Copepod Conundrum: Changing Community Composition and Abundance of Copepods in the Upper San Francisco Estuary

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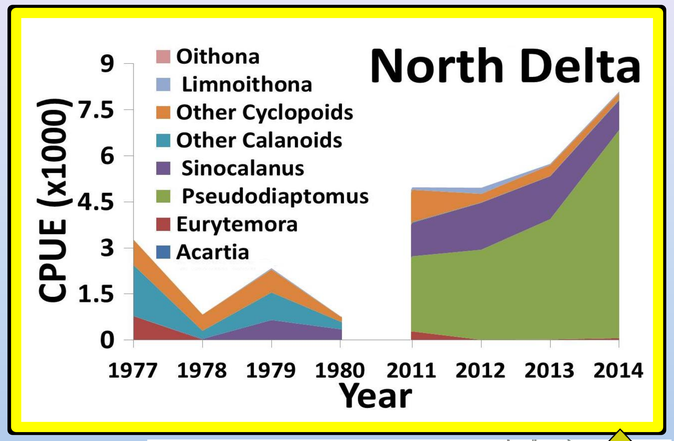
Introduction

- Copepods are an important component of the pelagic food web, providing a key trophic link between fish and phytoplankton in the upper San Francisco Estuary (SFE).
- Changes to their community composition and abundance have been linked to the decline of several fish species.[1]
- We updated trends in copepod abundance through 2014, in 3 sub-regions of the upper SFE: the Central Delta and Suisun regions, as well as the North Delta region, an area of relatively high fish presence.



Methods

Central Delta and Suisun Regions:

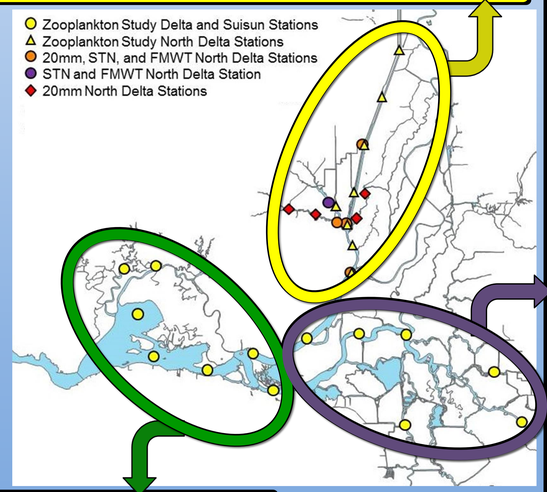
- Relative copepod abundances (CPUE: Catch Per Unit Effort) were obtained by the California Department of Fish and Wildlife's (CDFW) Zooplankton Study from 1972 to 2014.
- Pump data was used to estimate densities of smaller cyclopoids, *Limnoithona* and *Oithona,* and Clarke-Bumpus data (CB) was used for the remaining genera.

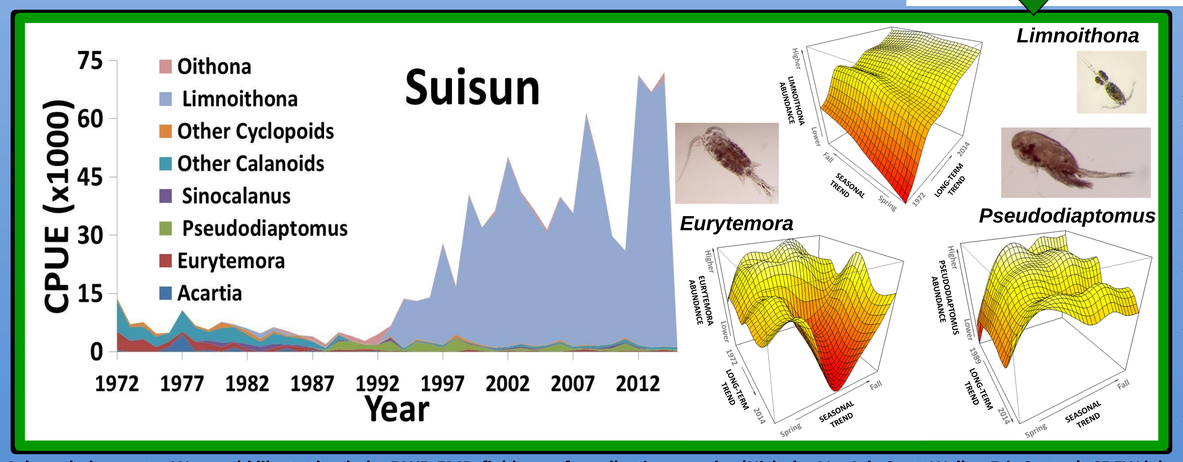
North Delta Region:

- Abundances from the Zooplankton Study were used for years 1977 to 1980; for 2011 to 2014, abundances came from the 20mm Study (March-May), Summer Townet Survey (STN,June-August), and Fall Midwater Trawl (FMWT,September-November).
- No pump data was collected from 2011 to 2014; only CB data (which underrepresents smaller cyclopoids, *Limnoithona* and *Oithona*) was used.

Analysis:

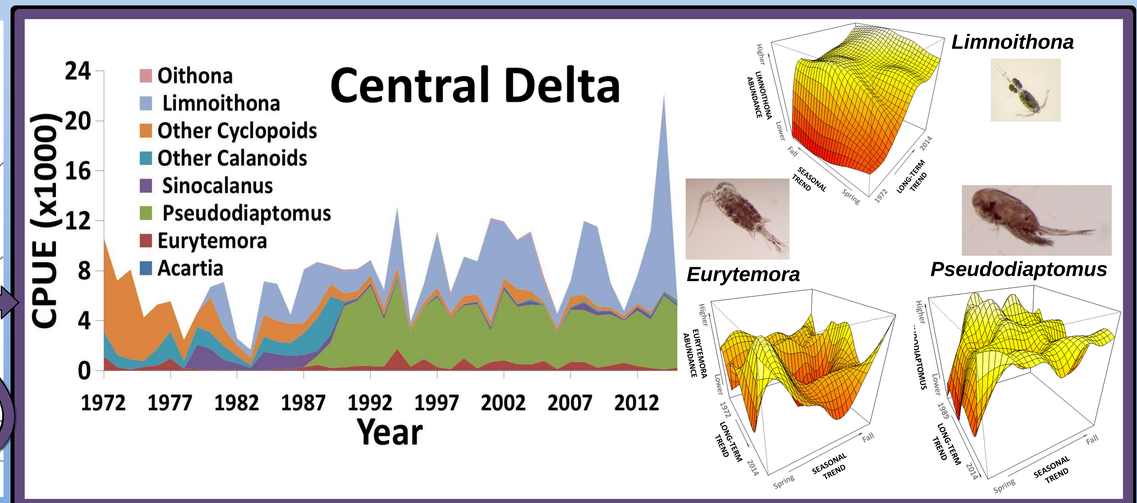
- For each genus, adult and juvenile CPUE were summed by station and monthly station means were used to calculate annual means for each region.
- Long-term and seasonal changes in abundance of the calanoids *Eurytemora* and *Pseudodiaptomus*, and the cyclopoid *Limnoithona* were assessed using generalized additive models.





Results

- The Suisun region now has the highest copepod abundance of the three regions (>3 times that of the Central Delta); the North Delta historically and currently has the lowest abundance (~1/2 that of the Central Delta, but see methods).
- The invasions of *Limnoithona* and *Pseudodiaptomus* have resulted in substantial increases (2-4 fold) in total copepod abundances in every region. These copepods are present March-November, with little change in abundance.
- Calanoid copepods are more abundant in the Central Delta and North Delta regions than historically. *Pseudodiaptomus* has replaced *Eurytemora* as the most abundant calanoid copepod.
- The abundance of *Eurytemora* has declined in all regions over time, but especially in Suisun; additionally, its seasonality has narrowed (historically present through the fall, currently present in early spring).



Discussion

- Substantial changes to the community composition and abundance of copepods occurred in all regions.
- Copepod abundance has increased in all regions over time. In the North Delta, this increase is due primarily to the introduction of the calanoid *Pseudodiaptomus*; in Suisun, it is due to the invasion of the cyclopoid *Limnoithona*. Both species dominate the Central Delta community.
- The calanoid copepod *Eurytemora* now peaks in abundance early in the spring and decreases the rest of the year. Both invasive species are present year round.
- In both the North and Central Deltas, but not Suisun, calanoid copepods are a significant proportion of the community.
- The changes in community composition and abundance are most evident in Suisun, a region heavily impacted by *Potamocorbula amurensis*, an invasive clam introduced in 1986. This clam competes with copepods for food and also feeds on copepod nauplii.[2]
- Due to their small size *Limnoithona* and *Oithona* copepods are likely a poor food source for planktivorous fish.[1]

Acknowledgements: We would like to thank the DWR-EMP field crew for collecting samples (Nicholas VanArk, Scott Waller, Eric Santos), CDFW lab staff for processing samples (Sally Skelton, Tina Enderlein , Danae Jordan), and Tricia Bippus (CDFW) for her beautiful photographs.

References: 1) Winder & Jassby (2010) *Estuaries and Coasts,* DOI 10.1007/s12237-010-9342-x
2) Kimmerer, Gartside, &Orsi (1994), *Marine Ecology Progress Series.* (113): 81-93.