Foodweb support for the threatened delta smelt and other estuarine fishes in Suisun Bay and the western Sacramento−San Joaquin Delta

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This project addresses two distinct but related topics:

1. Foodweb support for the threatened delta smelt, and
2. Potential mechanisms underlying relationships of abundance or survival of some fish to freshwater flow

These two topics are related through the productivity of the foodweb of the estuarine Low-Salinity Zone (LSZ) or oligohaline zone. This region, which encompasses a salinity of ca. 0.5 – 6 psu, is a key region of the estuary and the rearing area for numerous estuarine-dependent fishes.

Topic 1: The threatened delta smelt (*Hypomesus transpacificus*) is now the principal species of concern for management of freshwater flow and diversions in the Sacramento-San Joaquin Delta, and the principal target for restoration in the upper San Francisco Estuary. The abundance of this federally-listed threatened species has been low since the early 1980s, and it has not recovered to the point where it can be considered for delisting; indeed, the 2005 abundance index was the lowest on record. Potential reasons for its low abundance are many, but evidence points to the direct and indirect effects of export pumping of freshwater in the south Delta, toxic substances, and low food supply as likely contributing factors. We believe that the feeding environment of delta smelt may be implicated in the continued low abundance of this species. Delta smelt feed for their entire lives on zooplankton, principally copepods, mainly in the brackish waters of the western Delta and Suisun Bay, and copepod abundance is depressed in this region.

Topic 2: Previous work on the responses of the estuarine ecosystem to interannual variation in freshwater flow has demonstrated a decoupling between the abundance of lower trophic levels and that of fish and shrimp (Kimmerer 2002a, b, 2004). This decoupling may imply that variability in foodweb support is unimportant to variability of higher trophic levels, but there are some important pieces missing from the puzzle. Chief among these is the fact that the supply of labile organic matter from freshwater to the LSZ varies with freshwater flow, and this flux has not been accounted for in analyses of the estuarine foodweb.

Our research project is aimed at understanding and possibly improving the foodweb supporting delta smelt and other estuarine species. *This project will address the following key questions regarding this foodweb, focusing on the Low-Salinity Zone of the northern estuary:*

1. How do benthic grazing, available solar irradiance, and the concentrations of and composition of nitrogenous nutrients interact to influence the species composition and production of phytoplankton?

2. How does bacterial production respond to changes in particulate and dissolved organic carbon (POC & DOC) delivered primarily through river flow?
3. What is the role of the microbial foodweb in supporting higher trophic levels?
4. To what extent is copepod production dependent on these alternative energetic pathways (phytoplankton and bacterial production)?

We will try to answer the following questions:

1. *To what extent is abundance and biomass of phytoplankton, particularly diatoms, controlled by benthic grazing, light limitation, salinity stress, or nutrient composition in the LSZ?* It has seemed clear since 1988 that benthic grazing was having an overwhelming effect on phytoplankton in Suisun Bay, particularly given the low growth rates possible in that turbid water. However, it is not clear whether clams have the filtration capacity to suppress the development of blooms during all seasons We do not anticipate an "either-or" answer to this question; rather, we propose to determine the relative importance of these two mechanisms and examine their inter-dependence.

2. *What is the relative importance of each of the alternative trophic pathways in Figure 1?* This question is of very broad interest among aquatic scientists. We have a good chance of answering it here for several reasons. The first is the extensive background information available on the northern estuary, from which we can draw general information as well as specifics. The second is the intensive, ongoing monitoring programs run by the Interagency Ecological Program and the USGS. The third is our study design, which includes all of the key elements of the foodweb, and will allow us to measure the relevant material fluxes on samples from the same water body at the same time.