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

Grace M. Wilkinson,*1 Jonathan J. Cole,2 Michael L. Pace1
1Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia
2Cary Institute of Ecosystem Studies, Millbrook, New York

Abstract

Hydrogen stable isotopes (δ2H) are used for quantifying resources supporting food webs. However, application of δ2H 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 δ2H 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 δ2H before and after lipid extraction for 61 aquatic samples. The average change in consumers’ δ2H 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’ δ2H, especially in combination with cautionary sensitivity analysis.