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Compound-specific fatty acid $d^{13}C$ and $d^{2}H$ analysis: a new method for high-spatial-resolution tracking of origin and mobility

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Methods for identifying the origin, movement, and foraging areas of animals are essential for understanding ecosystem connectivity, nutrient flow, and other processes of trophic ecology. Telemetric or tagging tracking methods provide precise spatial coverage but are limited to larger-bodied specimens and require recovery. Stable H and C isotopes are increasingly used to track animal migration by linking the animal tissue's terrestrial or aquatic landscape-driven isotope patterns to their movement (e.g., isoscapes). However, compared to telemetric methods, the spatial resolution of bulk tissue stable isotope analyses (e.g., feather, muscle) is low (typically >100s km).

To overcome low spatial resolution isoscape limitations, we introduce a new method using specific tissue-based hydrogen and stable carbon isotopes of fatty acids ($d^{2}H_{FA}$ and $d^{13}C_{FA}$) obtained from fish liver, muscle, brain, and eyes for quantifying spatial site-specificity (16 sites) in a small-scale (30 x 30 km) sub-alpine river catchment area. Using linear discrimination analysis of compound-specific fatty acids dual-stable isotope values, 95 % of fish could be correctly assigned to their location of origin at a few km resolution. Compound-specific dual-isotope analysis of fatty acids has the potential to become a highly effective tool for better refining fine to large-scale movement and foraging areas of animals in combination with bulk tissue samples. Even finer spatial scale movement resolution is possible (e.g., at meter scale) with FA stable isotopes in aquatic systems to quantify the seasonal feeding depths of zooplankton in standing waters.