The use of strontium isotopes to unravel the life history of fish in California

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Laser ablation analysis of strontium isotope ratios ($^{87}Sr/^{86}Sr$) in fish otoliths (ear bones) is a powerful tool to determine life history patterns in both modern and archaeological samples. We applied this technique to a number of threatened and endangered fish species in the San Francisco Bay-Delta including Delta Smelt, Chinook Salmon, and White Sturgeon, covering the recent drought and flood periods. In addition, we investigated archaeological salmon otoliths to determine habitat use in the Estuary prior to the gold rush in the 1850s.

Our findings show that strontium isotope analysis add to our understanding of these fish species and that catch, tagging, and historical data often underestimate the complex life history strategies used by these fish. Combining our detailed life history reconstructions with environmental data (temperature, fresh-water outflow) can be used to investigate the underlying drivers and mechanisms, which in turn will help us to better inform water management and restoration efforts.

In addition to contributing to the ongoing ecological studies we investigated the use of other calcified fish tissues such as scales, spines, and fin rays to extract valuable chemical information as a non-lethal alternative to otolith extraction. However, unlike otoliths that are predominantly aragonite, these tissues are comprised of biological apatite, complicating their analysis using laser-ablation. Using experimental validation studies, we developed an analytical protocol to overcome these constraints, providing a powerful new tool to reconstruct life histories and origins of fish. These method developments also have direct implications for the use of other bioapatite samples, such as teeth and bones, for archaeological and forensic studies.