DISSOLVED OXYGEN (DO)

Dissolved oxygen, oftentimes abbreviated as DO (dee-oh), is the measure of the amount of free oxygen (O₂) that is dissolved in the water. Fish and invertebrates use their gills to breathe oxygen gas underwater, just like humans use lungs to breathe oxygen gas from the atmosphere. It is one of the most important water quality indicators, because respiration is fundamental for life.

**Dissolved Oxygen (DO) levels**

In general, dissolved oxygen values 5 mg/L and above support proper metabolism, growth and reproduction for marine animals. Many fish can handle very low DO levels, which is why we still see pinfish, tarpon and mullet in canals with very low DO; however, fish with higher oxygen requirements, like grouper, will leave areas with low DO (Fig. 1).

**Temperature and Salinity**

The temperature, salinity and atmospheric pressure determine the amount of oxygen that can physically be dissolved into the water. Dissolved oxygen has an inverse (opposite) relationship with temperature:

- **Temperature** increases, **dissolved oxygen** decreases.

Salinity also affects oxygen saturation. Seawater holds about 20% less oxygen than freshwater at the same temperature and altitude. When the ocean temperature is 30°C (86°F), the oxygen content is 5 milligrams of oxygen per liter (mg/L), which is equivalent to 80% dissolved oxygen saturation (Fig. 2).

**Temperature and Dissolved Oxygen (DO)**

![Temperature vs. Dissolved Oxygen (DO)](image)

**What is Dissolved Oxygen?**

Shelly Krueger
Florida Sea Grant Agent
University of Florida IFAS Extension, Monroe County
ShellyKrueger@UFL.edu/305-292-4501
monroe.ifas.ufl.edu

What is Dissolved Oxygen?

Dissolved oxygen (DO) is the oxygen in the water that can be used by aquatic organisms. It is an important water quality indicator because it affects the health and survival of aquatic life. Dissolved oxygen levels are influenced by factors such as temperature, salinity, and the rates of photosynthesis and respiration.

How does oxygen enter the water?

- **Diffusion** – Atmospheric O₂ via mixing from waves, wind, currents, tides and groundwater
- **Photosynthesis** – O₂ production in the water from seagrasses, algae and phytoplankton
- **Artificial** – water over a dam, aerators and fountains

![How does oxygen enter the water?](image)

**What Factors Affect Dissolved Oxygen (DO)?**

Dissolved oxygen (DO) levels vary depending upon a number of physical and biological factors. DO levels are highest at the poles and lowest at the equator. DO levels are highest when the water is cold and lowest when the water is warm. DO levels are higher during the day and decrease at night.

![What Factors Affect Dissolved Oxygen (DO)?](image)

DIEL = NIGHT + DAY

Diurnal means during the day, and nocturnal means during the night. Diel refers to the 24 hour period of both day and night. Just like the plants and trees on Earth, the plants and algae in the water produce oxygen, and need oxygen to breathe. When the sun shines, they produce oxygen, but at night, they only consume oxygen – this is why early morning tends to have the lowest levels of dissolved oxygen – until the sun rises, when photosynthesis starts again. Afternoon oxygen levels can exceed 100% DO saturation (super-saturated) because the rate of photosynthesis is high from solar energy (Fig. 4).

![DIEL = NIGHT + DAY](image)

**DECOMPOSITION**

Decomposition is the decay of organic matter. When seagrasses and algae decay the microbes that break them down consume oxygen through their metabolism, which depletes the water of oxygen. In the absence of oxygen, the process of decomposition can create hydrogen sulfide, which releases the characteristic “rotten egg” smell.

**DISSOLVED OXYGEN SATURATION**

Dissolved oxygen saturation varies throughout the day and night. When there is more oxygen consumption by animals, plants and bacteria than oxygen production by plants and mixing from the atmosphere, oxygen saturation values naturally go down. The oxygen is being consumed by animals, plants and bacteria faster than it is being replenished. DO saturation also declines with depth (Fig. 3). The highest dissolved oxygen levels tend to be at the surface because oxygen concentrations are higher in the atmosphere and most mixing occurs at the surface through diffusion. In order to meet Florida Department of Environmental Protection (FDEP) state standards for water quality, coastal waters must have a diel average at or above 42% DO saturation. Percent dissolved oxygen saturation is a good calculation for marine life because it incorporates local conditions for temperature, salinity and atmospheric pressure.

**Literature Cited:**


**Funding provided by the EPA South Florida initiative Grant #00D41115**
Phytoplankton (Microscopic organisms that float in the top layers of the Earth's oceans and produce 40% of the Earth's oxygen supply. They grow on land, and P stimulate plant and algal growth in the marine environment. One of the biggest consequences of too many nutrients is too much phytoplankton, followed by low dissolved oxygen in the water.

Seagrasses (True Plants) and algae are divided into two groups: micro-algae and macro-algae.

Primary producers are plants and algae that perform photosynthesis to create energy and oxygen. Primary producers are incredibly important because they form the base of the food chain and produce the oxygen we breathe in the atmosphere. Primary producers are the only group that can create their own food; all other organisms on Earth must eat to obtain energy for growth and reproduction. There are two types of primary producers in the ocean: seagrasses, which are true plants, and algae. Algae are divided into two groups: micro-algae and macro-algae.

Phytoplankton (Micro-algae) are microscopic, single-celled organisms that float in the top layers of the Earth's oceans and produce 40% of the Earth's oxygen supply.

Seaweeds (Macro-algae) are large, visible algae. Sargassum, halimeda, mermaid's cups, shaving brushes and hair algae are common seaweeds in the Florida Keys.

Seagrasses (True Plants) are flowering plants that grow in the marine environment. They are one of the most productive habitats on Earth. Seagrasses are divided into two groups: halimeda and mermaid's cups, shaving brushes and hair algae.

What are Nutrients?

Primary producers proliferate: The N and P act like fertilizers, stimulating exponential phytoplankton (microalgae), seaweed (macroalgae) and seagrass growth.

Algae Bloom: The abundance of phytoplankton creates an algae bloom. The phytoplankton bloom may become so thick they can block light to the seagrasses at the bottom. The water may appear very green or red-brown.

Decomposition: The phytoplankton decay, and the decomposition of the organic matter by microbes removes oxygen from the water.

Very low oxygen levels lead to fish kills. Some phytoplankton blooms cause health effects in humans, and death for dolphins and manatees.

Non-point source pollution is the type of pollution that comes from diffuse sources. The more impervious surfaces, like parking lots, roads and urban development, the more nonpoint source pollution enters waterways. This is because after a rain event, the rainwater literally runs-off into the nearest waterbody – rivers, lakes, estuaries and oceans. When rainwater travels over the ground, it picks up whatever pollutants the water encounters – sediment, fertilizers, pesticides, fossil fuels, animal waste and heavy metals, and carries them through the watershed via gravity to waterways. It is important to educate residents about nonpoint source pollution because we can all prevent pollution entering waterways in the first place.

What is a Harmful Algal Bloom (HAB)?

A proliferation of algae is called an algal bloom. Algal blooms can deplete the water of oxygen and cause fish kills. Some phytoplankton species contain toxins that are harmful to humans, which are called Harmful Algal Blooms (HABs). The red tide causing species, Karenia brevis, causes respiratory problems in humans, fish kills and dolphin deaths. Drinking or inhaling contaminated water from some toxic blooms, or eating contaminated shellfish, can cause liver disease and long-term cognitive dysfunction in humans and marine mammals.

What is Chlorophyll A?

Chlorophyll A is the primary photoreceptor used for photosynthesis by aquatic plants and algae. Chlorophyll A gives plants and algae their green pigment and it is used as a proxy to estimate the amount of phytoplankton in the water column. There are scientific instruments and even satellites that measure the chlorophyll A pigment to estimate the abundance of phytoplankton in the environment.

Funding provided by the EPA South Florida Initiative Grant #00D41115.