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Deuterium as a food source tracer: Sensitivity to environmental water, lipid content, and hydrogen exchange

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Abstract

Hydrogen stable isotopes (δ^2H) are used for quantifying resources supporting food webs. However, application of δ^2H in mixing models requires; (1) correction for environmental water (ω) in consumer tissues, (2) consideration of differential fractionation among biochemical constituents, and (3) consideration of differential H-exchange among samples and standards. We present data and sensitivity analyses addressing each of these issues and provide recommendations for future isotope food web studies. First, we determined from field data that maximum ω for aquatic consumers averaged 0.23 ± 0.03, similar to the median ω from a survey of published values (0.22 ± 0.02). Resource use estimates based solely on δ^2H data were sensitive to the selected ω value. Second, to quantify the potential bias in bulk tissue analysis from differential tissue fractionation, we calculated the change in whole organism δ^2H before and after lipid extraction for 61 aquatic samples. The average change in consumers' δ^2H after lipid extraction was a positive shift of 11.8‰ relative to the pre-extraction value. This shift resulted in a minor change in resource use estimates when correcting for lipids. Finally, we evaluated the impact of correcting for H-exchange in samples using standards with dissimilar H-exchange portions. The impact of the correction factor for H-exchange on resource use estimates could be large if suitable standards are not used for comparison. From these analyses we conclude that despite these complicating factors, analysis of resource use is possible using whole organisms' δ^2H, especially in combination with cautionary sensitivity analysis.