Controls on spatial and temporal variation of nutrient uptake in three Michigan headwater streams
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We measured whole-stream uptake of ammonium ($NH_4^+$), nitrate ($NO_3^-$), and phosphate (as soluble reactive phosphorus [SRP]) in two reaches of three forested headwater streams eight times from May 2003 to April 2004 (n = 46 measurements per nutrient type). We also measured factors that could affect uptake, including ambient nutrient concentrations, whole-stream metabolism, and organic matter standing stocks. In all three streams, we measured the highest rates of $NH_4^+$ and $NO_3^-$ uptake velocity ($V_f$) during the spring. Low ambient $NH_4^+$ concentrations limited $NH_4^+$ uptake (U) in two streams. In one stream, when ambient $NO_3^-$ concentrations increased during summer, $NO_3^-$ $V_f$ decreased. Temporal patterns of SRP $V_f$ varied among streams, but were unrelated to variability in ambient SRP concentration. However, in all three streams, seasonal variation in SRP $V_f$ was strongly influenced by heterotrophic metabolism (as measured by community respiration; State Creek $r$ = 0.81, = 0.03; Shane Creek $r$ = 0.89, $p < 0.01$; Walton Creek $r$ = 0.91, $p < 0.01$). Although heterotrophic processes typically dominate in forested headwater streams, we found that variability in nutrient uptake among streams was also explained by variables related to autotrophic activity (i.e., proportion coverage of large inorganic substrata and gross primary production). We suggest that the unexpected influence of autotrophy in this study was a result of stream sampling frequency, which included winter and spring—seasons not typically sampled. Our study demonstrates that examining nutrient uptake across streams and during different seasons can provide insight into factors controlling nutrient uptake parameters.