Water Action Volunteers

Volunteer Monitoring Factsheet Series

2010

Dissolved Oxygen:

Aquatic Life Depends on It

Why are we concerned?

- Both aquatic plants and animals depend on dissolved oxygen (D.O.) for survival.
- D.O. concentrations are influenced by many factors including water temperature, the rate of photosynthesis, the degree of light penetration (turbidity and water depth), the degree of water turbulence or wave action, and the amount of oxygen used by respiration and decay of organic matter.

Time Needed:

40 minutes

Equipment Needed:

— Hip boots

— Hach dissolved oxygen water test kit

— Thermometer

— Safety goggles

— Disposable plastic/latex gloves

— Form to record data

— Pen/pencil

When to Measure:

Usually early in the morning.
Check with your local coordinator for schedules.

Definition of Terms

Cold-blooded: Animals whose body temperatures match that of their surroundings. Fish, invertebrates, snakes, frogs and toads are cold-blooded.

Diel: Involving a 24-hour time period.

Diffusion: The movement of molecules, for example oxygen molecules, from an area of higher concentration (e.g. the air) to an area of lower concentration (e.g. the water).

Endpoint: The completion of a chemical reaction. It is often determined by the change in color of an indicator solution.

Floc: Short for flocculent precipitate. These fine, suspended particles look like heavy snow.

Photosynthesis: The process in which green plants convert carbon dioxide and water, using the sun's energy, into simple sugars and oxygen.

Respiration: The cellular process in which plants and animals use oxygen and release carbon dioxide. Basically, it is the reverse of photosynthesis because carbon dioxide, water and energy are released in the process.

Supersaturation: An indication that more oxygen is dissolved in water than would be in a state of equilibrium. Supersaturation could indicate that some processes are affecting the water's natural balance found in the state of equilibrium.

Titrant: The solution of known strength used for measuring the extent of a chemical reaction, in this case it is sodium thiosulfate.

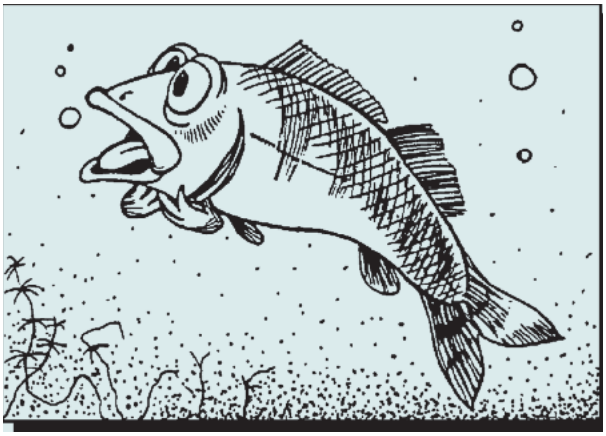
Background on Dissolved Oxygen

Oxygen is a clear, colorless, odorless, and tasteless gas that dissolves in water. Small but important amounts of it are dissolved in water. It is supplied by diffusion of atmospheric (air) oxygen into the water and by production of oxygen from photosynthesis by aquatic plants. Wind, waves, and tumbling water in fast-moving streams increase the rate of diffusion.

Oxygen: Aquatic Life Depends on it

Both plants and animals depend on dissolved oxygen for survival. Lack of dissolved oxygen can cause aquatic animals (e.g. fish, macroinvertebrates) to quickly leave the area or face death. Under extreme conditions, lack of oxygen can kill aquatic plants and animals. Measuring dissolved oxygen is probably the most significant water quality test to determine the suitability of a stream for fish and many other aquatic organisms. However, these measures only provide a snapshot of the oxygen levels at that particular time. Levels can fluctuate widely throughout the day and year. Fish and other organisms have to live and breathe in that water all year long. A short time without oxygen can be fatal.

Dissolved oxygen (D.O.) is reported as milligrams of oxygen per liter of water (mg/L) which can be called parts per million by weight (ppm). Different aquatic organisms have different oxygen needs. Trout and stoneflies, for example, require high dissolved oxygen levels. Trout need water with at least 6 mg/L D.O. Warm water fish like bass and bluegills survive nicely at 5 mg/L D.O. and some organisms like carp and bloodworms can survive on less than 1 mg/L D.O. Based on this, there are stream classifications in Wisconsin that define the minimum amount of oxygen allowed at a site (see Table 1).



The oxygen demand of aquatic plants and cold-blooded animals also varies with water temperature. A trout uses five times more oxygen while resting at 80° F (26.7° C) than at 40° F (4.4° C).

TABLE 1: Minimum dissolved oxygen levels allowed for waters with varied classification in Wisconsin.

STREAM CLASSIFICATION	MINIMUM DISSOLVED OXYGEN ALLOWED
Trout waters	6 mg/L (out of spawning season) and 7 mg/L (during spring/fall spawning season)
Fish or aquatic life-designated waters	5 mg/L
Limited forage fish waters	3 mg/L
Limited aquatic life waters	1 mg/L

Factors Affecting Oxygen Levels

There are many factors that affect the amount of dissolved oxygen in the water (see inset boxes). A major one is photosynthesis. Aquatic plants produce oxygen by photosynthesis during daylight hours but they also use oxygen for respiration. High day-time levels of D.O. are often countered with low night-time levels (see a sample diel cycle for dissolved oxygen in Figure 1). This is due to respiration of living organisms, including fish, bacteria, fungi and protozoans, as well as the cessation of photosynthesis. Wide daily fluctuations of D.O. stress fish and other aquatic animals. Oxygen depletion can occur because of heavy plant growth. Complete depletion of D.O. can sometimes be detected with your nose. Anaerobic decay results in a rotten egg smell (hydrogen sulfide gas). However, good management practices such as planting or maintaining vegetation that filters rainwater runoff and shades the water, cooler water temperatures and protecting the stream channel in other ways to maintain or increase turbulence all promote good dissolved oxygen levels.

FACTORS THAT COULD **INCREASE** THE AMOUNT OF DISSOLVED OXYGEN IN WATER
• High atmospheric pressure • Clear water • Photosynthesis • A lot of turbulence/wave action • Cold water • Presence of excessive amounts of plants (during daytime)

FACTORS THAT COULD **DECREASE** THE AMOUNT OF DISSOLVED OXYGEN IN WATER
• Respiration of animals and plants living in the water • Chemical reactions of the decaying process • Low atmosphere pressure • High levels of turbidity (such as from erosion) • Warm water • Very colored water • Presence of excessive amounts of plants (at nighttime) • Excessive organic materials (such as sewage, manure or fertilizers)

Percent Saturation

Recording dissolved oxygen differs from other tests in that it requires two distinct calculations. We are interested in both the absolute amount of D.O. (mg/L or ppm) and how close the value is to the equilibrium value for that temperature and air pressure - which is the percentage of saturation. Values between 90% and 110% of saturation are excellent (see Figure at right). Supersaturated (over 100%) values may sound good but they can also indicate problems, such as excessive plant growth. You can assess the range of dissolved oxygen levels that aquatic plants and animals at your stream site must withstand by monitoring twice in one day – early in the morning, just before sunrise, and later in the afternoon when plants have been exposed to the most direct sunlight for an extended period.

DISSOLVED OXYGEN LEVELS (% SATURATION)
Excellent: 91-110 Good: 71-90 Fair: 51-70

SOURCE: Field Manual for Water Quality Monitoring (13th Edition)

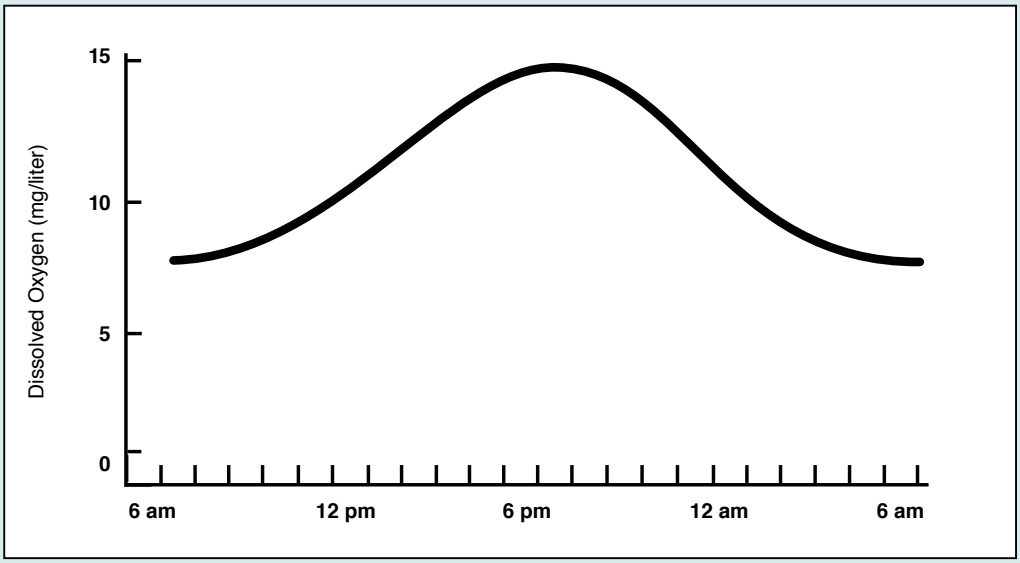


FIGURE 1: Diel Fluctuation in dissolved oxygen

TEMPERATURE CONVERSION CHART

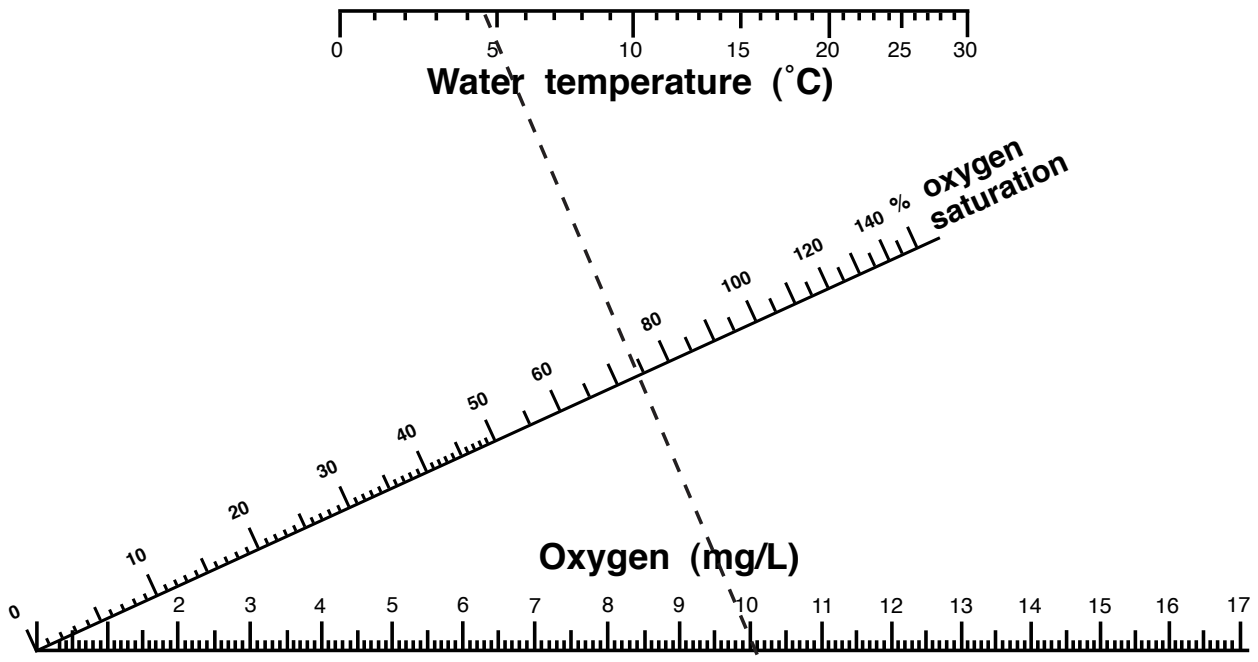
Fahrenheit	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Celsius	.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5	5.6	6.1	6.7	7.2	7.8	8.3	8.9	9.4	10	10.6

Fahrenheit	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
Celsius	11.1	11.7	12.2	12.8	13.3	13.9	14.4	15	15.6	16.1	16.7	17.2	17.8	18.3	18.9	19.4	20	20.6	21.1

Fahrenheit	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
Celsius	21.7	22.2	22.8	23.3	23.9	24.4	25	25.6	26.1	26.7	27.2	27.8	28.3	28.9	29.4	30	30.6	31.1	31.7

How to Find Percent Saturation:

Using a straight edge, find your water temperature (convert from Fahrenheit if necessary using above chart). Align with the oxygen (mg/L) scale. The measured percent saturation is on the point where the line connecting those two points crosses the oxygen saturation line. For example, 5˚C with 10 mg/L of oxygen aligns with 75% saturation, which is your answer.



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Water Action Volunteers is a cooperative program between the University of Wisconsin-Extension and the Wisconsin Department of Natural Resources. For more information, contact the Water Action Volunteers Coordinator at 608/264-8948.