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Sources and fates of dissolved organic carbon in lakes as determined by whole-lake carbon isotope additions

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Abstract Four whole-lake inorganic ^{13}C addition experiments were conducted in lakes of differing trophic status. Inorganic ^{13}C addition enriched algal carbon in ^{13}C and changed the $\delta^{13}C$-DOC by +1.5‰ to +9.5‰, depending on the specific lake. This change in $\delta^{13}C$-DOC represented a significant input of algal DOC that was not completely consumed by bacteria. We modeled the dynamics in $\delta^{13}C$-DOC to estimate the fluxes of algal and terrestrial carbon to and from the DOC pool, and determine the composition of the standing stock. Two experiments in lightly stained, oligotrophic lakes indicated that algal production was the source of about 20% of the DOC pool. In the following year, the experiment was repeated in one of these lakes under conditions of nutrient enrichment, and in a third, more humic lake. Algal contributions to the DOC pool were 40% in the nutrient enriched lake and 5% in the more humic lake. Spectroscopic and elemental analyses corroborated the presence of increased algal DOC in the nutrient enriched lake. Natural abundance measurements of the $\delta^{13}C$ of DOC in 32 lakes also revealed the dual contributions of both terrestrial and algal carbon to DOC. From these results, we suggest an approach for inferring the contribution of algal and terrestrial DOC using easily measurable parameters.

Keywords Allochthonous · Autochthonous · Carbon stable isotopes · Dissolved organic carbon

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