



CALFED Progress Report
California Sea Grant College Program

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Project Information

ProjectNo_2C R/SF-36 StartDate_3a 10/1/2008 EndDate_3b 9/30/2010
 ProjectTitle_4 Plankton Dynamics in the Sacramento-San Joaquin Delta: Long-term Trends and Trophic Interactions

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 CALFED

Project Objectives: Please type your responses, and answer the questions in a style appropriate for laymen.

ProjectObjectives_10

Primary consumers (zooplankton) are a critical trophic link for energy transfer to upper trophic levels and a key food source for threatened and endangered fish species in the Delta. Yet long-term trends and patterns for zooplankton and mechanisms that regulate their abundances remain largely unstudied despite the fact that the importance of food availability for fish has been recognized as one potential major component for the observed fish declines and a taxonomically-rich historical plankton data set exists. The proposed research aimed to identify spatial and temporal plankton variability and biotic interactions by quantitatively analyzing the long-term database from the Delta, which has a 33-year record related to the planktonic food web along with complementary environmental data.

The proposed project addresses the following objectives:

- (1) Identification of long-term spatial and temporal patterns in zooplankton
- (2) Identifying long-term interactions between primary producers and zooplankton
- (3) Identification of biotic interactions in the plankton community

We proposed that through integrating plankton variability into the management and restoration plan for the Delta, the dynamics of the ecosystem can be viewed from a new perspective.

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

Objective (1) Identification of long-term spatial and temporal patterns in zooplankton

To date the zooplankton abundance and mysids data from 1972 to 2008 have been converted to carbon biomass and the long-term dynamics described for major taxonomic groups and for individual genera/species. In addition, long-term trend of average zooplankton size and mysids has been calculated. Principal component analysis suggested a separation into two subregions - an upstream freshwater and a downstream mesohaline region. Statistical trend statistics were calculated for each taxon and group. In addition we focused on biomass changes before and after the POD decline.

Zooplankton community in the Delta was strongly characterized by major species shifts associated with the establishment of invasive species and biomass declines. This part of the project is conducted in collaboration with Alan Jassby and is currently being finalized and considered for submission at Estuaries and Coasts.

Objective (2) Identifying long-term interactions between primary producers and zooplankton

Owing to poor phytoplankton data quality, we decided to focus on other aspects of the long-term data. However, we are investigating long-term interactions between chlorophyll and zooplankton dynamics in the Delta.

Objective (3) Identification of biotic interactions in the plankton community

We analyzed long-term trends of zooplankton and mysids in concert with flow rates, salinity, and chlorophyll concentration. A conceptual food-web model including plankton-fish interactions is included in the paper that addresses objective (1) (see above). In addition, we examined changes in total biomass, community composition and size structure in different regions of the Delta, all of which we used to infer changes in the food supply to higher trophic levels, including the pelagic fishes currently at risk. We intend to describe long-term zooplankton interactions in more detail using statistical modelling.

A remarkable feature of the Delta was the introduction of invasive zooplankton and mysids species during prolonged drought period or extreme water years. Currently, we investigate this aspect in more detail and address the hypothesis that prolonged climate shifts may open a window for non-indigenous species to establish and eventually displace the local fauna. We are in progress to analyze the data and in writing the manuscript.

I also participated in an NCEAS working group that focused on the 'Interactions between the near coastal ocean and the San Francisco Estuary, California, USA'. We are in the process of finalizing a manuscript of this study using long-term trawl data.

from the San Francisco Bay.

PROJECT MODIFICATIONS: Please explain any substantial modifications in research plans, including new directions pursued. Describe major problems encountered, especially problems with experimental protocols and how they were resolved. Describe any ancillary research topics developed.

Modifications_12

We decided to modify the following parts of the proposed project owing to data quality and the stop work order:

a) Proposed objective (2) was modified owing to the poor quality of the long-term phytoplankton data. Because long-term quantitative phytoplankton data from the Delta are not available, we decided that a quantitative plankton modeling approach is not meaningful to pursue in more detail. However we concentrated on chlorophyll-zooplankton interactions instead.

b) At the time of the work stop order I was invited to contribute to a special issue on 'Phenology in Ecology and Evolution' for the Philosophical Transactions B. As I was not able to work with the Delta long-term data at that time, I decided to focus on a global analysis on phytoplankton annual cycles. This study was conducted in collaboration with Jim Cloern, one of my community mentor. We compiled long-term chlorophyll data from lake, estuarine-coast, and open ocean systems and applied wavelet analysis to extract the dominant periodicity and recurrence strength of annual phytoplankton cycles. This paper is currently in final revision at Philosophical Transactions B.

BENEFITS AND APPLICATIONS: Suggest the relevance of these new findings to management. Describe any accomplishment, that is significant effects your project has had on resource management or user group behavior. CALFED is looking for "management cue" (see <http://science.calwater.ca.gov/pdf/soemgmtcues.pdf>).

BenefitsApplic_13

to our knowledge this is the first project that describes long-term zooplankton trajectories in terms of carbon available for higher trophic levels. Consequently, these findings will be of importance to understand to what extent change in food supply for fish affected the long-term and more recent declines of many pelagic fish species.

While the long-term decline of diverse fisheries in the Delta coincided with reduced primary and secondary production, our analysis showed that the sudden drop of many pelagic fishes around 2000 was not accompanied by an equivalent decrease in quantity of zooplankton carbon. Substantial zooplankton and mysids declines occurred in the mid to late 1980s, and biomass of both taxonomic groups remained at a consistent low level from 1995–2001 to 2002–2008. This suggests that changing prey quantity was not a dominant factor contributing to the recent fish declines. However, it is expected that a combined effect of low food supply and changing prey conditions, resulting from zooplankton taxonomic shifts enhanced food limitations for higher trophic levels.

PUBLICATIONS: List any publications, presentations, or posters that have resulted from this funded research. Give as many details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and CALFED Science Conference during the duration of the fellowship.

Publications 14

Winder M, Cloern JE (in final review). The annual cycles of phytoplankton biomass. Transactions of the Royal Society B.

Winder M, Jassby AD (in prep) Zooplankton dynamics in the upper San Francisco Estuary: Long-term trends and food web implications. To be submitted to Estuaries and Coasts. This paper will be submitted within the next few weeks.

Cloern JE, Di Lorenzo M, Hieb K, Jacobson T, Jassby A, Lagier J, Meiring W, Peterson W, Powell Z, Sanso B, Stacey, Winder M. (in prep) Biological Communities in San Francisco Bay Track North Pacific Gyre Oscillations.

Conferences:

Winder M, Cloern J: Does the terrestrial phenological concept apply in water? CERF 2009, Portland. Oral Presentation.

Winder M, Cloern J: Does the terrestrial phenological concept apply in water? Aquashift workshop, IFM-GEOMAR, Kiel, Germany. Invited presentation.

Winder M, Jassby AD. Zooplankton dynamics in the upper San Francisco Estuary: Long-term trends and food web implications. ALSO, Santa Fe, June 2010. (upcoming).

Winder M, Jassby AD. Shifts in zooplankton community structure: implications for food-web processes in the San Francisco Estuary. Delta Science Conference, Sacramento, Sept 2010. (upcoming).
