Isoscapes in a dynamic system: Advancing tools to reconstruct salinity and temperature life histories of fishes in the San Francisco Estuary

Malte Willmes[1], Christina Parker[1], Alyssa Baldo[1], Levi S. Lewis[1], Christian Denney[1], Randall Baxter[2], Louise Conrad[3], Carol Kendall[4], James A. Hobbs[1]

[1] Wildlife, Fish and Conservation Biology, UC Davis, mwillmes@ucdavis.edu

[2] California Department of Fish and Wildlife, Randy.Baxter@wildlife.ca.gov

[3] Delta Science Program, Louise.Conrad@deltacouncil.ca.gov

[4] United States Geological Survey, ckendall@usgs.gov

Understanding how estuarine and migratory fish, such as Delta and Longfin Smelt, Chinook Salmon, and White Sturgeon utilize the San Francisco Estuary (SFE) is critical for effective management and conservation. Otoliths (fish ear bones) accrete continuously throughout the life of a fish and thus provide a record of age, growth, and environmental conditions. Strontium ($^{87}Sr/^{86}Sr$) and oxygen isotopes ($\delta^{18}O$) measured in otoliths can be used to reconstruct the life history and habitat utilization of fish, if the isotopic compositions can be related to changes in salinity and temperature in the environment.

In the dynamic San Francisco Estuary, the isotopic composition of the water reflects complex processes driven by the mixing of freshwater inputs, mainly from the Sacramento and San Joaquin rivers, and the Pacific Ocean. To understand these processes in more detail, we collected water samples in 2018 across the entire spatial extent of the SFE, capturing a large range of salinity and water temperature combinations. Environmental strontium isotope ratios vary among different geologic regions and provide a robust proxy for salinity from freshwater to low salinity (<6-8 psu). Oxygen isotope ratios vary as a function of water source and evaporation, and show a strong correlation with salinity across a large geographic gradient from 4-32 psu. The combination of both isotope systems can be used to estimate salinity habitats of fish in the entire SFE (0-32 psu). In addition, $\delta^{18}O$ in otoliths can be used to reconstruct ambient water temperature if salinity can be estimated independently. The results of our isotope mixing models will be evaluated over the next year and will be used to predict salinity and temperature habitat for fish utilizing the dynamic estuary.