

Monitoring Monday – Let’s look at Dissolved Oxygen (DO).

Join us each Monday as the Clean Water Team shares resources on water quality monitoring. This week we look at dissolved oxygen (DO).

Although water molecules (H₂O) contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in natural waters. A small amount of oxygen (O₂) is actually dissolved in water. This free oxygen in water is the form necessary for most types of aquatic life to exist.

Water bodies receive oxygen from the atmosphere and from aquatic plants. Oxygen is added to water through several means. Re-aeration happens when oxygen from air is dissolved in water at its surface, mostly through turbulence. Examples of this include water tumbling over rocks (rapids, waterfalls, riffles) and wave action. Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen than the still water of a pond or lake. The process of photosynthesis (during daylight) produces oxygen when plants photosynthesize. DO is generally highest in the late afternoon, and lowest in the early morning hours before sunrise (diel cycle).

When water holds all the DO it can at a given temperature, it is said to be 100 percent saturated with oxygen. Water can be supersaturated with oxygen under certain conditions (e.g. when algae are growing rapidly and producing oxygen more quickly than it can be used up or released to the atmosphere).

Most aquatic organisms need oxygen to survive and grow. Low levels of oxygen ([hypoxia](#)) or no oxygen levels ([anoxia](#)) can occur when excess organic materials, such as large algal blooms, are decomposed by microorganisms. During this decomposition process, DO in the water is consumed. Low oxygen levels often occur in the bottom of the water column and affect organisms that live in the sediments. In some water bodies, DO levels fluctuate periodically, seasonally and even as part of the natural daily ecology of the aquatic resource. As DO levels drop, some sensitive animals may move away, decline in health or even die.

DO is considered an important measure of water quality as it is a direct indicator of an aquatic resource’s ability to support aquatic life. While each organism has its own DO tolerance range, generally, DO levels below 3 milligrams per liter (mg/L) are of concern and waters with levels below 1 mg/L are considered hypoxic and usually devoid of life. For many species of [salmonids](#), exposure to levels of dissolved oxygen less than 5.0 - 6.0 mg/L can result in mortality.

The water quality objectives for dissolved oxygen vary from region to region. Check with the [Regional Water Quality Control Board](#) in your area. Water quality objectives are included in their [Basin Plan](#). For waters that support coldwater fishes, the objective requires that the dissolved oxygen concentration shall not fall below 6 to 8 mg/l (depending on the region of California). The amount of dissolved oxygen needed varies from creature to creature. For waters that support warm water fishes, the objective may require that the dissolved oxygen concentration shall not fall below 5 to 6 mg/l (depending on the region of California). Some Regional Water Boards describe objectives in terms of percent saturation. For example, the dissolved oxygen shall not fall below 80% saturation. For ocean waters, the dissolved oxygen concentration shall not be depressed more than 10 percent from that which occurs naturally.

DO is often measured with multiparameter probes, single parameter meters, or sondes. Some of which can be deployed to measure data over a long period of time and retrieved at a later date, while some other meters are used to continuously measure DO and report that data in real time. DO can also be measured through simple colorimetric titrations. You can learn more about these methods through the [National Environmental Methods Index](#).

Did you know that water holds less oxygen at higher altitudes, holds more oxygen when cold than when warm, or that as salinity or mineral content increases dissolved oxygen decreases? Continue learning more through the resources shared below.

Resources:

Indicators: Dissolved Oxygen - <https://www.epa.gov/national-aquatic-resource-surveys/indicators-dissolved-oxygen>

Water Science School: Dissolved Oxygen and Water - https://www.usgs.gov/special-topic/water-science-school/science/dissolved-oxygen-and-water?qt-science_center_objects=0#qt-science_center_objects

Guidance Compendium for Watershed Monitoring and Assessment:

- 3.1.1 [Dissolved Oxygen Measurement Principles and Methods](#) (Information Paper)
 - 3.1.1.0 Fact Sheet: Dissolved Oxygen [[English](#)] | [[Español](#)]
 - 3.1.1.1 [Dissolved Oxygen Measured with a Colorimetric Ampoule](#)
 - 3.1.1.2 [Measurements of Dissolved Oxygen with the Modified Winkler Titration](#) (SOP)
 - 3.1.1.3 [Measurements of Dissolved Oxygen \(D.O.\) with an Electrode](#) (SOP)

National Field Manual for the Collection of Water-Quality Data - [Chapter A6.2. Dissolved Oxygen](#)

The “National Field Manual for the Collection of Water-Quality Data” (NFM) provides guidelines and procedures for U.S. Geological Survey (USGS) personnel who collect data used to assess the quality of the Nation’s surface water and groundwater resources. This chapter, NFM A6.2, provides guidance and protocols for the measurement of dissolved oxygen, which include the scientific basis of the measurement, selection and maintenance of equipment, calibration, troubleshooting, and procedures for measurement and reporting. It updates and supersedes USGS Techniques of Water-Resources Investigations, book 9, chapter A6.2, version 3.0, by Stewart A. Rounds, Franceska D. Wilde, and George F. Ritz. Dissolved oxygen is routinely measured when water samples are collected, is often continually measured at USGS streamgages, and is a parameter regularly measured during laboratory and field experiments. The field method for measuring dissolved oxygen described in this chapter is applicable to most natural waters.

Dissolved Oxygen Measurement Methods

<https://www.fondriest.com/environmental-measurements/measurements/measuring-water-quality/dissolved-oxygen-sensors-and-methods/>

Ventura River Diel Cycle Study – Santa Barbara Channelkeeper

https://www.sbck.org/wp-content/uploads/2020/12/2008.08.23-Ventura-Diel-Cycle_July-25-2008-19pp..pdf

Videos:

- **Why Monitor for Dissolved Oxygen** - www.youtube.com/watch?v=hrU7X7G4Ac8
- **Probes: Dissolved oxygen measurement** - www.youtube.com/watch?v=y7zbmlEaPAs
- **Dissolved Oxygen Estimation by Winkler's method Experiment** - www.youtube.com/watch?v=frtln5ZoeNQ
- **CHEMets® Self-filling Ampoules** - www.youtube.com/watch?v=GCQ9cklbhBA
- **Collecting Water Quality Samples Using A Sampling Pole And A Dissolved Oxygen Sampler** - www.youtube.com/watch?v=4xs1MsVD6EM&list=PLMSa5d-ill6PjYhV9cc4S-mNEteXts58
- **SWAMP FIELD METHODS MODULE 2 - WATER QUALITY MEASUREMENTS – WQ Measurements** - https://www.youtube.com/watch?v=TgxGln4c0Qo&list=PLMSa5d-ill6OnEHUbybDqeGRRui_t3kMf&index=2&t=2155s

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