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## The dual influences of dissolved organic carbon on hypolimnetic metabolism: organic substrate and photosynthetic reduction

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**Abstract.** We investigated the effect of dissolved organic carbon (DOC) on hypolimnetic metabolism (accumulation of dissolved inorganic carbon (DIC) and methane (CH<sub>4</sub>)) in 21 lakes across a gradient of DOC concentrations (308 to 1540  $\mu\text{mol C L}^{-1}$ ). The highly colored nature of the DOC in these lakes suggests it is mostly of terrestrial origin. Hypolimnetic methane accumulation was positively correlated with epilimnetic DOC concentration (Spearman rank correlation = 0.67;  $p < 0.01$ ), an indicator of allochthonous DOC inputs, but not with photic zone chlorophyll *a* concentration (Spearman rank correlation = 0.30;  $p = 0.22$ ). Hypolimnetic DOC concentrations declined in 19 of 21 lakes during the stratified period at rates that ranged from 0.06 to 53.9  $\text{mmol m}^{-2} \text{d}^{-1}$ . The hypolimnetic accumulation of DIC + CH<sub>4</sub> was positively correlated with, and, in most cases of comparable magnitude to, this DOC decline suggesting that DOC was an important substrate for hypolimnetic metabolism. The percentage of surface irradiance reaching the thermocline was lower in high DOC lakes ( $\sim 0.3\%$ ) than in low DOC lakes ( $\sim 6\%$ ), reducing hypolimnetic photosynthesis (as measured by the depth and magnitude of the deep dissolved oxygen maxima) in the high DOC lakes. In June, the hypolimnia of lakes with  $< 400 \mu\text{mol L}^{-1}$  DOC had high concentrations of dissolved oxygen and no CH<sub>4</sub>, while the hypolimnia of lakes with DOC  $> 800 \mu\text{mol L}^{-1}$  were completely anoxic and often had high CH<sub>4</sub> concentrations. Thus, DOC affects hypolimnetic metabolism via multiple pathways: DOC was significant in supporting hypolimnetic metabolism; and at high concentrations depressed photosynthesis (and therefore oxygen production and DIC consumption) in the hypolimnion.