Understanding Dissolved Oxygen
Introduction

Welcome to the Understanding Dissolved Oxygen learning module. This section provides information on the following topics:

- ☑ How dissolved oxygen is defined and measured in numbers
- ☑ Why dissolved oxygen is important
- ☑ Natural and human influences on dissolved oxygen

After completing this module you should be able to perform the following:

- ☑ Define the term dissolved oxygen
- ☑ Explain how dissolved oxygen is measured in numbers
- ☑ List some reasons why dissolved oxygen is important to aquatic life
- ☑ List some natural and human influences on dissolved oxygen

To begin the module, click the **Next** button at the bottom right of the screen.

Understanding Dissolved Oxygen
What is dissolved oxygen?

Dissolved oxygen (DO) refers to microscopic bubbles of gaseous oxygen (O_2) that are mixed in water and available to aquatic organisms for respiration—a critical process for almost all organisms.

Primary sources of DO include the atmosphere and aquatic plants.

- ☑ Surface waters, which are in contact with the atmosphere, absorb oxygen from the air.

- ☑ Aquatic plants release oxygen into the water as a byproduct of photosynthesis.

Understanding Dissolved Oxygen

How is dissolved oxygen measured in numbers?

Dissolved oxygen can be measured as a concentration or as a partial pressure. SCORE volunteers measure DO as a concentration of milligrams of DO per liter of water (mg/L). If one liter of water has five milligrams of DO in it, the measurement is written as the following:

- ☑ 5 mg/L

The measurement of mg/L will be equal to the measure of parts DO per million parts water (ppm). An example can help illustrate this point:

- ☑ 5 mg/L = 5 ppm

That is, 5 milligrams of DO per liter of water is equal to 5 parts DO per million parts water.

Understanding Dissolved Oxygen

Understanding the numbers

Which of the following statements is false?

A) Dissolved oxygen is typically measured as a concentration of milligrams of DO per liter of water (mg/L).
B) Dissolved oxygen is typically measured as a concentration of parts DO per million parts water (ppm).
C) 5 mg/L = 10 ppm
D) 5 mg/L = 5 ppm

The correct response is C!

Dissolved oxygen is typically measured as a concentration of milligrams of DO per liter of water (mg/L). This quantity is equal to the measure of parts DO per million parts water (ppm). For example, 5 milligrams of DO per liter of water is equal to 5 parts DO per million parts water (that is, 5 mg/L = 5 ppm).

Understanding Dissolved Oxygen
The importance of dissolved oxygen

Oysters and other aquatic life are just as dependent on gaseous oxygen dissolved in the water as people are dependent on gaseous oxygen in the air. Aquatic organisms can only function properly within a certain range of DO concentrations. Although high DO concentrations can be harmful, this upper range is rarely reached. Low DO concentrations are more common.

DO concentrations that are too low may have the following effects:

- ☑ Prevent organisms from growing, feeding, or reproducing properly
- ☑ Lead to unhealthy and less biologically diverse communities

Important note: Sessile (or immobile) species, such as oysters, are especially at risk in areas with low DO concentrations because they are unable to move to areas with higher concentrations.

Understanding Dissolved Oxygen
The importance of dissolved oxygen

Waters with a DO concentration of 0 mg/L are considered *anoxic* and do not support aquatic life. Estuarine and marine waters with a DO concentration above 0 mg/L, but below 2.8 mg/L, are considered *hypoxic* and frequently cause adverse biological effects. Typical DO concentrations at SCORE restoration sites range from 4 mg/L to 8 mg/L, which are safely above the hypoxic range.

Understanding Dissolved Oxygen
Understanding the importance of dissolved oxygen

When DO concentrations are too low, which of the following may occur?

A) Organisms cannot grow, feed, or reproduce properly
B) Estuarine communities become unhealthy and less biologically diverse
C) Both A and B
D) None of the above

The correct response is C!

DO concentrations that are too low may prevent organisms from growing, feeding, or reproducing properly, and lead to unhealthy and less biologically diverse communities.

Understanding Dissolved Oxygen
Influences on dissolved oxygen

Dissolved oxygen can be affected by both human and natural influences.

Natural influences:

- ☑ Temperature and season
- ☑ Time of day
- ☑ Salinity
- ☑ Suspended sediments
- ☑ Water turbulence

Human influences:

- ☑ Nutrient pollution
- ☑ Thermal pollution
- ☑ Sediment pollution

Understanding Dissolved Oxygen
Natural influences on dissolved oxygen (temperature and seasons)

DO concentration decreases as water temperature increases. This is because oxygen is less soluble in warm water than in cool water.

- ☑ DO concentrations are highest during the winter when water temperatures are lowest.

- ☑ DO concentrations are lowest during the summer when water temperatures are highest.

Understanding Dissolved Oxygen
Natural influences on dissolved oxygen (time of day)

Although DO concentration decreases as water temperature increases, DO concentration is actually higher during the day than at night.

- ☑ During the day, aquatic plants release oxygen into the water through photosynthesis.

- ☑ During the night, photosynthetic activity ceases and oxygen continues to be consumed through respiration by aquatic plants and animals.

Understanding Dissolved Oxygen
Natural influences on dissolved oxygen (salinity)

DO concentration decreases as salinity increases. Salinity refers to the amount of salts dissolved in water. Dissolved salts, such as sodium chloride (NaCl), occupy space in water that would otherwise be available for oxygen molecules (O_2) to dissolve in. Thus, as the amount of salts dissolved in water increases, DO decreases.

Understanding Dissolved Oxygen
Natural influences on dissolved oxygen (suspended sediments)

DO concentration can decrease as the concentration of suspended sediments in water increases. Suspended sediment refers to the amount of loose particles of clay, silt, and sand floating in the water.

Suspended sediments can have the following effects:

- ☑ Make oxygen less soluble in water by absorbing heat and raising water temperature
- ☑ Limit oxygen production in plants by interfering with sunlight needed for photosynthesis

Understanding Dissolved Oxygen
Natural influences on dissolved oxygen (water turbulence)

Water turbulence can affect DO concentration. Turbulence refers to water that is moving rapidly and irregularly due to physical forces caused by wind, tides, wave action, and currents.

Water turbulence may lead to an increase in DO concentration through the following:

- ☑ Increasing the mixing between surface water and the atmosphere (surface waters absorb oxygen from the air)

- ☑ Increasing the mixing between bottom waters (which typically have low DO concentrations) and surface waters (which typically have higher DO concentrations)

Understanding Dissolved Oxygen
Natural influences on dissolved oxygen (water turbulence)

Water turbulence may also lead to a decrease in DO concentration by performing the following:

- ☑ Stirring up bottom sediments – increases the concentration of suspended sediments in water
- ☑ Increasing shoreline erosion – which also increases the concentration of suspended sediments in water

Understanding Dissolved Oxygen
Understanding natural influences on dissolved oxygen

Which of the following properties of water can result in a low DO concentration?

A) Low temperature
B) Low salinity concentration
C) High suspended sediment concentration
D) All of the above

The correct response is C!

A high concentration of suspended sediments in water can result in a low DO concentration. Low water temperature and a low salinity concentration can actually decrease DO concentration.

Understanding Dissolved Oxygen
Understanding natural influences on dissolved oxygen

Which of the following statements is true?

A) DO concentrations are higher during the day than at night
B) DO concentrations are lower during the day than at night

The correct response is A!

DO concentrations are higher during the day when plants produce oxygen as a by-product of photosynthesis. At night, photosynthetic activity ceases, and oxygen continues to be consumed through respiration by aquatic plants and animals.

Understanding Dissolved Oxygen
Human influences on dissolved oxygen (nutrient pollution)

Nutrient pollution (excess nutrients in water) may lead to a decrease in DO concentration.

- ☑ Excess nutrients in water—particularly nitrogen and phosphorous—can increase the growth of phytoplankton (tiny microscopic plants) and cause algal blooms.
- ☑ Algal blooms are dense floating masses of phytoplankton that discolor the water's surface.
- ☑ When phytoplankton die, they are decomposed by bacteria that consume DO during the process.

Understanding Dissolved Oxygen
Human influences on dissolved oxygen (nutrient pollution)

Nutrient pollution can be classified into two types, point source and nonpoint source.

Point sources of nutrient pollution include the following:

- ☑ Sewage treatment plants
- ☑ Industrial treatment plants

Nonpoint sources of nutrient pollution carried by stormwater runoff include the following:

- ☑ Fertilized agricultural lands, residential lawns, and golf courses
- ☑ Livestock farms (animal waste)

Understanding Dissolved Oxygen
Human influences on dissolved oxygen (thermal pollution)

As you learned earlier, water temperature has a direct effect on DO concentration. Thermal pollution (the artificial warming of natural water bodies) causes DO concentration to decrease.

- ☑ Thermal pollution increases water temperature.
- ☑ As water temperature increases, DO concentration decreases.

Sources of thermal pollution include the following:

- ☑ Impervious surfaces – surfaces, such as roads and parking lots – that are generally hot and cause stormwater to heat up as it flows across the land and into natural waters
- ☑ Power plants, which routinely discharge heated wastewater into natural waters

Understanding Dissolved Oxygen
Human influences on dissolved oxygen (sediment pollution)

Sediment pollution may lead to a decrease in DO concentration by increasing the concentration of suspended sediments in water.

Human activities that often contribute to sediment pollution include the following:

- ☑ Boating – increases shoreline erosion
- ☑ Dredging – stirs up bottom sediments
- ☑ Development of land – impervious surfaces (such as roads and driveways) and removal of vegetation increase stormwater runoff and soil erosion

Understanding Dissolved Oxygen
Understanding human influences on dissolved oxygen

Which of the following can result in a low DO concentration?

A) Fertilization of soils
B) Impervious surfaces
C) Development
D) All the above

The correct response is D!

Fertilization of soils, impervious surfaces, and development can all result in a low DO concentration. Fertilizers are a source of nutrient pollution, impervious surfaces are a source of thermal pollution, and development is a source of sediment pollution. Each of these pollution types is caused by humans and has unique ways of lowering DO concentration.

Understanding Dissolved Oxygen
Review

Congratulations! You have completed the Understanding Dissolved Oxygen learning module. In this section you learned about the following topics:

- ☑ How dissolved oxygen is defined and measured in numbers
- ☑ Why dissolved oxygen is important
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You should now be able to perform the following:

- ☑ Define the term dissolved oxygen
- ☑ Explain how dissolved oxygen is measured in numbers
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