Cary Institute of Ecosystem Studies

# Conductivity

**What is conductivity?**
Conductivity, or electrical conductivity (EC), is a measurement of the concentration of total dissolved ions in solution.

**What affects conductivity?**
*The higher the concentration of total dissolved ions and salts in solution, the greater the conductivity.* Dissolved ions and salts come from substances which dissociate into ions in solution, including electrolytes ("salts") and inorganic compounds. The concentration of free-moving ions is what makes a solution a stronger or weaker conductor. While electrolytes and inorganic compounds are good conductors, organic compounds (oils, phenols, sugars, and alcohols) are not. Distilled water is purified of ions, so it is a poor conductor. Temperature affects solution conductivity, as well. The higher temperature, the better the conductor.

**Why measure conductivity?**
*We measure conductivity levels in order to determine the solution's capacity for electrical conduction by measuring the concentration (in microsiemens per centimeter us/cm) of total dissolved ions in solution. In ecosystem studies, we measure the conductivity levels of solutions within ecosystems in order to determine their health.* First, we determine the normal conductivity level of a solution. For example, a scientist picks a body of water such as a stream, and monitors its conductivity level, throughout a year. As long as it has been a typical year (no chance events which cause irregular chemical activity in the water), the scientist is able to accumulate "baseline" water conductivity data. In future years, if scientists notice an irregular fluctuation in water conductivity, they may wonder what environmental factor has caused the change.

**Which environmental factors affect conductivity?**
Conductivity levels change due to: the geology and size of the waterway, amount of entering wastewater, and bacterial metabolism. There are a few other factors, but these are the main sources of dissolved ions in wa ter.

**Geology:** As water flows, it passes over bedrock and soils. Rocks and soils of different chemical composition provide naturally occurring ions such as chloride, iron and aluminum. So for example, if water flows over a bedrock of limestone, it tends to have a higher conductivity level because of the dissolved carbonate minerals leaching in from the bedrock.

**Size:** The smaller the body of water, the larger the effect of conductivity-influencing factors. For example, take a small stream and a large stream, side by side. On a sunny day, the sun exerts the same amount of heat and causes the same amount of evaporation from both streams. Yet, as streams heat up, the smaller stream's relative concentration of ions, and water which evaporates, becomes greater than the larger stream.

**Wastewater:** Wastewater from domestic or commercial property, industries, and agriculture can affect ion concentration and therefore conductivity levels. Problems with wastewater treatment plants, sewer overflows and urban runoff are likely contaminants.

**Bacteria:** If soils are washed into water, organic material in the soil may be decomposed by normally occurring aquatic bacteria, causing an increase in bacterial waste and increased conductivity levels.

**What are the normal conductivity levels for NYS waters?**
In the Hudson River Basin, the Boreas River in the Adirondacks flows over crystalline bedrock, where conductivity is only 35 µs/cm. In comparison, the Batten Kill River, which flows over a combination of shale, sandstone and carbonate bedrock, has a conductivity of 245 µs/cm. The Lower Hudson River is an estuary due to the mixing of Hudson River water with Atlantic Ocean water. Conductivity in the Hudson north of Newburgh is usually between 100-300 µs/cm, but the closer you get to the mouth of the Hudson River, the higher the values. Sometimes, you can get levels upwards of several thousand µs/cm around the George Washington Bridge or further south.

**What are the dangers of unnatural fluctuations in conductivity levels?**
Every aquatic ecosystem has specific "normal" chemical levels which allow certain aquatic and non-aquatic organisms to live there. If conductivity levels change more or quicker than normal, scientists may decide to monitor this change and possible causes. If organisms don't have enough time to adapt to the changes, they may be poisoned or die. It is important for scientists to monitor irregular conductivity fluctuations in order to learn about natural ecosystem changes, but also to prevent accidental stream contamination by humans.

**What does this mean?**
Distilled water maintains a conductivity of 0.5-3 us/cm, and inland freshwaters range 150-500 us/cm. River conductivity ranges 50-1500 us/cm, and estuaries, salt lakes, and oceans have much higher conductivity levels. Polluted industrial water may be as high as 10,000 us/cm, but high conductivity alone doesn't tell you whether your aquatic ecosystem is impacted by pollution. It is important for us to establish baseline data (see "What are typical conductivity levels for NYS"), for scientific research and to safeguard ecosystems from accidental ecosystem contamination.

**Works Consulted**


Behar, Sharon (1996). *Testing the Waters: Conductivity*. Montpelier,VT: River Watch Network.

Lake Access: An Impact Metro Project (2005). *Why is conductivity important?* Retrieved Jan 7, 2008 from http://lakeaccess.org/russ/conductivity.htm.

United States Environmental Protection Agency (1996). *Conductivity*. Retrieved Jan 7, 2008, from http://www.epa.gov/volunteer/stream/vms59.html.