

Holocene paleoclimate records from a large California estuarine system and its watershed region: linking watershed climate and bay conditions

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Abstract

The San Francisco Bay-Delta system includes a watershed that covers a large area of California and provides water to two-thirds of the State's population. Climate over the estuary and its watershed in the dry summer months is controlled by the subtropical high which dominates and deflects storms from California. The subtropical high weakens and migrates south as the Aleutian Low strengthens, bringing wet winter storms to the region. Paleoclimatic records from the Bay and its greater watershed, spanning the Holocene, are reviewed here in order to better understand natural variations of precipitation and runoff and the linkages between those variations and the salinity and ecosystems of the estuary. To better understand regional-scale climate patterns, paleoclimate records from coastal California and the Great Basin are also considered. Large fluctuations in climate have occurred during the period of interest, and there is generally good agreement between the paleoclimate records from different regions. Early Holocene climate throughout California was marked by rising temperatures and reduced moisture as seen in fire records from the watershed. This warmth and aridity peaked about 5000–7000 years ago and was followed by a cooling trend, with variable moisture conditions. The Estuary formed relatively rapidly in response to a high rate of sea level rise that dominated the Holocene until about 6000 years ago, and the subsequent reduced rate of inundation allowed vast tidal marshes to form along the edges of the estuary, which have since been recording changes in environmental conditions.

The impacts of changing regional climate patterns are experienced in the San Francisco Bay-Delta system, as altered fresh water flows result in altered estuary salinity. For example, approximately 3800 cal yr B.P., records from throughout the state indicate a cool, moist period, and Bay salinity was reduced; this period was followed by a general drying trend throughout California over the last two millennia, punctuated by decades to centuries-long droughts and brief, extremely wet events. In particular, during the period ca. 1000–800 cal yr B.P. (A.D. 950–1150) conditions seem to have been unusually dry in many parts of the watershed, reducing the fresh water flows to the estuary, and shifting tidal marsh plant assemblages toward less diverse, but more salt-tolerant plants. In contrast, the Little Ice Age (ca. 550–200 cal yr B.P.) brought unusually cool and wet conditions to much of the watershed, and lowered salinity in the Bay. Many reconstructions suggest that notably stable conditions have prevailed over the instrumental period, i.e., after ca. A.D. 1850, even including the severe, short-term anomalies experienced during this period. Interdecadal variability is common in many of the records, with timescales of ca. 55, 70, 90, 100, 150, and 200 years.