

### Background

The primary goal of this project was to gain a better understanding of the long-term feasibility of restoring tidal marshes in San Pablo Bay in the San Francisco Estuary, by identifying sources of inorganic sediments that maintain the marshes' elevations relative to sea level. More specifically, the project focused on comparing sediment inputs from local rivers (e.g., Napa River, Sonoma Creek, Novato Creek and Petaluma River) draining directly to San Pablo Bay to those from rivers draining into the massive Sacramento-San Joaquin river delta.

This comparison is important because it gives insights into the degree to which human activities have altered sediment transport in the delta and whether the current sediment supply is sufficient to maintain marshes in the face of rising sea level.

### CALFED Fellow

In 2003, Frances Malamud-Roam won a CALFED Science Fellowship to study sediment supply to marshes in San Pablo Bay. Her research was conducted in collaboration with Drs. B. Lynn Ingram of UC Berkeley, Dave Schoellhamer of the U.S. Geological Survey (USGS) in Sacramento and Joshua Collins of the San Francisco Estuary Institute, with additional support from the USGS.

Malamud-Roam has long had an interest in understanding the environmental and human dimensions of climate change. Her master's thesis examined environmental changes preceding the shift from hunter-gatherer societies to early agrarian ones in China. Her doctoral research focused on inferring past climate variability in the San Francisco Estuary by examining changes in patterns of

marsh vegetation. To a certain extent, her CALFED research is a natural progression of her doctoral research, as climate change has a strong influence on sediment supply and transport.

### Project

This CALFED project addressed four primary questions, all related to whether sediment supply is sufficient to maintain tidal marsh habitats. These questions and brief answers, based on the CALFED research, are provided below:

*Q. Which is a more significant source of inorganic sediment in marshes, those that flow through the Sacramento-San Joaquin Delta, or those from local watersheds?*

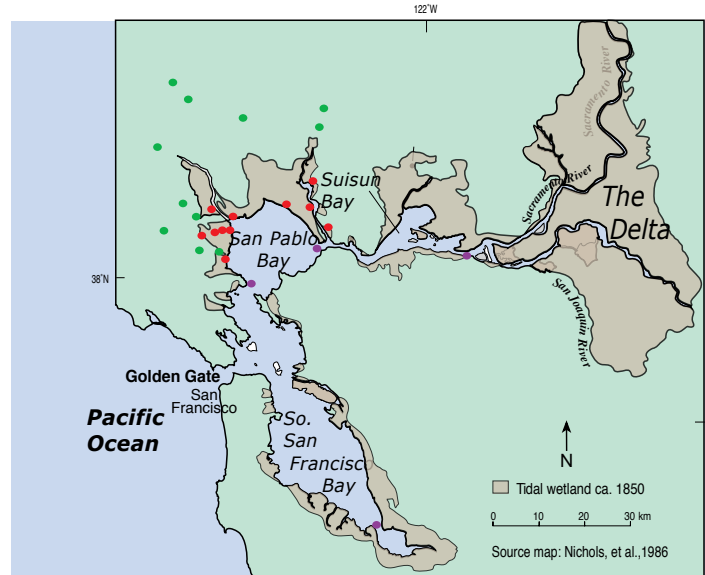
A. The findings suggest that local streams, rivers and creeks are more important to marshes in the

San Pablo Bay area than previously thought. In general, local watersheds were estimated to provide between 50–75 percent of the total marsh sediment. In addition, sediments from Napa and Sonoma creeks are important sediment sources to some marshes.

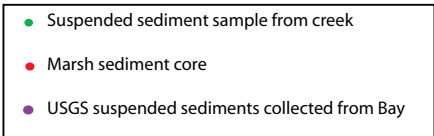
Because local sources appear to be a somewhat more important source of sediment than previously thought, dams on the Sacramento and San Joaquin rivers and their tributaries may have less of an impact on renewing sediments than previously thought.

*Q. How does the importance of local sediment sources vary with distance from the bay?*

A. Local streams are a more important source of sediment inland.



Location of sampling sites around San Pablo Bay in the San Francisco Estuary.



Closer to the coast, the larger rivers feeding the delta are more important.

**Q. How has sediment supply to local marshes changed in the last 200 years?**

A. The scientist reported the discovery of a pulse of delta-derived sediments 75–100 years ago, perhaps from hydraulic mining. The amount of material in this pulse has diminished in recent years.

**Q. Can changes in sediment sources be ascribed to climatic fluctuations or anthropogenic change?**

A. 4,000-year-old sediment core from China Camp suggests that climate variability has certainly influenced the amount of sediments flowing from different sources. Malamud-Roam and colleagues are still trying to refine dates for the last century to more closely analyze changes in relation to other data sets.

### Methods

The findings reported above are based on sediment fingerprinting, X-ray diffraction and isotopic analyses of sediment cores taken from four marshes around San Pablo Bay and from a long core from China Camp.

### Implications

As mentioned previously, the key issue is whether the sediment supply is sufficient to support marshes in the future.

“This is a toughie,” Malamud-Roam said. “I would say that if sea level continued to rise at 1–2 mm



(Left) Taking sediment cores at Petaluma Marsh in San Pablo Bay. Photo: M. Gorman (Below) The San Joaquin River in Fresno, California. Photo: F. Malamud-Roam

per year, as it has for the last several thousand years, and if the supply of sediments remains relatively stable, then ‘yes.’

“However, there are a bunch of unanswered questions, some of which I hope to be able to answer when I get more precise dates on some of my cores. Better dating will give some indication as to whether the sediments received in the last few decades have come as a pulse resulting from human activities such as farming and clearing or whether we can expect a continuation of the current sediment input,” she said.

To a certain extent, it appears that some of the “pulses” of sediment may remain in the bay and be redistributed over time. These may remain available for marsh maintenance, buffering for a time the rise in sea level. The organic sediments are also important to marsh plants, and particularly in the brackish and fresh water marshes, where the organic component is “pretty high.”

However, if sea level rise accelerates, which some scientists believe is happening, the current sediment supply may not be enough, she said.



One thing is clear: as sea level rises, the amount of land surrounding the bay for marsh restoration will decrease. “We have a lot of development right on the edges of marshes,” she pointed out. “There is really no place to retreat.”

### Mentors

**Research:** B. Lynn Ingram, UC Berkeley  
**Community:** Dave Schoelhamer, U.S. Geological Survey; Joshua Collins, San Francisco Estuary Institute

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The CALFED Bay-Delta Program is a collaborative effort of more than 20 state and federal agencies with management or regulatory responsibilities for the San Francisco Bay-Delta system. The CALFED Science Fellows Program has been established to bring world-class science to all program elements to help achieve overall CALFED goals. California Sea Grant administers CALFED research projects towards those ends.

This document is available in PDF on the California Sea Grant Web site: [www.csgc.ucsd.edu](http://www.csgc.ucsd.edu).

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