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Food Quantity and Quality for Zooplankton in the Sacramento-San Joaquin Delta

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This article is part of a series of articles describing the components of a new CALFED-supported, collaborative study of the Sacramento-San Joaquin Delta's foodweb base (see Cloern 1999).

The Sacramento-San Joaquin Delta estuary (hereafter: the Delta) with its great diversity of habitats is home to a wide variety of primary producers including algae, aquatic plants, and riparian vegetation. These primary producers, as well as organic matter brought into the Delta from the surrounding watersheds, provide the food resource for higher-order producers such as aquatic invertebrates and fish. Growth and reproduction of these consumers as well as trophic transfer efficiency in the Delta food web depend to a large degree on the quantity and quality of the available food. Due to the diversity of habitats and primary producers in the Delta, the quantity and quality of food available to consumers is likely to vary greatly.

A direct way to assess food quantity and quality is to measure the growth and reproductive rates of consumers reared on food taken from natural habitats. In our study we feed food particles present in water taken from several Delta habitats to zooplankton. The habitats include river, marsh, floodplain, and flooded island sites and are sampled several times per year. Currently we are conducting these feeding studies with laboratory cultures of the filter-feeding cladoceran *Daphnia pulex*. Due to their rapid asexual reproduction and non-selective feeding behavior, these organisms are well suited to our feeding experiments. We also intend to conduct feeding experiments with calanoid copepods, which are often very abundant in the Delta and an important food resource for fish.

Feeding experiments similar to ours have previously been used in nutritional studies of freshwater cladocerans (Müller-Navarra 1995) and estuarine copepods (Jónasdóttir and Kiorboe 1996). Results from these and other recent studies have shown the concentration of several essential fatty acids as well as elemental ratios (particularly the carbon to phosphorus ratio) in food particles to be strongly correlated with zooplankton production. We are quantifying these and other food and habitat characteristics in cooperation with researchers involved in the larger group project (Cloern 1999; Canuel 1999). To gain further insight into the nature of the food resources utilized by Delta zooplankton, we are also measuring essential fatty acid concentrations and elemental and isotopic ratios in zooplankton collected from our study sites.

The strength and uniqueness of our approach lies in combining the direct assessment of food quality and quantity through feeding experiments with more indirect assessments utilizing numerous field measurements. Results obtained from this study will contribute to a greater understanding of nutritional habitat quality for higher-order producers in general, and for Delta consumers in particular. We also expect to better understand spatial and temporal variability of food quality and quantity for Delta zooplankton. For example, initial results suggest that when flooded, the Yolo Bypass may be a more productive habitat for zooplankton than the Sacramento River, and thus provide richer feeding grounds for young fish. Findings from our study will provide information critical to policymakers and agencies responsible for management of the Delta and its resources.

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Delta Smelt Concerns Result in Changes in SWP and CVP Operations

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State and federal export facility operations were modified in May and June in response to concerns over the distribution and high salvage of delta smelt at the SWP and CVP Delta pumping facilities. Since we have no direct measure of delta smelt losses at these facilities we use salvage of delta smelt as a surrogate for "take." 1999 was an above-normal (San Joaquin Basin) to wet (Sacramento Basin) water year (DWR 1999), but the distribution of young-of-year (YOY) delta smelt was more typical of a dry year hydrology with a greater proportion of the population remaining in the Delta through spring and early summer. It is uncertain why delta smelt remained in the Delta for so long this year, but water temperature may have been an important factor (Dale Sweetnam, personal communication).

Delta smelt spawn in areas of fresh water under tidal influence. In dryer years, spawning is often concentrated on the Sacramento River side of the Delta, especially in the Cache Slough area. In wetter years, spawning is widespread and can occur as far west as the Napa River, as it did this year. Similar to 1997, a large YOY delta smelt population in the central Delta resulted in higher take at the SWP and CVP facilities. The elevated take levels were surprising since this year's Delta hydrograph showed a similar pattern to 1996 (Figure 1). Delta exports were considerably higher in late May and June 1996 than they have been this year, yet delta smelt salvage in 1996 was less than half of the 1999 levels (Figure 2).

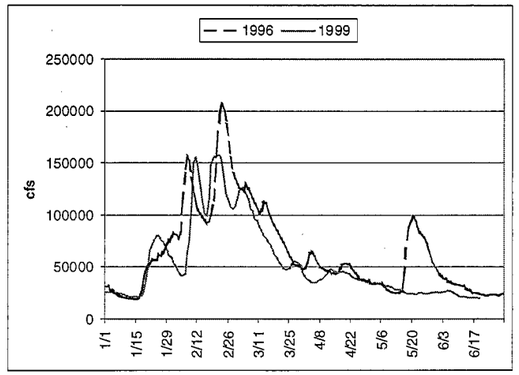

Figure 1 Delta inflow in 1996 and 1999

The US Fish and Wildlife Service biological opinion dealing with the effects of SWP and CVP operations on delta smelt uses two levels of combined SWP and CVP delta smelt salvage as triggers to initiate actions to reduce water project impacts on delta smelt. These thresholds include the following:

- The 14-day running average of combined delta smelt salvage, commonly referred to as the yellow light level.
- The cumulative total of combined salvage for each month, commonly referred to as the red light level.

The red light level is based on historical salvage data and varies among months and among water year types. For example, in an above-normal water year (like 1999) the red light level ranges from 733 fish in December to 11,990 fish in October. Monthly red light levels for below-normal water years are generally higher than for above-normal water years.