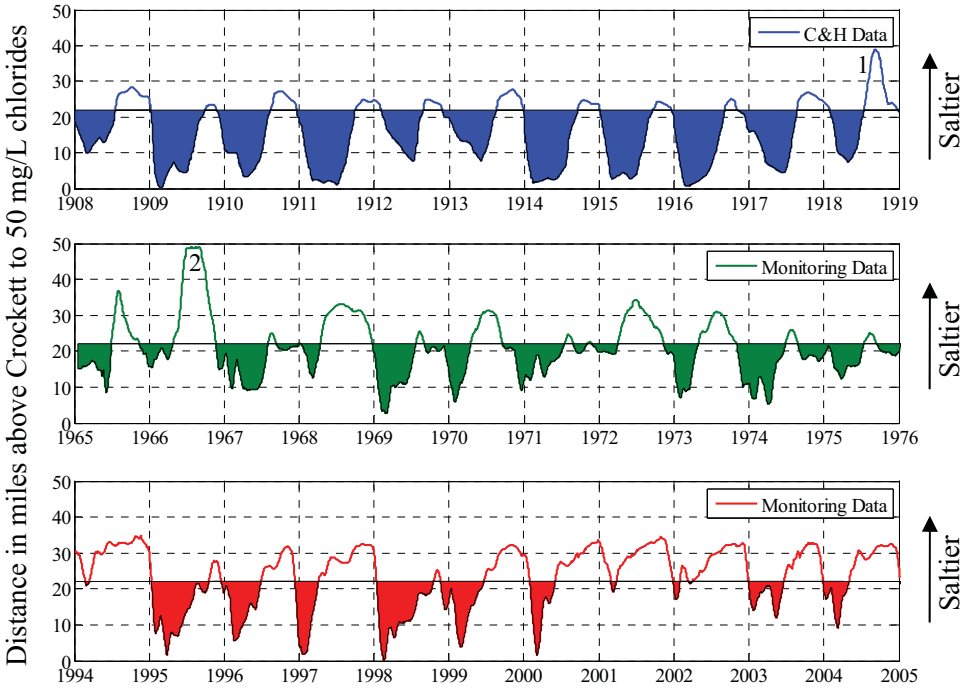
Historical Salinity Variability Summary

Seasonal Variability

Observations from the California & Hawaiian Sugar Refining Corporation (C&H) provide details on seasonal salinity fluctuation in the early 1900s. For comparison with recent observations, two time periods of similar hydrology are also shown below. The shading represents the amount of fresh water, with less than 50 mg/L chlorides, available below the confluence of the Sacramento and San Joaquin Rivers at Collinsville (approximately 22 miles above Crockett, see map on adjacent figure).

Fresh water was available below the confluence for a longer time period each year during the early 1900s. From 2001 to 2005, fresh water was seldom available below the confluence. Additionally, from 1994 to 2005, the distance to fresh water exceeded 30 miles (above Three Mile Slough) at some time during all years except wettest years (1995 and 1998).



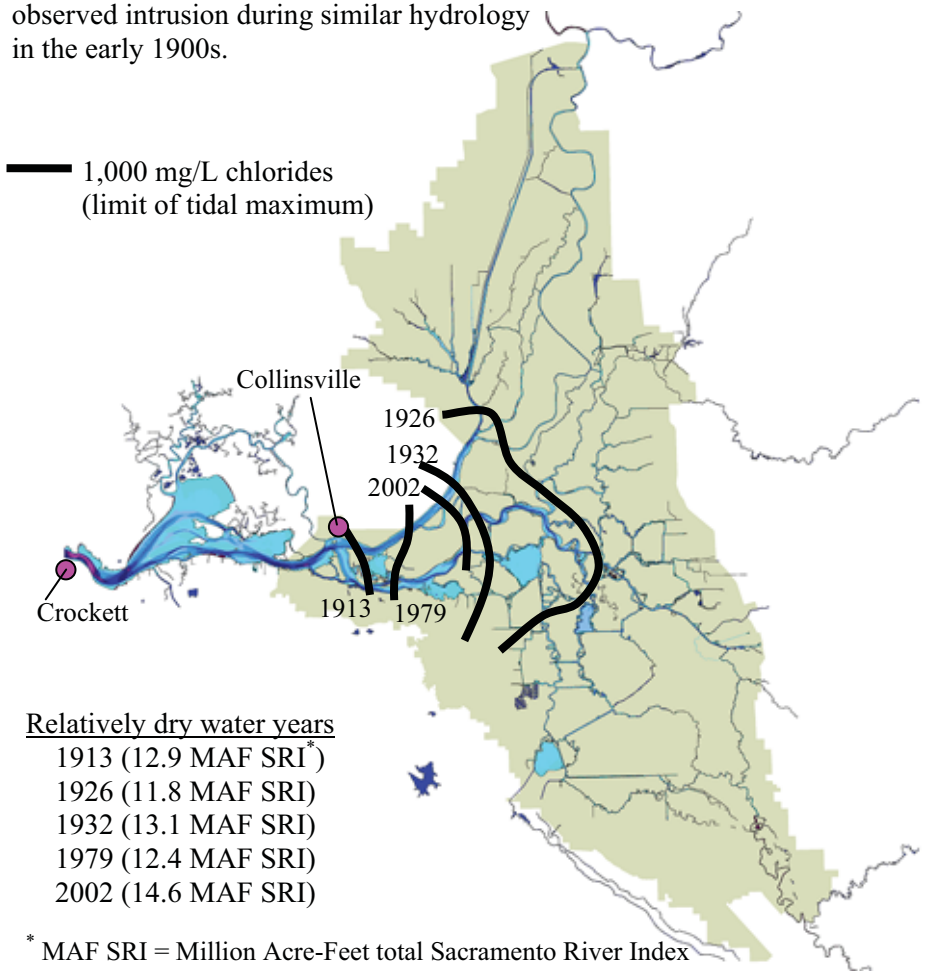
1 During August and September 1918, average water quality obtained by C&H exceeded 110 mg/L chlorides.

2 Salinity intrusion during 1966 is likely an overestimate due to inadequate spatial coverage of monitoring stations.

Annual Maximum Intrusion

Annual maximum salinity intrusion for relatively dry water years with similar total annual unimpaired runoff is illustrated by the location of the 1,000 mg/L chloride concentration. Water year 1913 experienced the least extent of intrusion, most likely because upstream diversions were significantly less than later years. Water years 1926 and 1932 were subject to extensive upstream agricultural diversions, while water years 1979 and 2002 had the benefit of the CVP and SWP to provide "salinity control".

Although "salinity control" limits the impact of upstream water diversions, annual maximum salinity intrusion during the post-Project era still exceeds the observed intrusion during similar hydrology in the early 1900s.



Relatively dry water years

1913 (12.9 MAF SRI*)
1926 (11.8 MAF SRI)
1932 (13.1 MAF SRI)
1979 (12.4 MAF SRI)
2002 (14.6 MAF SRI)

* MAF SRI = Million Acre-Feet total Sacramento River Index

Historical salinity variability as determined from a sediment core in northwestern Suisun Marsh broadly corresponds to independent climate indicators, with general agreement of higher salinity during the Medieval Warm Period and fresh conditions during the Little Ice Age. However, the recent increase in salinity since the mid-1800s observed in the sediment core does not correspond to regional climate change, but rather is primarily due to anthropogenic modifications.

The chronology of anthropogenic changes and salinity observations are summarized below. Up until 1917, the most significant impact on salinity was likely due to changes to the landscape of the Central Valley and Delta. Since 1917, flow management activities have the greatest impact on observed salinity.

Era	Anthropogenic Modifications	Salinity Characteristics
1860-1917 (Early Settlement)	Changes to the landscape of the Central Valley and Delta are significant. • Reclamation of marsh lands • Alluviation then erosion of mine-derived sediment • Deepening, widening, and straightening of Delta channels Water diversions increase throughout this period. (DPW, 1931) • By 1870, irrigation diversions noticeably reduce flow in the San Joaquin River • Gross annual irrigation diversions from the Sacramento and San Joaquin Rivers grow from 1.0 MAF in 1879 to 4.3 MAF in 1917	➢ Salinity intrusion is only reported during the drought of 1870. ➢ Earliest salinity measurements (1908-1917) indicate salinity of 1,000 mg/L chloride remained near the confluence of the Sacramento and San Joaquin Rivers, even during dry years.
1918-1944 (Pre-CVP)	Changes to the landscape are less substantial than the previous era. • Continued deepening of Delta channels • Continued erosion of mine tailings Water diversions continue to increase throughout this period. • Upstream storage capacity grows from 1.2 MAF in 1920 to 4.6 MAF in 1943 • Annual irrigation diversions exceed 6.5 MAF by 1944	➢ Salinity intrusion is greater than any other time period, likely caused by upstream diversions and lack of precipitation. ➢ Salinity retreats and fresh water reaches the confluence of the Sacramento and San Joaquin Rivers during the winter, even during dry years.
1945-1967 (Pre-SWP)	Changes to the landscape continue, but not as dramatic as earlier eras. Water diversions continue to increase with substantial increases in storage. • Shasta Reservoir (4.5 MAF) completed in 1945 • Upstream storage capacity increases to 17.5 MAF in 1966 • South of Delta exports begin in 1951, exceeding 1.6 MAF by 1966	➢ Salinity intrusion is "controlled" by reservoir releases, limiting the impact of upstream diversions but not returning to levels observed from 1908 to 1917, before significant upstream diversions altered the flow regime. ➢ Delta is generally saltier than would occur under unimpaired conditions during most months. ➢ Reservoir releases slightly freshen the Delta during February and September, primarily during wet years, likely due to flood control operations.
1968-1993 (Pre-ESA)	Water diversions continue to increase with substantial increases in storage. • Oroville reservoir (3.5 MAF) completed in 1968 • Upstream storage capacity increases to 30.4 MAF by 1979 • South of Delta exports increase to 6 MAF by 1990 Water quality, water rights, and other agreements impact timing of reservoir releases and south of Delta exports. • Water Rights Decision 1485 issued in 1978 • CVP Improvement Act approved by Congress in 1992	➢ Similar to the previous era, with increased reservoir capacity further freshening the Delta during September until the mid-1970s. Since the mid-1970s, the freshening effect of reservoir releases has been diminished. ➢ Starting in the mid-1970s, salinity during winter months at Collinsville often exceeds previously recorded levels, including the 1920s and 1930s.
1994-present (Post-ESA)	Water quality, water rights, and other agreements impact timing of reservoir releases and south of Delta exports. • Bay-Delta Accord sets interim water quality objectives in 1994	➢ Substantial increase in fall salinity in the western Delta during all but the wettest years; at Collinsville, fall salinity resembles the levels of the 1930s drought.