Thermal resilience of Delta Smelt: What can we learn from otoliths?

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The Sacramento-San Joaquin Bay-Delta forms a vital link in California's water supply and is managed for both human use as well as for several species of threatened and endangered fish, causing significant conflict over limited freshwater resources. The endangered Delta Smelt (*Hypomesus transpacificus*) is at the center of this conflict and its abundance levels are at an all-time low. Generally, high freshwater outflow years provide benefits for many estuarine species, including Delta Smelt. However, not all high outflow years produce higher abundance for Delta Smelt, indicating that other factors may be limiting abundance and complicating predictions of the effects of freshwater outflow management.

Otoliths (tiny bones in the inner ear of fish) provide a life-long archive of physiological and environmental conditions that a fish has experienced. Studies using otoliths in combination with extensive monitoring surveys have shown that Delta Smelt exhibit a diverse life history termed partial migration, which includes migratory, freshwater resident, and brackish-water phenotypes. Historically, this has allowed Delta Smelt to persist in the dynamic habitat of the Delta by spreading the risk of catastrophic mortality between multiple habitats. Here we use oxygen isotope ratios ($\delta^{18}O$) from archived, wild-caught Delta Smelt otoliths to reconstruct their thermal life history. As a first step, we calibrate the $\delta^{18}O$ temperature-dependent fractionation and validate the reconstruction of ambient water temperature from otolith $\delta^{18}O$ using Delta Smelt from lab experiments carried out at UC Davis. This tool will allow us to investigate the relationship between Delta Smelt abundance and water temperature. Understanding this relationship can give new insights into resilience and habitat utilization of Delta Smelt in the face of warming water temperatures during extensive drought periods and long-term climate change, which in turn will allow state agencies to better manage the limited water resources of California for both fish and people.