Water properties: Dissolved oxygen

The U.S. Geological Survey (USGS) has been measuring water for decades. Millions of measurements and analyses have been made. Some measurements, such as temperature, pH, and specific conductance are taken almost every time water is sampled and investigated, no matter where in the U.S. the water is being studied. Another common measurement often taken is dissolved oxygen (DO), which is a measure of how much oxygen is dissolved in the water - DO can tell us a lot about water quality.

Dissolved oxygen

You can't tell by looking at water that there is oxygen in it (unless you remember that chemical makeup of a water molecule is hydrogen and oxygen). But, if you look at a closed bottle of a soft drink, you don't see the carbon dioxide dissolved in that - until you shake it up and open the top. The oxygen dissolved in lakes, rivers, and oceans is crucial for the organisms and creatures living in it. As the amount of dissolved oxygen drops below normal levels in water bodies, the water quality is harmed and creatures begin to die off. Indeed, a water body can "die", a process called eutrophication.

Although water molecules contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. Oxygen enters a stream mainly from the atmosphere and, in areas where ground-water discharge into streams is a large portion of streamflow, from groundwater discharge. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive.

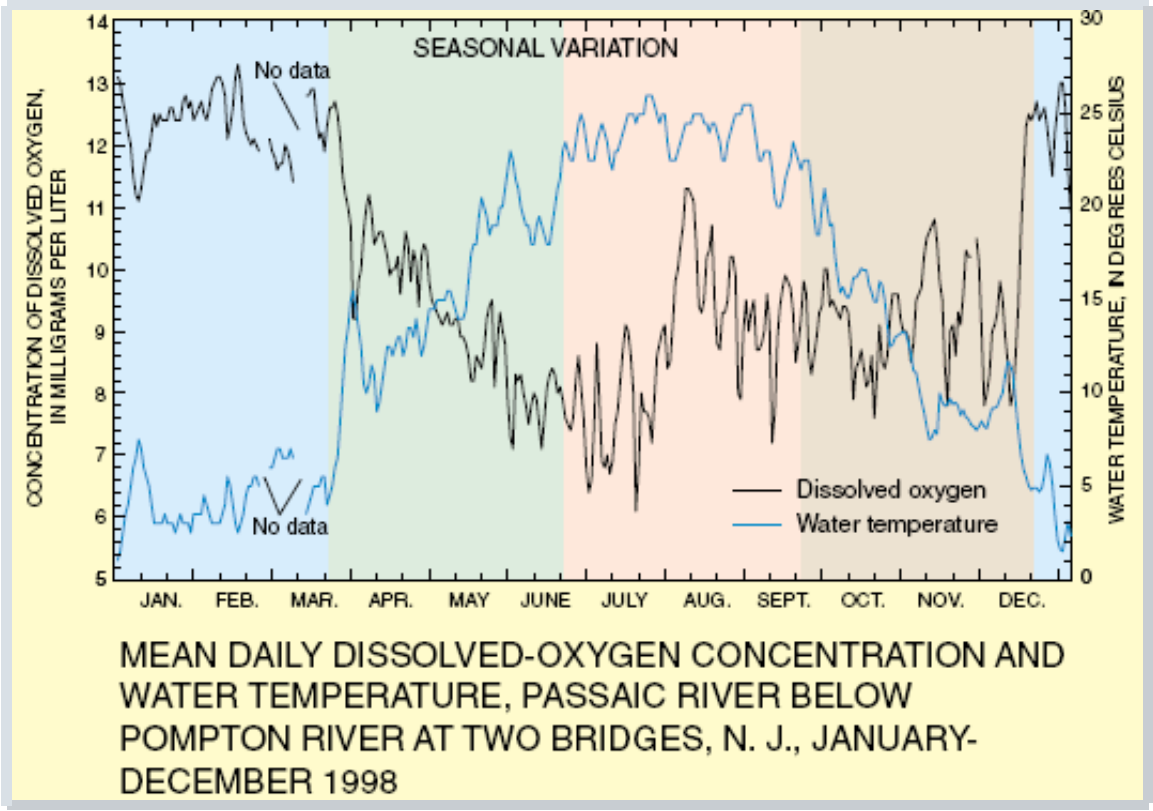
Dissolved oxygen and water quality

Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, whereas stagnant water contains less. Bacteria in water can consume oxygen as organic matter decays. Thus, excess organic material in lakes and rivers can cause eutrophic conditions, which is an oxygen-deficient situation that can cause a water body "to die." Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer (the concentration of dissolved oxygen is inversely related to water temperature), when dissolved-oxygen levels are at a seasonal low. Water near the surface

Eutrophic conditions, Hartbees River, South Africa
Credit: National Eutrophication Monitoring Programme

of the lake– the epilimnion– is too warm for them, while water near the bottom–the hypolimnion– has too little oxygen. Conditions may become especially serious during a period of hot, calm weather, resulting in the loss of many fish. You may have heard about summertime fish kills in local lakes that likely result from this problem. ((Source: A Citizen's Guide to Understanding and Monitoring Lakes and Streams)

Dissolved oxygen, temperature, and aquatic life



As this chart shows, the concentration of dissolved oxygen in surface water is controlled by temperature and has both a seasonal and a daily cycle. Cold water can hold more dissolved oxygen than warm water. In winter and early spring, when the water temperature is low, the dissolved oxygen concentration is high. In summer and fall, when the water temperature is high, the dissolved-oxygen concentration is low.

Dissolved oxygen in surface water is used by all forms of aquatic life; therefore, this constituent typically is measured to assess the "health" of lakes and streams. Oxygen enters a stream from the atmosphere and from ground-water discharge. The contribution of oxygen from ground-water discharge is significant, however, only in areas where ground water is a large component of streamflow, such as in areas of glacial deposits. Photosynthesis is the primary process affecting the dissolved-oxygen/temperature relation; water clarity and strength and duration of sunlight, in turn, affect the rate of photosynthesis. Dissolved-oxygen concentrations fluctuate with water temperature seasonally as well as diurnally (daily).

Measuring dissolved oxygen

Field and lab meters to measure dissolved oxygen have been around for a long time. As this picture shows, modern meters are small and highly electronic. They still use a probe, which is located at the end of the cable. Dissolved oxygen is dependent on temperature (an inverse relation), so the meter must be calibrated properly before each use.

Sources and more information

- USGS field manual for dissolved oxygen

Do you want to test your local water quality?

Water test kits are available from World Water Monitoring Day (WWMD). Teachers and water-science enthusiasts: Do you want to be able to perform basic water-quality tests on local waters? WWMD offers inexpensive test kits so you can perform your own tests for temperature, pH, turbidity, and dissolved oxygen.

World Water Monitoring Day is an international education and outreach program that builds public awareness and involvement in protecting water resources around the world.

Information on this page is from A Primer on Water Quality, by Swanson, H.A., and Baldwin, H.L., U.S. Geological Survey, 1965 and A Hydrologic Primer for New Jersey Watershed Management (WRIR 00-4140).

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URL: http://water.usgs.gov/edu/dissolvedoxygen.html
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