

# Historical Freshwater & Salinity Conditions

*in the Western Sacramento - San Joaquin Delta & Suisun Bay*

## REPORT HIGHLIGHTS

**Sacramento -  
San Joaquin Delta**

**Suisun Bay**

**San Pablo Bay**

**San  
Francisco**

*Pacific Ocean*



**CONTRA COSTA  
WATER DISTRICT  
WATER RESOURCES**

**DECEMBER 2009**



0 2 4 8 12 Miles

# Consistent with historical reports, paleosalinity records reveal a sustained period of freshwater conditions in the Delta, followed by a sharp, sustained increase in salinity starting about 100 years ago

In paleoclimatology, information from natural sources, such as atmospheric temperature (from ice cores) and precipitation cycles (from tree rings), is used to reconstruct past climate, providing a history of conditions before modern instruments. Salinity in the Bay and Delta tidal marshes has been reconstructed from sediment cores, providing evidence of salinity intrusion over the last 2,500 years.

The Delta was predominately a freshwater system for 2,500 years, even during century long droughts, until the early 1900's, as shown below at the Browns Island tidal marsh near the confluence of the Sacramento and San Joaquin Rivers (Figure 1). Although Suisun Bay experienced salinity intrusion during long drought periods (the last period ended approximately 700 years before present), salinity did not affect the western Delta to the same degree, likely due to the vast tidal marshes that existed until the early 20th century.

Furthermore, salinity levels in Suisun Bay during the past century exceed even the long drought periods of previous centuries, even though the watershed has received above average rainfall for the last 70 years. The abrupt increase in salinity during the last 100 years has been attributed to human activities, including reclamation of tidal marsh and diversion of fresh water.

## Approximately 100 years ago, salinity increased abruptly, exceeding salinity levels of the past 2,500 years

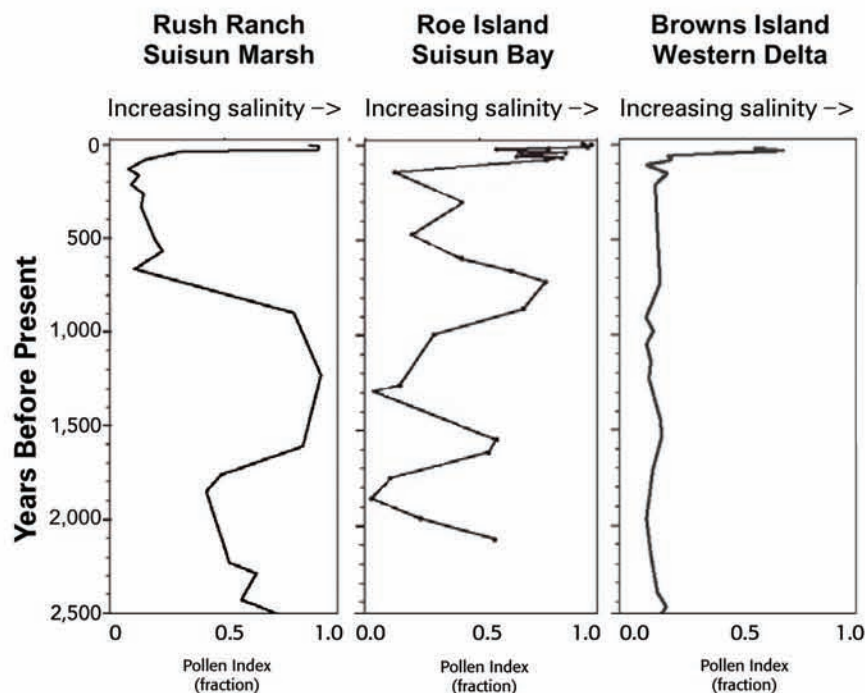


Figure 1. Paleosalinity records from three tidal marsh locations in the Western Delta and Suisun Bay and Marsh indicate a sharp increase in salinity during the last 100 years, resulting in conditions at least as salty as or saltier than at any period in the previous 2,500 years.

Figure adapted from Malamud-Roama and Ingram (2004)

# Earliest salinity measurements reveal a fresher Suisun Bay in the winter/spring and less salinity intrusion into the Delta in the fall

The earliest salinity measurements in the Delta were recorded by the California & Hawaiian Sugar Refining Corporation (C&H) from 1908 to 1929. C&H obtained fresh water by sending barges that traveled upstream along Suisun Bay and into the Delta until they reached water with a chloride concentration of less than 50 milligrams per liter (mg/L). The distance the barges traveled is a measure of salinity intrusion; increasing distance indicates increasing salinity.

Salinity started increasing in 1917 and by 1920 the salinity had increased to the point that C&H abandoned the Sacramento and San Joaquin Rivers during the summer and fall, replacing the water supply with an agreement with Marin County. The increase in salinity recorded by C&H is consistent with the paleosalinity archives, reports from early settlers, and the conclusions of the State of California salinity investigation of the 1920's.

Comparison of the C&H observations for 1908 through 1917 (prior to significant upstream diversions) with recent salinity levels from two time periods of similar hydrology (Figure 2) indicates that fresh water was present further downstream in Suisun Bay and the western Delta more often and for a longer portion of the year from 1908 to 1917 compared to recent years. The colored (lower) parts of the graphs below show the progressive loss of fresh water from the system and the upper lines show the increasing salinity intrusion into the Delta.

## Fresh water was available further downstream for a longer portion of the year in the early 1900's than in recent decades with similar hydrological conditions

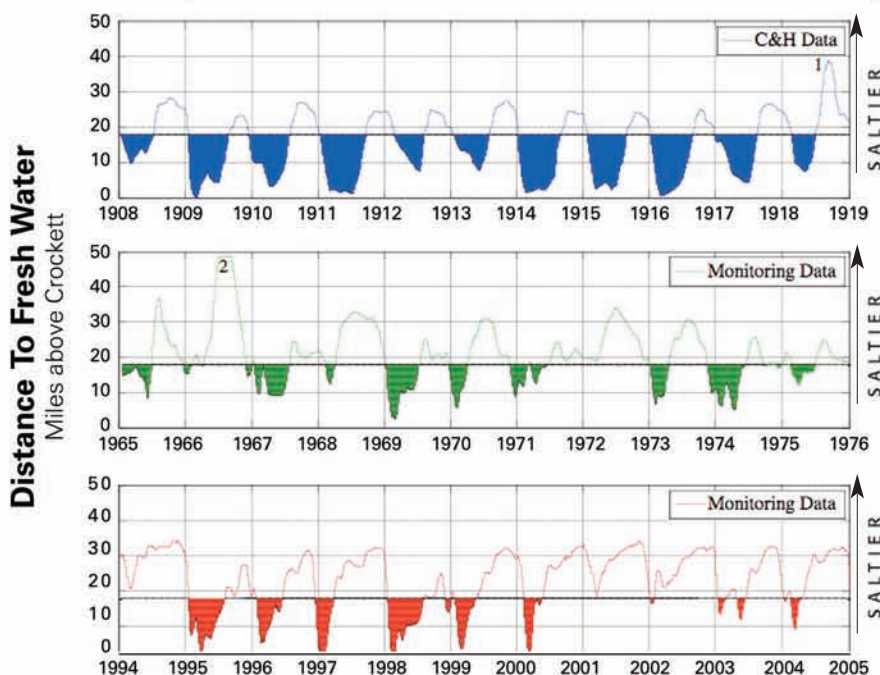


Figure 2. Fresh water was available within Suisun Bay for a longer time period each year during the early 1900's.

The colored portion on each chart represents the amount of fresh water (with less than 50 mg/L chloride or approximately 0.2 ppt salinity), that is available within Suisun Bay, downstream of the Delta boundary (approximately 18 miles above Crockett).

From 2001 to 2005, fresh water was seldom available below the Delta boundary, indicating that the Delta did not "flush". Without the seasonal freshening of the Delta, contaminants and toxics can accumulate in the system. Investigations found toxics to be a factor in the decline of the Delta ecosystem.

Note: While hydrological conditions were similar in the three time periods shown to the left, the sequence of wet and dry periods differs.

1 During August and September 1918, average water quality obtained by C&H exceeded 110 mg/L chloride

2 Salinity intrusion is likely an overestimate due to inadequate spatial coverage of monitoring stations in 1965 and 1966