Life-history diversity and the enigmatic relationship between freshwater outflow and the population dynamics of Delta Smelt

Malte Willmes[1], Eva Bush[1], Levi S. Lewis[1], James Hobbs[1]

[1] Wildlife, Fish and Conservation Biology, UC Davis, One Shields Avenue, Davis, CA 95616. mwillmes@ucdavis.edu, eebush@ucdavis.edu, lslewis@ucdavis.edu, jahobbs@ucdavis.edu

Delta Smelt (*Hypomesus transpacificus*) exhibit a life history strategy termed partial migration, which consists of migratory, fresh-water resident, and brackish-water phenotypes. These diverse life-history strategies allow Delta Smelt to persist in the dynamic habitat of the Delta by spreading the risk of catastrophic mortality between multiple habitats. Generally, high freshwater outflow years provide positive benefits for many estuarine species, including Delta Smelt. However, not all high outflow years (e.g., 2006) produce higher abundance for Delta Smelt, indicating that other factors may be limiting abundance and complicating predictions of the effects of fresh water outflow management.

Otoliths (ear bones) provide a life-long archive of physiological (growth) and environmental conditions (chemistry) that a fish has experienced and thus can be used to reconstruct complex life history patterns. Otolith strontium isotopic analysis from Delta Smelt year classes 2005-2006 and 2010-2014 revealed that the relative abundances of each phenotype varies inter-annually. The migratory phenotype contributes most (~70%) to the overall population, while the freshwater resident phenotype was important (up to 40%) in cooler years. Brackish-water residents contributed little to the population in most years, but were more important (23%) in 2006, the year with the highest spring outflow and high water temperatures. Thus, the migratory contingent provided population resilience, while the fresh-water and brackish-water contingents supported population stability, during different climate conditions. Last, we found a negative relationship between the relative abundance of the fresh-water resident phenotype and water temperature (even for wet years), suggesting that warmer summers may limit recruitment success of this contingent. The complex interplay between life history diversity and climate variability may explain the variable population level responses of Delta Smelt to fresh-water outflow.