# Sources and nature

Dissolved organic matter (DOM) in lakes and rivers is derived from two natural processes: production by aquatic organisms and leaching of decaying vegetation from terrestrial sources. Both sources yield a wide array of organic molecules of varying sizes and chemical composition that form the aggregate water quality constituent we call DOM.

Anthropogenic sources, such as wastewater effluent and urban and agricultural runoff, also contribute to the DOM pool in many waters. DOM differs chemically depending on its source, and understanding the relationships between sources and DOM composition is still a work in progress.

Colored dissolved organic matter (CDOM), which in high concentrations is associated with runoff from forested wetlands, is a complicated mixture of tannins and breakdown products of woody vegetation. CDOM molecules absorb light increasingly with decreasing wavelength in the blue and UV regions, giving rise to a yellow-brown tint to CDOM-rich waters. CDOM is the most abundant DOM fraction in natural waters of forested watersheds with wetlands, which are common in northern areas of the Great Lakes States.

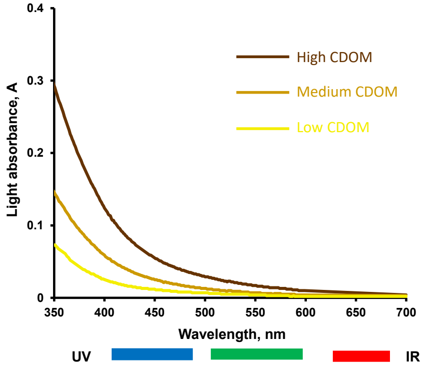


CDOM can be measured from 1) smartphone photos of a Secchi disk placed at a fixed depth in lakes, or 2) from photos of white buckets filled with lake water.

## Measurement of CDOM

Traditionally, CDOM is measured by filtering a water sample to remove suspended particles and measuring the light absorbance in the blue region (~ 440 nm) with a spectrophotometer. An older method compares the color of filtered water to calibrated colored glass disks. We have developed methods to measure CDOM in lakes using satellite imagery, which provides the ability to examine landscape patterns in CDOM levels at local to regional scales. We also have found that smartphone cameras can measure CDOM by photographing the white part of Secchi disks at a fixed depth in the water. An app that uses RGB information from digital photos is being developed for use by citizen monitoring programs.






CDOM light absorption increases exponentially as wavelength decreases in the blue and UV regions.

## For more information:

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# Colored Dissolved Organic Matter in Water

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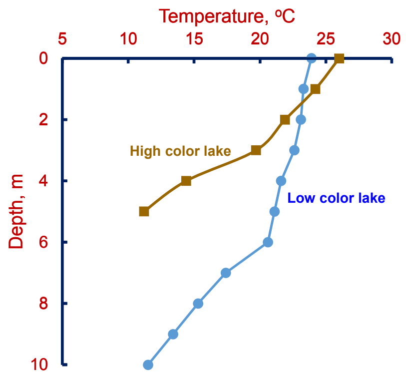
## Ecological importance

CDOM plays a central role in the behavior of freshwater ecosystems. It attenuates sunlight, and this affects physical, chemical, and biological processes in surface waters. CDOM regulates heat transfer to water, controlling lake temperatures, mixing and stratification, and UV impacts on biota are ameliorated by high CDOM levels. CDOM tends to lower the pH of water; it forms chemical complexes with heavy metals, leading to increased concentrations in colored waters, and it affects transfer of contaminants such as mercury into food webs. CDOM is an important source of reactive intermediates in the indirect photolysis of aquatic organic contaminants, and photobleaching of CDOM (time scale of weeks to months) is important in transforming bio-refractory CDOM molecules into forms more susceptible to biodegradation.




By reducing visible light, CDOM suppresses primary productivity and also affects productivity of higher trophic levels. CDOM shifts the metabolic balance in lakes toward heterotrophy, stimulating carbon burial. The key role of CDOM in regulating biogeochemical cycles and aquatic food webs is a paradigm that has emerged from research of the past two decades. In addition, CDOM affects nitrogen, phosphorus, and sulfur cycling through effects on microbial metabolism.

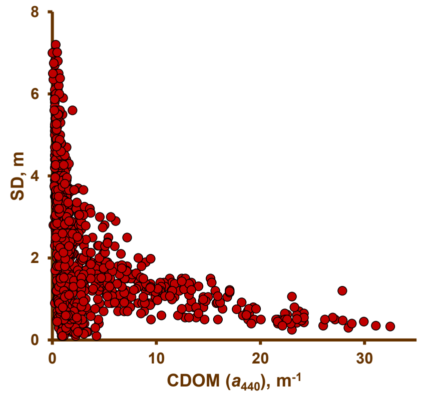
High iron concentrations often are found in highly colored waters, and it is common to hear people attribute the color to the presence of iron. This actually is not correct. Our recent studies have shown that almost all the brown color in lakes and wetlands of northern Minnesota comes from organic matter and not the varying levels of iron associated with it.

*"I was surprised to learn that lake color was not due to iron."*

Unnamed homeowner,
South Lake Sturgeon.

## CDOM and Secchi depth

Secchi depth (SD), a measure of water clarity, is widely used to assess the eutrophication status of lakes and their suitability for recreation. In many lakes SD is controlled by chlorophyll (a measure of algal abundance), but in northern Minnesota, high color levels, which absorb light, often are more important SD controls than chlorophyll. Caution thus must be used in interpreting SD values strictly as a measure of trophic state.




SD encompasses a wide range in low-color lakes, reflecting how much chlorophyll (algae) is present, but high colored lakes have low SD because of the light-absorbing properties of CDOM. Data points represent SD and CDOM values for lakes sampled in 2015-2018.

## CDOM and drinking water treatment

Although DOM is not directly harmful to human health, it has negative effects on the production of safe drinking water. DOM, especially CDOM, increases consumption of treatment chemicals such as chlorine, and CDOM levels are linearly related to the formation of potentially harmful disinfection byproducts such as trihalomethanes and haloacetic acids when water is chlorinated.