

## **Thirty-Five Years of Fish Studies in Suisun Marsh: Perspectives and Animations**

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Suisun Marsh is a key part of the San Francisco Estuary. Thirty-five years of monthly trawling and seining for fish at numerous locations in the Marsh has established its importance as a highly productive area for fish and invertebrates. We examine some of our complex findings with both conventional graphics and data animations. Over 60 species of fishes and macroinvertebrates have been collected, and data show that native and non-native species populations mostly follow similar trends. Abundance of most species is driven by young-of-year which show large variability from year to year in quantity, timing, and location, as illustrated by data from the most abundant native species in the Marsh, Sacramento splittail. Trends in two of the Pelagic Organism Decline species show different patterns from those in the rest of the estuary. The Suisun Marsh study is a long-term monitoring and research program that is unusual because of its focus on fish assemblages from its inception. It has been a major source of new information on estuarine fishes and their relationship to a changing environment.

**Keywords:** Suisun, fish, splittail, pelagic organism, decline, animation, long-term monitoring

**Session Title:** Suisun Marsh and the Arc: New Findings on Tidal Marsh Fishes

**Session Time:** Wednesday 8:20AM – 10:00AM Room 311-313

## Fishes of Suisun Marsh: Trends and Connectivity

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**Problem:** The 50+ species of fish in Suisun Marsh show considerable variability in populations among years and places, a phenomenon poorly understood prior to this study. Migratory fishes, such as splittail, seemed to show the strong influence of outside factors, such as river flow.

**Approach:** We documented the abundance of fishes in trawls and seines monthly for 35 years. Otoliths were removed from splittail for microchemistry analysis to determine the success of spawning inside and outside the marsh.

**Results:** Populations of native and alien species show some concordance; both declined during severe drought. Species that spawned outside the marsh, such as splittail and striped bass, showed response to both outside and inside factors. Otolith analysis revealed splittail spawned both on floodplains, as expected, and in brackish water. The ability to spawn in brackish water bolsters the population during extended droughts.

**Conclusions:** Suisun Marsh has a novel fish assemblage with fish abundance influenced by conditions both inside and outside the marsh. Abundant native fishes, such as splittail, have adaptations that allow them to persist despite alien species and severe habitat alteration.

**Keywords:** Suisun Marsh, fish assemblage, splittail, otolith

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## Fishes of the North Delta: Trophic Pathways & Habitat Use

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**Problem:** The Cache Slough Complex in the Sacramento-San Joaquin Delta is characterized by high fish species diversity and a diversity of habitat. Each slough within the Cache Slough Complex has unique habitat characteristics, and a unique community of native and nonnative fishes. However, little is understood about interactions between these fish species, the role that these fish play in local food webs, and their use of differing habitats.

**Approach:** In order to address this deficiency we used a combination of stable isotope analysis and targeted fine-scale habitat sampling to evaluate local food webs and fish communities.

**Results:** Our analysis of food web structure has demonstrated the existence of multiple trophic pathways in various sites within the Cache Slough Complex. Notably, there are strong differences in trophic structure between Cache and Lindsey sloughs and their tributaries. Differences in carbon sources and nitrogen enrichment suggest the importance of differing pathways to native and nonnative fishes. Sampling of fine-scale habitats has provided insight into habitat preferences of fish and invertebrates. Native and nonnative benthic fish and large invertebrates show significant differences in substrate and vegetation preference, consistent across regions, including both the North Delta and Suisun Marsh.

**Conclusions:** Together, these conclusions provide insight into the importance of physical and chemical habitat in supporting various trophic pathways and differing fish communities.

**Keywords:** Food web, habitat preference, fish communities

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## Hydrodynamics and Pelagic Productivity: Suisun Marsh and Cache Slough

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**Problem:** The interaction between pelagic productivity and hydrodynamic transport are poorly understood in the Sacramento-San Joaquin Delta.

**Approach:** Empirical data on chlorophyll-a concentration and zooplankton abundance are compared to modeled residence time distributions in Suisun Marsh and the Cache Slough Complex.

**Results:** Low residence time habitat is characterized by more stable temperatures and DO values, low levels of chlorophyll-a (mg/L), and low zooplankton density. High residence time habitat is characterized by variable temperatures and DO values, high levels of chlorophyll-a, and high zooplankton density. Unique pointsources in certain areas also affect *in situ* chlorophyll-a and zooplankton production. Hydrodynamic interactions along the slough gradient result in the dispersal and concentration of production.

**Conclusions:** Combining empirical data with modeling provides an elegant method for describing lower trophic food-web dynamics in channelized, tidal environments. Comparing sites from different regions contrasts the effects of adjacent land management practices, channel morphology and hydrodynamics, and nutrient supply on *in situ* channel food web production. This approach has the potential to guide the understanding of effects of proposed restoration sites on pelagic productivity and the conditions under which hot spots of production may occur.

**Keywords:** Hydrodynamic modeling, Residence-time, Productivity, Food-web, Chlorophyll-a, Phytoplankton, Zooplankton, Suisun, North-Delta

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## Passive and Active Restoration of Tidal Habitat in Suisun Marsh

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**Problem:** The Suisun Marsh plan mandates that 5,000-7,000 acres of Suisun marsh will be restored to tidal marsh in the next 30 years, but little is known of the effectiveness of restoration design for native fishes in the region.

**Approach:** We compared fish and macro-invertebrates in Blacklock tidal marsh restoration site with surrounding tidal sloughs and a managed pond that is operated to enhance waterfowl hunting conditions.

**Results:** We found that Blacklock has lower productivity, fish abundance, and fish diversity than an adjacent tidal slough and a more intensively managed pond. This is most likely due to the high tidal exchange and low residence time within the restoration site.

**Conclusions/Relevance:** Comparing open restoring sites to managed wetlands provides an opportunity to understand potential endpoints of future restoration projects. It is imperative to evaluate both benefits and losses of returning managed wetlands to tidal marsh, and choose sites and strategies which will promote desirable outcomes. In the future, managed wetlands should be constructed with features that support adaptive management through effective experimental design.

**Keywords:** restoration, wetlands, managed wetlands, fish, pelagic production, adaptive management

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