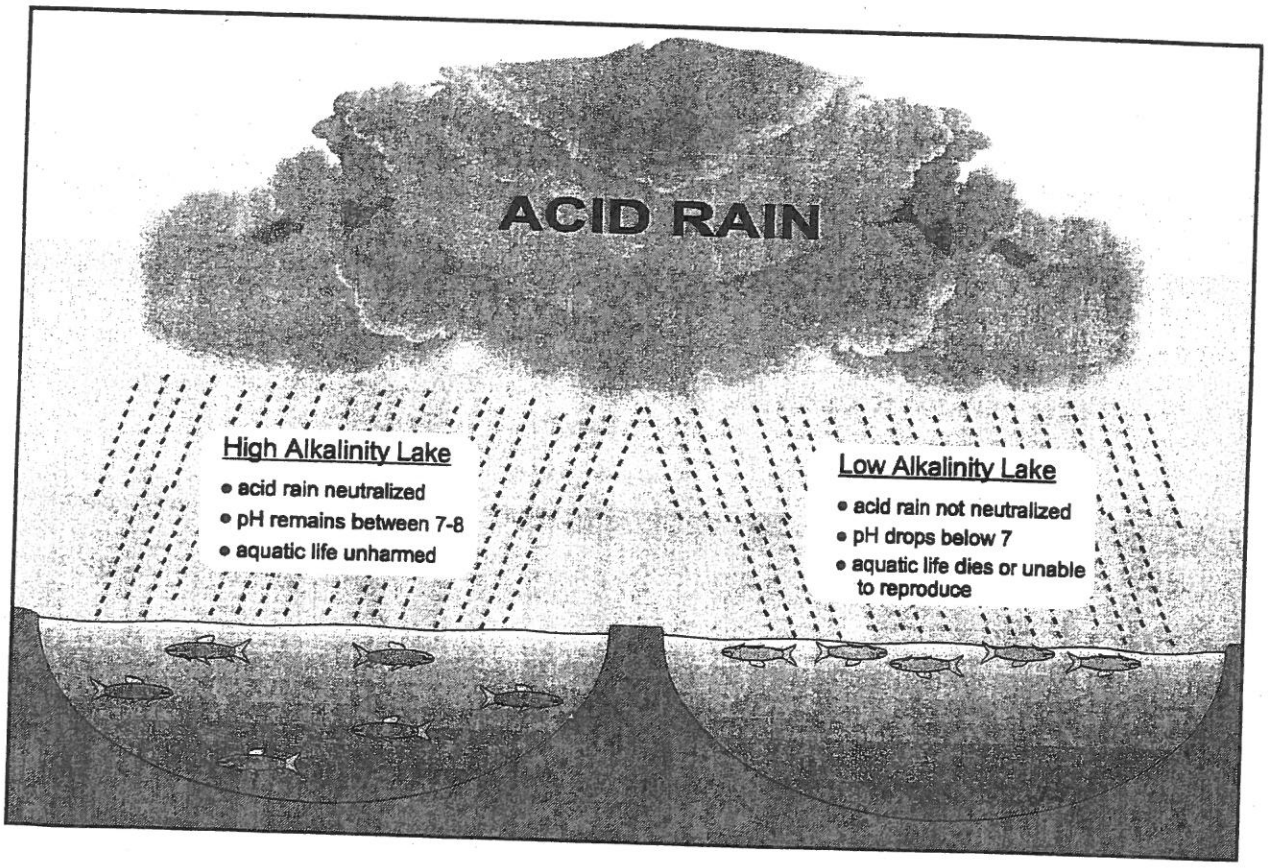
INTRODUCTION

The alkalinity of water is a measure of how much acid it can neutralize. If any changes are made to the water that could raise or lower the pH value, alkalinity acts as a buffer, protecting the water and its life forms from sudden shifts in pH. This ability to neutralize acid, or H^+ ions, is particularly important in regions affected by acid rain.

Effects of Alkalinity Levels

- Buffers water against sudden changes in pH
- Protects aquatic organisms from sudden changes in pH

In the diagram below, for example, the lake on the right has low alkalinity. When acid rain falls, it is not neutralized, so the pH of the water decreases. This drop in the pH level can harm or even kill some of the aquatic organisms in the lake. The lake on the left, however, has high alkalinity. When acid rain falls in this lake, the acid is partially neutralized and the pH of the water remains fairly constant. In this way, a high alkalinity level helps maintain the health of the water and the organisms that live there.



Alkalinity should not be confused with pH. The pH of a solution is a measure of the concentration of acid, or H^+ ions, in the water. Alkalinity is a measure of the water's capacity to neutralize an acid, or H^+ ions, thereby keeping the pH at a fairly constant level.

The alkalinity of surface water is primarily due to the presence of hydroxide, OH^-, carbonate, CO_3^{2-}, and bicarbonate, HCO_3^-, ions. These ions react with H^+ ions by means of the following chemical reactions:

$$OH^- + H^+ \longrightarrow H_2O$$

$$CO_3^{2-} + H^+ \longrightarrow HCO_3^-$$

$$HCO_3^- + H^+ \longrightarrow CO_2 + H_2O$$

Most alkalinity in surface water comes from calcium carbonate, $CaCO_3$, being leached from rocks and soil. This process is enhanced if the rocks and soil have been broken up for any reason, such as mining or urban development. Limestone contains especially high levels of calcium carbonate.

Sources of Alkalinity

- Leached from rock
  - limestone
- Leached from minerals
  - dolomite
  - calcite
- Leached from soil

Alkalinity is significant in the treatment of wastewater and drinking water, because it will influence treatment processes such as anaerobic digestion. Water may also be unsuitable for use in irrigation if the alkalinity level in the water is higher than the natural level of alkalinity in the soil.

Expected Levels

Alkalinity is reported in units of mg/L $CaCO_3$, because the carbonate ion, CO_3^{2-}, is its primary constituent. Alkalinity levels will vary across the country. Some sample data are shown in Table 1. In general, water in the eastern half of the United States will have a higher alkalinity than water in the west because of a higher occurrence of limestone. Areas in the extreme northeast that have had the limestone scoured away by glacial action will often have a lower alkalinity.

Table 1: Alkalinity of Selected Rivers

Site	Alkalinity (mg/L $CaCO_3$)
Missouri River, St. Joseph, MO	224
Missouri River, Garrison Dam, ND	178
Cataloochee Creek, Cataloochee, NC	626
Columbia River, Northport, WA	49
Merrimack River, Lowell, MA	7

Summary of Method

Alkalinity is measured by titrating a water sample with sulfuric acid. The Vernier pH Sensor is used to monitor pH during the titration. The equivalence point will be at a pH of approximately 4.5, but will vary slightly, depending on the chemical composition of the water. The volume of sulfuric acid added at the equivalence point of the titration is then used to calculate the alkalinity of the water.