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Dissolved organic carbon and nutrients as regulators of lake ecosystems: Resurrection of a more integrated paradigm

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Abstract

The primary interpretive paradigm used to study lakes is their trophic status. Oligotrophic lakes have low nutrient loading and low productivity, while eutrophic lakes have high nutrients and high productivity. The strong empirical relationship between nutrient loading and productivity is a valuable tool for teaching, for research, and for management of lakes. In order to incorporate the variety of other known anthropogenic impacts on lakes, however, lake characterization needs to extend beyond the nutrient-productivity paradigm. For example, acid precipitation, heavy metal and toxic organic contaminants, increases in UV radiation, and global warming are all recognized threats to lake ecosystems. One of the key characteristics of lakes that determines how they respond to disturbances such as these is their concentration of colored dissolved organic carbon (CDOC). Here we argue that a paradigm that includes CDOC (using the absorption coefficient at 320 nm as a proxy) as well as nutrients will be useful in predicting and understanding the response of lake ecosystems to multiple stressors. We propose to resurrect the CDOC axis that was proposed by investigators earlier this century and to extend it by adding some operational definitions to permit placing some of the major lake types on the axes in a way that will help us to better understand the structure, function, and response to disturbance of lake ecosystems that are subject to natural and anthropogenic environmental changes at the local, regional, and global scales. Data from a few diverse lakes and a successional sequence in Glacier Bay, Alaska, are used to illustrate the potential utility of the 2-axis model in separating lake types.