Feast or Famine: Fish Food in the Upper San Francisco Estuary

April Hennessy (april.hennessy@wildlife.ca.gov), Danae Jordan (danae.jordan@wildlife.ca.gov), Tina Enderlein (tina.enderlein@wildlife.ca.gov)
California Department of Fish and Wildlife, Stockton, California

Introduction

- Zooplankton are small aquatic invertebrates that provide an important trophic link between primary producers and fish.
- To assess trends in fish food resources in the upper San Francisco Estuary (SFE), the Interagency Ecological Program's Zooplankton Study provides annual zooplankton abundance estimates.
- The objective of the State of the Estuary Report is to evaluate the status and trends of indicators of estuarine health. Zooplankton are an important part of the ecosystem processes that sustain the pelagic food web and were included in the report to evaluate the health of the food web in the upper SFE.
- Calanoid copepods and mysids are crustaceans that were chosen for the zooplankton indicator because they are important food items for pelagic fish, including Delta Smelt and Longfin Smelt, two listed fish species in the upper SFE.

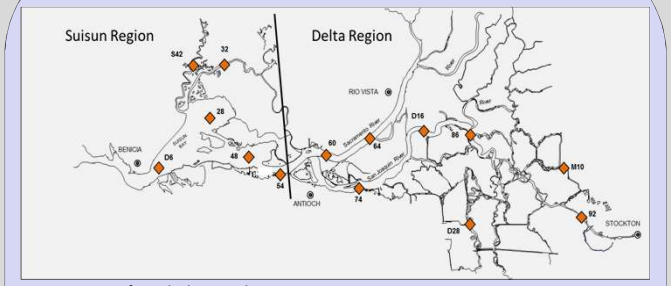
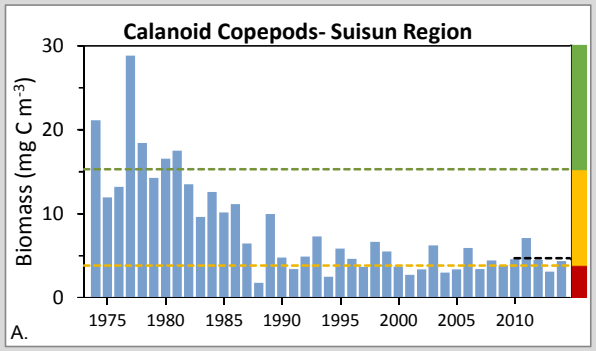


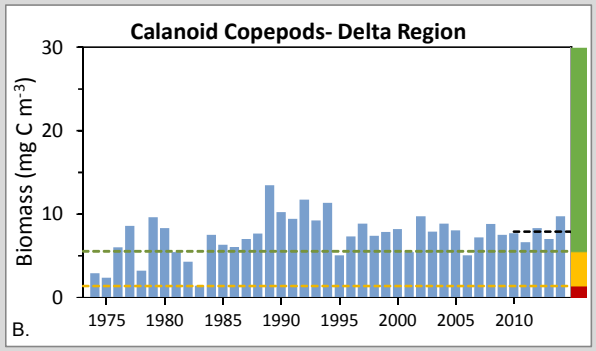
Figure 1. Map of Zooplankton Study stations

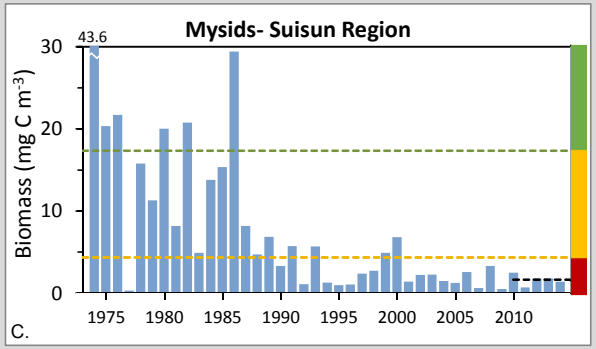
Methods

- The California Department of Fish and Wildlife's Zooplankton Study consistently sampled zooplankton monthly at 14 fixed stations in the Suisun and Delta regions from 1974 through 2014, these stations were used to evaluate the status and trend of this indicator (Figure 1).
- Average annual biomass, which is indicative of available carbon, of calanoid copepods and mysids was calculated using March through November data.
- The benchmark for each taxa and region was determined from the 1974-1986 mean biomass, before the disturbance caused by the introduction of *Potamocorbula amurensis*. At or above this benchmark was considered "good", down to 25% of this benchmark was considered "fair", and below 25% of this benchmark was considered "poor".
- The trend over time was determined by a linear slope of the annual data, and the significance of this slope was determined by a Mann-Kendall test (p<0.005 was considered significant).

Acknowledgements-
We would like to thank the DWR-EMP field crew for collecting samples (Nicholas VanArk, Scott Waller, Eric Santos), Sally Skelton (CDFW) for processing hundreds of thousands of mysids throughout the years, Tricia Bippus (CDFW) for taking beautiful photos for us, and Steven Slater (CDFW) for providing helpful comments.







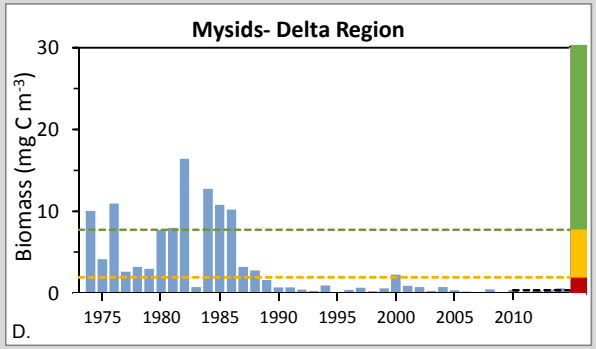
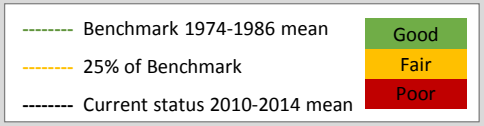


Figure 2. Annual mean March-November biomass in milligrams of Carbon per cubic meter of water sampled for calanoid copepods in the Suisun Region (A) and the Delta Region (B), and mysids in the Suisun Region (C) and Delta Region (D) for 1974-2014.



Results

- Calanoid copepod biomass declined significantly from 1974-2014 in the Suisun region (p<0.001) and the current status of calanoid copepods in this region is "fair" (Figure 2A).
- Calanoid copepod biomass increased significantly from 1974-2014 in the Delta region (p=0.0047) and the current status of calanoid copepods in the Delta region is "good" (Figure 2B).
- Mysid biomass declined significantly from 1974-2014 in both regions (p<0.001 in both regions), and the current status for both regions is "poor" (Figures 2C and 2D).

Discussion

- Mysids have declined in both the Suisun and Delta regions since monitoring began, and the current status of this important fish food resource in both regions is "poor". This has been attributed in part to food limitation caused by competition with *P. amurensis* for phytoplankton.
- In the Suisun region, calanoid copepods have declined since monitoring began and the current status is at the low end of "fair". In the Delta region calanoid copepod biomass has increased and the current status is "good", although remains much lower than it was historically in the Suisun region. Most of this increase was also driven by the introduced copepod *Pseudodiaptomus forbesi*, that although a good quality fish food, peaks during the summer in the eastern Delta where temperatures are usually too warm for small native fish to take advantage of this food resource.
- The food web of the upper SFE has been highly altered by the introduction of non-native invasive species, particularly the clam *P. amurensis*. The resultant zooplankton decline in the low salinity zone near Suisun has been implicated as one of the many causes of the pelagic organism decline (POD) which described the dramatic decline of several pelagic fish species.
- Recovery of listed fish species such as the Delta Smelt and Longfin Smelt relies in part on food availability.