Using δ^2H and δ^{18}O in assessing evaporation and water residence time of lakes in EPA's National Lakes Assessment.

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Stable isotopes of water and organic material can be very useful in monitoring programs because stable isotopes integrate information about ecological processes and record this information. Most ecological processes of interest for water quality (i.e. denitrification) require significant time and effort to collect using traditional methods. Thus, measurements of these processes are often excluded from spatially extensive monitoring programs such as EPA's National Aquatic Resource Surveys. The stable isotopes contained in samples collected during brief monitoring visits can be used to elucidate some of these ecological processes of interest. We used the stable isotopes of water (δ^2H and δ^{18}O) and of aquatic insects (δ^{13}C and δ^{15}N) collected in the 2007 National Lakes Assessment to derive information on evaporation, water residence time, denitrification and methanogenesis. Here, we report on the results from the water stable isotopes. After chemical analysis, water samples were measured for δ^2H and δ^{18}O using a laser isotope system. Water isotopes for precipitation inputs were estimated using the spatially explicit models found at Waterisotopes.org. Lake water isotopes ranged from 5 to -20 for δ^{18}O and 20 to -135 for δ^2H with d-excess values (an indicator of evaporation) ranging from 13 to -43. Most lakes were more enriched than the local precipitation with dual-isotope slopes less than 8, indicating evaporation as the cause for this difference. While climate patterns across the USA drive some of the spatial patterns of evaporation in lakes, variation in lake water residence time is also a driver. Using d-excess and lake–precipitation differences as indices of evaporation, we rated lakes for high evaporation by comparing them to reference lakes within the same ecoregion. Interestingly, we found that highly-evaporated natural lakes were four times more likely to be in poor biological condition compared to less evaporated lakes, but evaporation was not correlated with biological condition in man-made lakes (i.e. reservoirs). We do not currently understand the mechanisms that would explain this correlation and it leads to some intriguing research directions for future research. Water isotopes will also be collected during the 2012 National Lake Assessment so that temporal trends can begin to be assessed.