Differences in Salinity Tolerance in Two populations of Sacramento Splittail

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Differences in physiological responses to environmental stressors between populations of fishes may be attributed to phenotypic plasticity and/or genetic differences associated with local adaptation. Using a common-garden experimental design, we examined the effects of salt water on two populations of wild-caught Sacramento splittail (*Pogonichthys macrolepidotus*), the Central Valley population and the San Pablo population. Previous work suggests that the San Pablo population is relatively tolerant to salt water while the Central Valley population is more sensitive. We observed higher mortality in the Central Valley population after 7 d exposure to 16 ppt salt water compared with no mortality in the San Pablo population. Additionally, the Central Valley population showed evidence of osmoregulatory disturbance after 7 d of exposure to 14 ppt salt water relative to the San Pablo population. We then used RNA-sequencing to compare the cellular responses in both populations after exposure for 72 hrs and 168 hrs to 14 ppt salt water. We compared these responses to a fresh water control group for each population. We found evidence of a conserved general response to salt water in the two populations suggestive of phenotypic plasticity. We also found distinct differences in the gene expression profiles with the saltwater tolerant population upregulating the expression of genes involved in ion regulatory mechanisms and gill tissue remodeling at 168 hrs suggesting an enhanced ability to acclimate to higher salinities, patterns not observed in the saltwater sensitive population. These differences in the cellular response to salinity, in addition to genetic variation between the populations, suggest that the populations have adapted to their local environmental conditions. Understanding how populations respond to environmental conditions is critical for the conservation of native species in California.

Keywords: fish, salinity, intraspecific variation, splittail
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The Highs and Lows of Twenty Years of Juvenile Winter-run Chinook Salmon Abundance Monitoring at Red Bluff Diversion Dam

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Quantitative assessments of juvenile Chinook salmon passage and estimates of fry production using rotary traps have been conducted at the Red Bluff Diversion Dam by the US Fish and Wildlife Service since 1995. Four runs of Chinook salmon spawn upstream of this sample site in various subwatersheds and at very different levels of abundance. Endangered winter-run Chinook salmon spawn exclusively in the mainstem Sacramento River upstream of Red Bluff Diversion Dam and our monitoring work has, and continues to be, of great importance for evaluating the effects of fishery and water management actions as well as ecological fluctuations. Trends in juvenile winter-run Chinook abundance, estimates of egg-to-fry survival rates, and comparisons to adult spawner abundance estimates will be presented highlighting the variability observed over twenty years of fish monitoring at the Red Bluff Diversion Dam. Declines in juvenile winter-run Chinook production estimates during a period of increasing adult returns in recent low water runoff years will be discussed with potential explanatory environmental and biological variables.

Keywords: Chinook, salmon, drought, monitoring, rotary traps, management
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Life on the Edge: Temperature and Flow Restrict Steelhead Productivity in a Large Central Valley, California River

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Steelhead trout (*Oncorhynchus mykiss*) are native to the American River in California's Central Valley, but are restricted to the lowermost 37 km of the river below Folsom Dam. The lower American River provides a limited amount of moderate gradient habitat for steelhead spawning and rearing, the quality of which is mediated by flow. Potentially a more critical limitation to steelhead production is water temperature above the optimum for juvenile steelhead during the summer-to-early-fall rearing period. California Department of Fish and Wildlife (CDFW) has worked with U.S. Bureau of Reclamation and other collaborators since 2001 on specific questions regarding steelhead oversummering relative to temperature, flow, and other manageable habitat attributes on the American River. The objectives of this work are to measure changes in distribution, relative abundance, growth, and condition of juvenile steelhead in response to temperature and flow conditions over time. Associated hypotheses are that as temperature becomes supraoptimal: steelhead distribution downstream from Folsom Dam will become more restricted; growth and condition of steelhead will decrease; and, consequently, steelhead relative abundance will decrease. Results to date suggest high site fidelity of juvenile steelhead such that no upstream shift in distribution occurs in response to worsening thermal conditions. As predicted under extreme drought conditions (2014-2015), results indicate reduced spawning and rearing distribution in downstream habitat areas previously supporting these functions, and lower juvenile steelhead abundance was evidenced through low catch rates and loss of steelhead at specific sites over a season. Unexpectedly, juvenile steelhead condition remained high, and we hypothesize that the effect of low steelhead abundance, by reducing density-dependent effects on individual growth, may have been more influential on steelhead condition than temperature. These results demonstrate threshold ecosystem conditions at which the lower American River no longer provides suitable flow and thermal conditions for natural steelhead production.

Keywords: Steelhead trout, American River, temperature, flow
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Larval Fish Assemblage Structure and Prey Availability in Liberty Island

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Liberty Island is a restoring (levee breached) wetland in the northern Delta that demonstrates potential processes and outcomes of tidal freshwater restoration. It provides important habitat for native species and is occupied by larval Delta Smelt, Longfin Smelt, and Sacramento Splittail when they occupy brackish and tidal freshwater regions of the northern Delta. However, the extent to which vegetation colonization, habitat complexity, habitat patchiness and landscape position influences larval fish assemblages, their prey resources, and food web support is largely unknown. From February to June of 2015, we focused on the dichotomy between open water and vegetated marsh habitats in Liberty Island and the greater Cache Slough Complex. Our goals were to establish the temporal and spatial structure of larval fish assemblages in these contrasting habitats and determine the prey availability and selection of larval fish species in flooded shallow water habitats, tidal marsh channels, and submerged aquatic vegetation. Emerging results indicated that under the severe drought conditions in 2015, the larval fish assemblage in Liberty Island was largely composed of nonnative species (80%). Diets among all species analyzed showed little variability in prey selection and were dominated by *Pseudodiaptomus forbesi*. We will present how the larval fish assemblage structure differed between vegetated and non-vegetated habitats and whether prey availability explained the variation in assemblage structure relative to abiotic variables in Liberty Island and the greater Cache Slough Complex. This study will advance our understanding about how complex estuarine landscapes, and particularly restoring wetlands, support ecologically sensitive organisms in the Cache Slough Complex.

Keywords: Liberty Island, larval fish, food web, abundance, abiotic
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Physics to Fish: Linking Stationary and Dynamic Habitat Features to Small-Scale Fish Distribution in the Sacramento-San Joaquin Delta

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A better understanding of the processes influencing the distribution and movements of fishes, such as the endangered Delta Smelt, is needed to guide water project operations to improve water supply reliability while conserving imperiled species. This information is especially needed as drought conditions and very low Delta Smelt population abundances interact to limit operational flexibility and water deliveries. Here, we report on interdisciplinary studies linking stationary (i.e., bathymetry and channel junctions and configuration) and dynamic (i.e., hydrodynamics, water quality, food availability) habitat features to small-scale (within site) fish distribution in the Sacramento-San Joaquin Delta. High frequency physical and biological sampling in the San Joaquin River at its junction with False River has been conducted to learn how habitat features drive the vertical and lateral distribution of small pelagic fishes and their movements through channel junctions, the configurations of which may have important implications for movement into unfavorable habitats.

Keywords: fish, hydrodynamics, habitat, delta smelt, smeltcam
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