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Lake metabolism: Relationships with dissolved organic carbon and phosphorus

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Abstract

Recent literature has suggested that for many lakes and rivers, the respiratory breakdown of organic matter (R) exceeds production of organic matter by photosynthesis (gross primary production [GPP]) within the water body. This metabolic balance (GPP $<$ R; ''heterotrophy'') implies that allochthonous organic matter supports a portion of the aquatic ecosystem's respiration. Evidence that many lakes are heterotrophic comes from diverse approaches, and debate remains over the circumstances in which heterotrophy exists. The methods used to estimate GPP and R and the limited extent of lake types studied, especially with respect to dissolved organic carbon (DOC) and total phosphorus (TP) concentrations, are two reasons for differing conclusions. We deployed O_2 and CO_2 sondes to measure diel gas dynamics in the surface waters of 25 lakes. From these data, we calculated GPP, R, and net ecosystem production (NEP = GPP − R). Over the broad range in TP and DOC among the lakes, diel CO_2 and O_2 changed on a near 1 : 1 molar ratio. Metabolism estimates from the two gases were comparable, except at high pH. Most lakes in our data set had negative NEP, but GPP and R appeared to be controlled by different factors. TP correlated strongly with GPP, whereas DOC correlated with R. At low DOC concentrations, GPP and R were nearly equal, but, at higher DOC, GPP and R uncoupled and lakes had negative NEP. Strong correlations between lake metabolism and landscape related variables suggest that allochthonous carbon influences lake metabolism.