New Insights into the Complex Life History of Delta Smelt from Otolith Microchemistry

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The endangered Delta Smelt (*Hypomesus transpacificus*) is a small, endemic fish of the tidal San Francisco Estuary and is nearing extinction in the wild. This highly altered estuary is managed for human use as well as for several species of threatened and endangered fish and the Delta Smelt is at the center of conflict over the use of the limited water resources. Extensive studies have shown that Delta Smelt exhibit a diverse life history with both resident and migratory contingents within a genetically homogenous population, however the details of this life history remain unclear. Otoliths (fish ear bones) provide a powerful tool to investigate the life history of individual fish. They consist of calcium carbonate and accrete continuously, providing a life-long archive of physiological and environmental conditions that a fish has experienced.

Here we used strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) isotope tracers from Delta Smelt otoliths to reconstruct life history and thermal resilience at fine temporal scales. $^{87}Sr/^{86}Sr$ ratios can be used to reconstruct salinity habitats, while $\delta^{18}O$ reflects the water temperature. However, $\delta^{18}O$ in otoliths is also influenced by the ambient water $\delta^{18}O$ and species dependent isotope fractionation. Consequently, as a first step we calibrated 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 with known temperature history. This new method is then applied to wild-caught Delta Smelt for which salinity habitat reconstructions based on $^{87}Sr/^{86}Sr$ have already been established.

The combination of these two isotopic tracers will allow us to investigate the relationship between Delta Smelt life history, abundance, freshwater outflow 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 prolonged drought periods and long-term climate change.