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Metabolic and physiochemical responses to a whole-lake experimental increase in dissolved organic carbon in a north-temperate lake

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Abstract

Over the last several decades, many lakes globally have increased in dissolved organic carbon (DOC), calling into question how lake functions may respond to increasing DOC. Unfortunately, our basis for making predictions is limited to spatial surveys, modeling, and laboratory experiments, which may not accurately capture important whole-ecosystem processes. In this article, we present data on metabolic and physiochemical responses of a multiyear experimental whole-lake increase in DOC concentration. Unexpectedly, we observed an increase in pelagic gross primary production, likely due to a small increase in phosphorus as well as a surprising lack of change in epilimnetic light climate. We also speculate on the importance of lake size modifying the relationship between light climate and elevated DOC. A larger increase in ecosystem respiration resulted in an increased heterotrophy for the treatment basin. The magnitude of the increase in heterotrophy was extremely close to the excess DOC load to the treatment basin, indicating that changes in heterotrophy may be predictable if allochthonous carbon loads are well-constrained. Elevated DOC concentration also reduced thermocline and mixed layer depth and reduced whole-lake temperature. Results from this experiment were quantitatively different, and sometimes even in the opposite direction, from expectations based on cross-system surveys and bottle experiments, emphasizing the importance of whole-ecosystem experiments in understanding ecosystem response to environmental change.