

# A LEGACY OF CONTAMINANTS IN SF BAY AND WETLAND CORES

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## Abstract

With residence times of decades or even longer, sediments can serve as a reservoir of legacy pollutants long after new inputs have reduced or stopped. San Francisco Bay has been listed as impaired by pollutants, including mercury, copper, and PCBs. A previous study found pollutants in cores of deeper Bay sediments at depositional locations, a potential reservoir of legacy contaminants that could threaten ecosystem health if re-exposed by erosion. It has been over 15 years since that study, so a new coring study was conducted to characterize the Bay at a wider range of sites. Cores were collected from 6 wetland and 11 sub-tidal Bay sites, radiodated, and analyzed for a suite of trace metal and organic pollutants. Cores from depositional wetland areas showed sharp peaks in concentrations of pollutants generally corresponding to expected periods of high pollutant loads and ambient concentrations. In contrast, subtidal cores from open-water areas showed elevated pollutants, but with less distinct or no peaks in concentration. These patterns suggest long-term dispersion and mixing of past loads in Bay open waters, which would require cleanup of less concentrated but ever larger sediment volumes with passing time, or waiting many more decades for concentrations to dilute or disperse to safer levels. Although deep sediment contamination may not be as widespread or severe as once feared, these results underscore the importance of controlling pollutants at or near their sources, where management actions can be applied most effectively and efficiently.

## Introduction

A previous study by USGS (Hornberger 1999) found elevated pollutants in several cores at depositional sites, but the majority of cores collected in that study showed no trends in screening analysis and were not further analyzed. Because much of the Bay has recently seen net erosion, this study sought Bay cores to characterize pollutant distributions more representative of average conditions, not seeking any particular sedimentation regime. Cores from depositional wetland sites were taken to characterize pollutant loading trends. These data will help us understand pollutant and sediment loadings and fate processes for use in conceptual and numerical models.

## Methods

Cores were collected from 11 sub-tidal Bay sites and from 6 wetland sites at the margins of the Bay (Figure 1). Bay cores were collected by vibracoring to depths 1.5-2 meters below the sediment surface (Figure 2). Wetland cores were collected manually by piston (Livingstone) corer (Figure 3), to depths of ~1.5 meters below the surface.

Collected cores were frozen and sectioned, and distributed to labs for analysis. Parameters measured (reporting labs in parentheses) included mercury by CVAFS (MLML), PCBs by HRGMS (EBMUD), radioisotopes by gamma counting (USC), and trace metals by ICP-MS (SFPUC).

Figure 2

Vibracoring in San Francisco Bay



PHOTOGRAPH BY JOHN GRAM

Figure 3

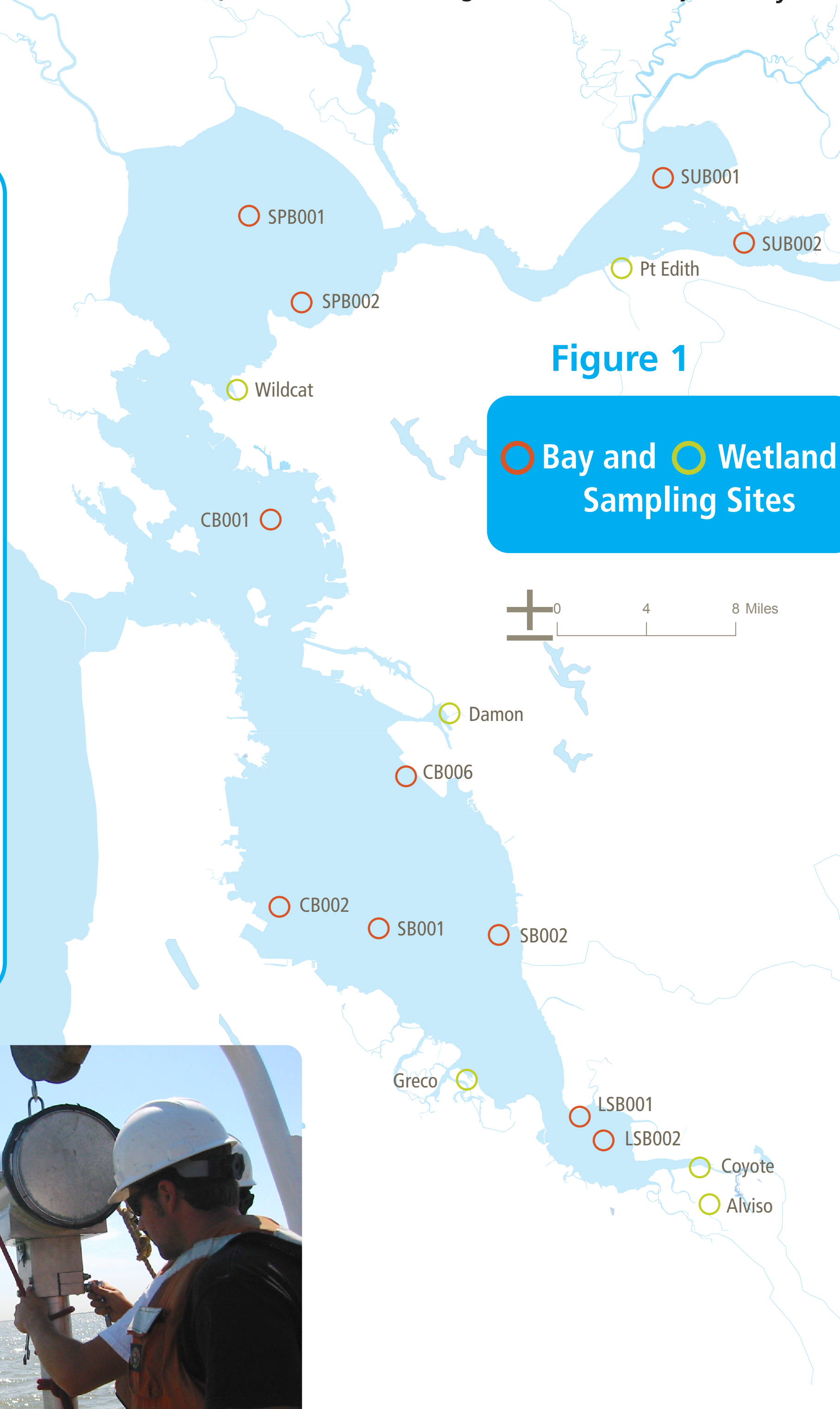
Wetland piston coring



PHOTOGRAPH BY BRYAN BEMIS

Figure 1

Bay and Wetland Sampling Sites



## Results & Discussion

### RADIODATING

Estimated sedimentation from radioisotope dating using  $^{137}\text{Cs}$  and  $^{210}\text{Pb}$  at Bay sites qualitatively matched those estimated from changes in bathymetry by Jaffe (USGS). Cores from most areas showed either erosion or no net change recently with only Lower South Bay sites showing significant net deposition above the  $^{137}\text{Cs}$  maximum from ~1960 (Figure 4).

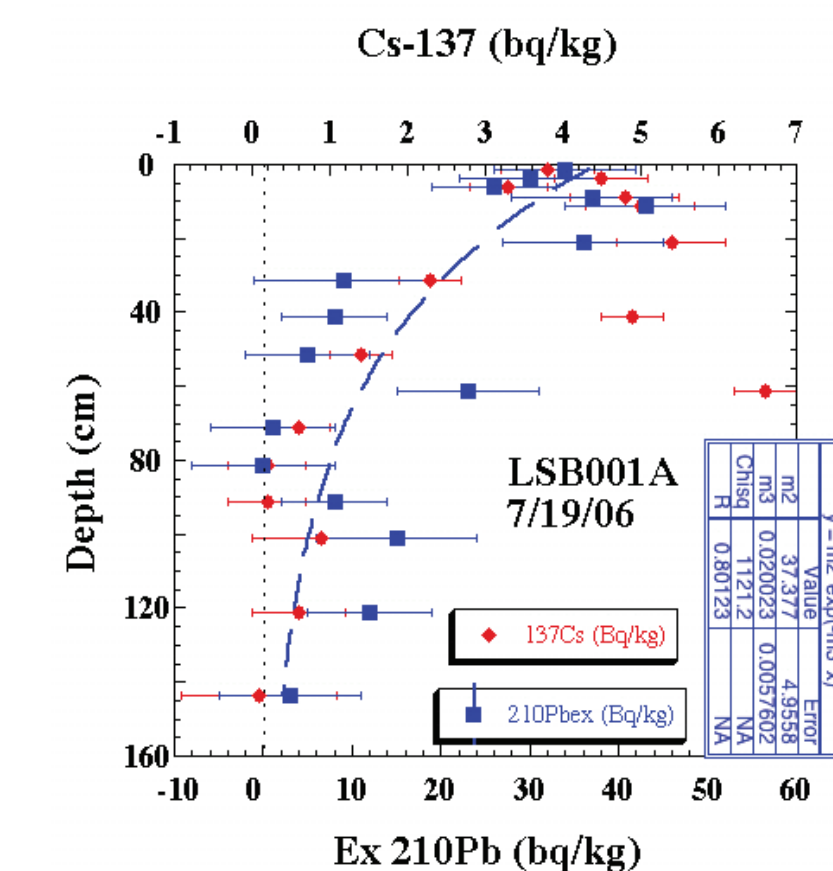


Figure 4  
Radioisotope dating profile

### MERCURY

Wetland cores from Central Bay (Damon Slough, Oakland) and Lower South Bay (Coyote Creek, San Jose) showed distinct peaks in mercury concentration, with other wetlands showing weaker signals (Figure 5). Bay cores generally showed weak or no peaks, with mercury concentrations at depth similar to current concentrations at the surface (Figure 6).

The majority of mercury mining activity at New Almaden in Lower South Bay occurred during the latter 1800s (Figure 7, Bailey and Everhart 1964). A peak of mercury around 1960 found here and in previous work (Conaway 2004) would suggest very slow processes for transport of mining waste from the upper watershed.

However, a similar peak occurred in a Central Bay wetland (Figure 6), not near any known large mines. This suggests a more urban mercury source, as both Central and Lower South Bay sites are near larger urban centers (Oakland and San Jose, respectively). For example, coal usage temporarily peaked in the 1940s, a period when there were limited emissions controls (Figure 8, USDoE 2001).

Figure 5 Mercury in wetland cores

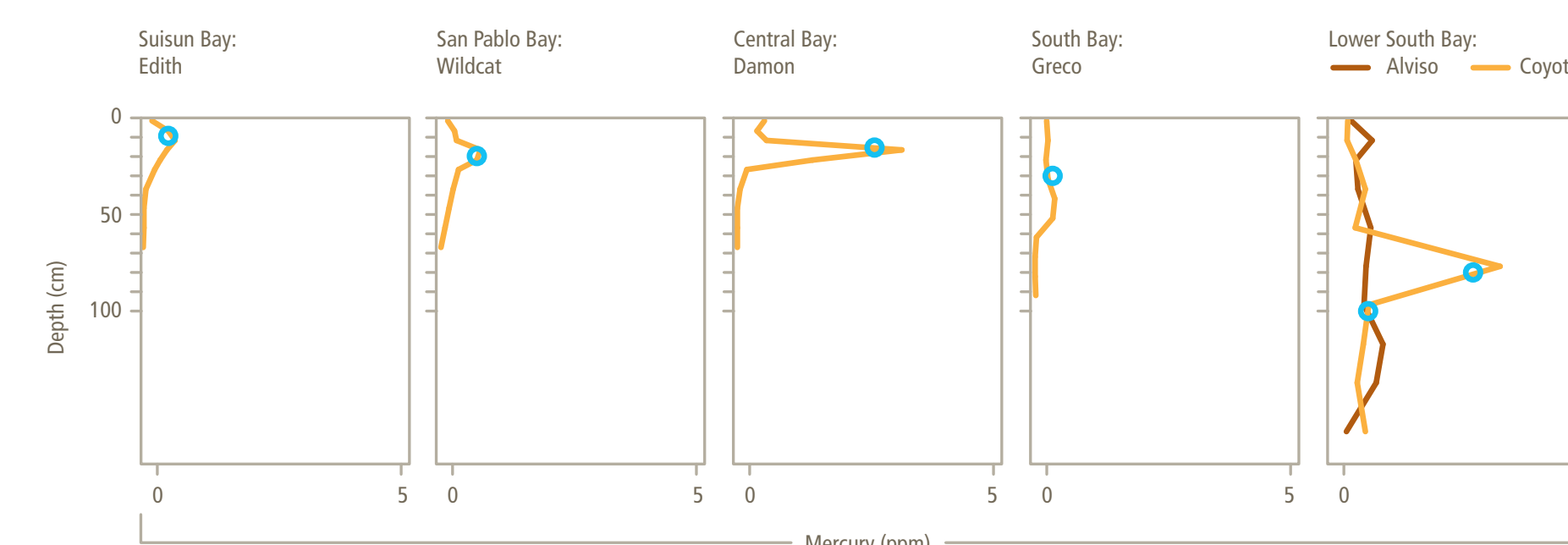


Figure 6 Mercury in bay cores

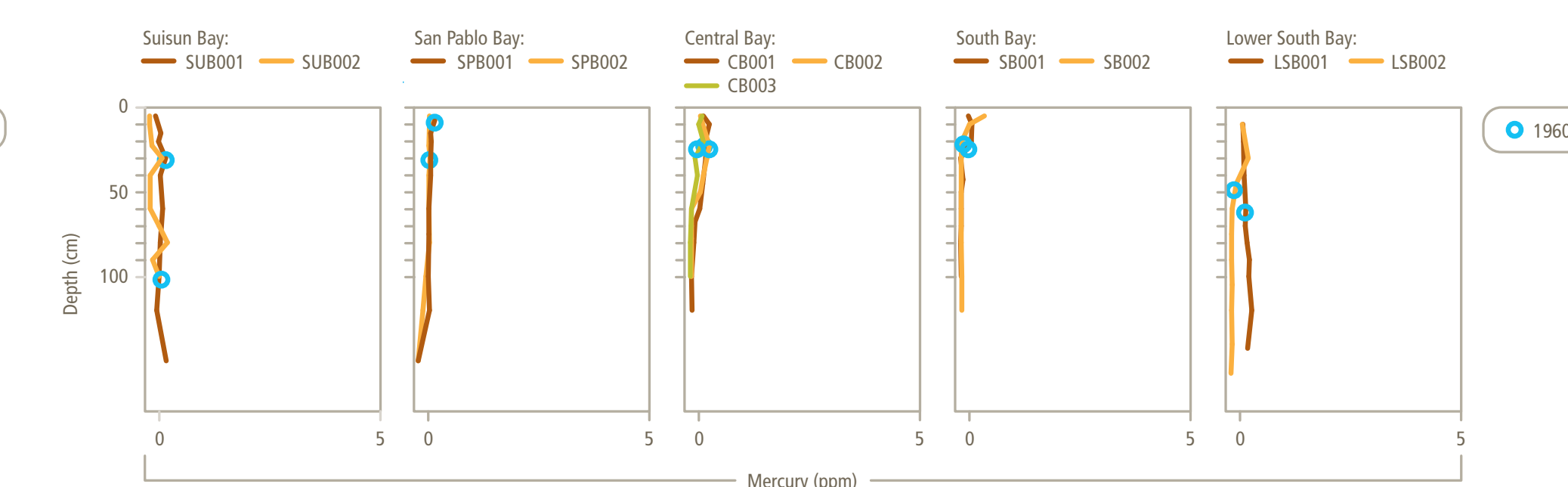


Figure 7 New Almaden mercury production 1847-1945

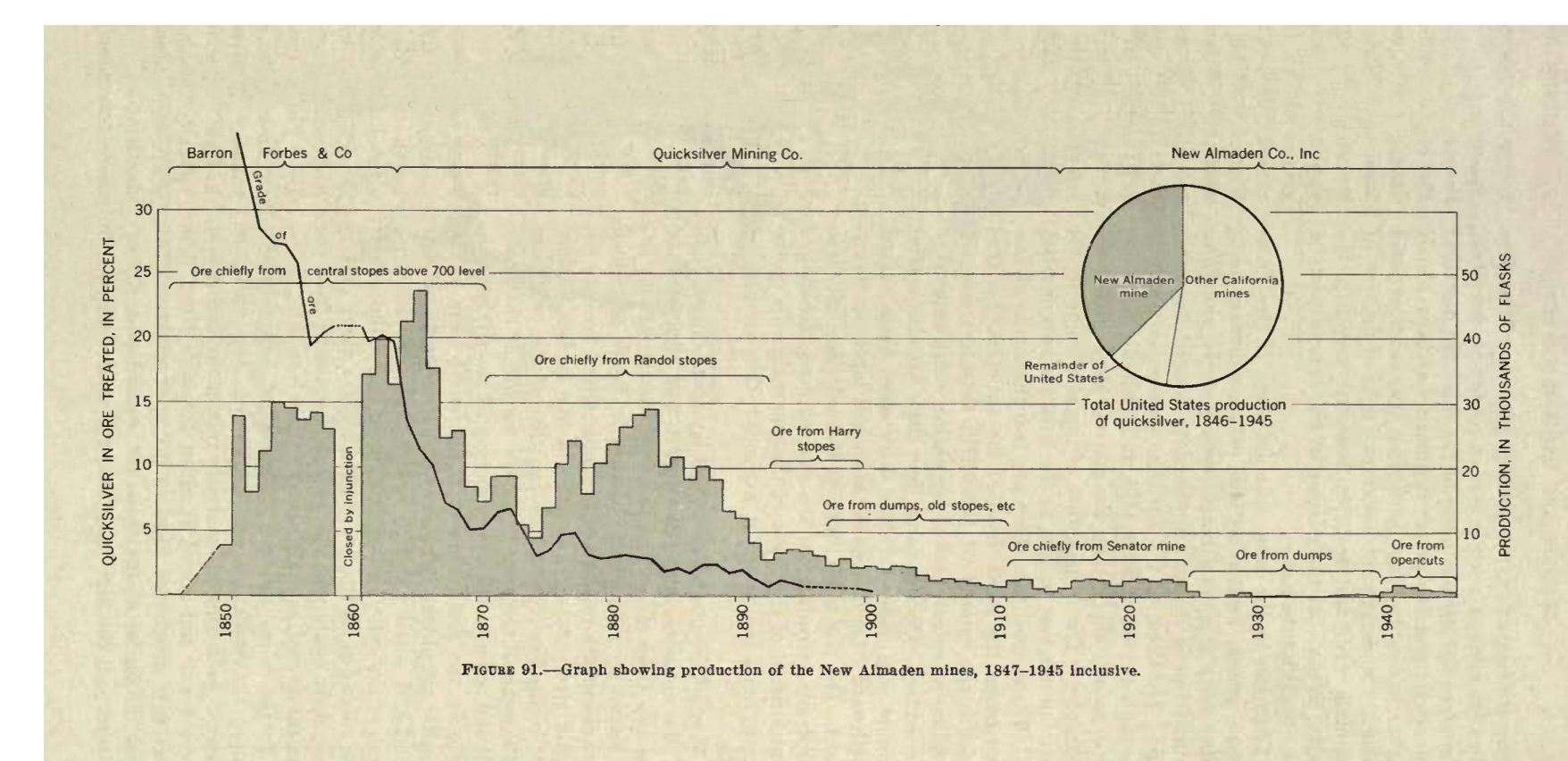
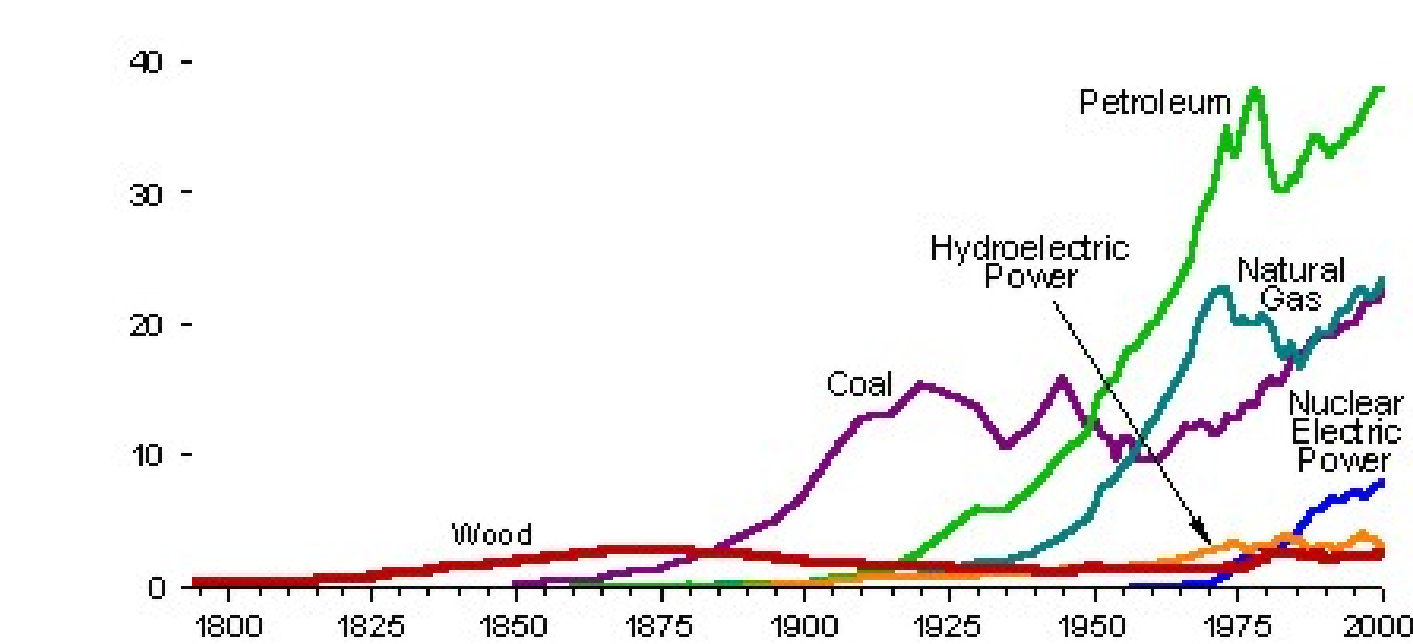


Figure 8 U.S. Energy Consumption 1800-2000



### COPPER

Wetland cores from Central Bay and south showed peaks in copper concentration in the post 1960s layers, with North Bay wetlands showing peaks around 1960 (Figure 9). Bay cores (Figure 10) generally showed smaller differences in copper concentration with depth than wetland cores.

Peaks in copper concentration for South Bay around 1980 coincide with peaks in copper from long term monitoring of clams and sediment in the Palo Alto mudflats by USGS (Hornberger 1999), and correspond to reductions in copper discharges from the Palo Alto wastewater treatment plant around that time (Figure 11).

Figure 9 Copper in wetland cores

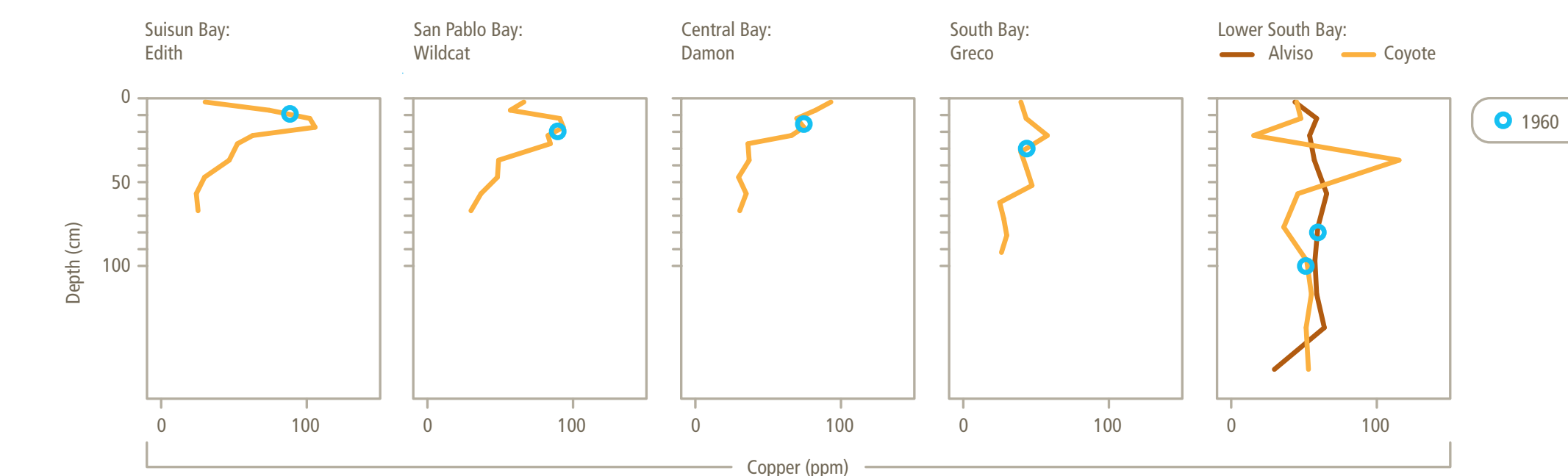


Figure 10 Copper in bay cores

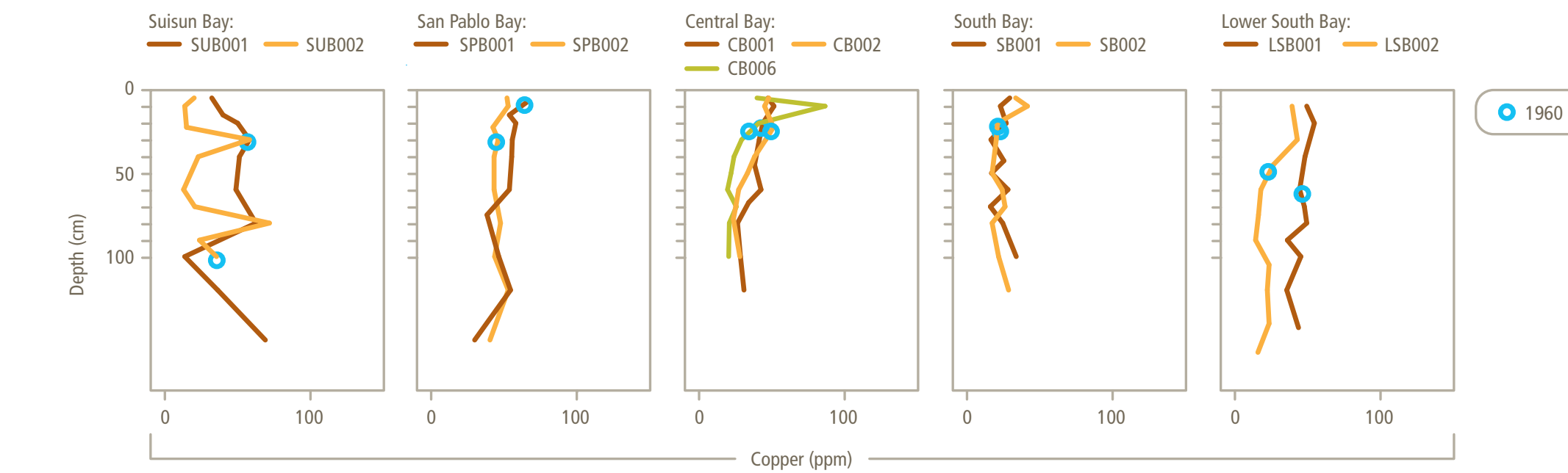
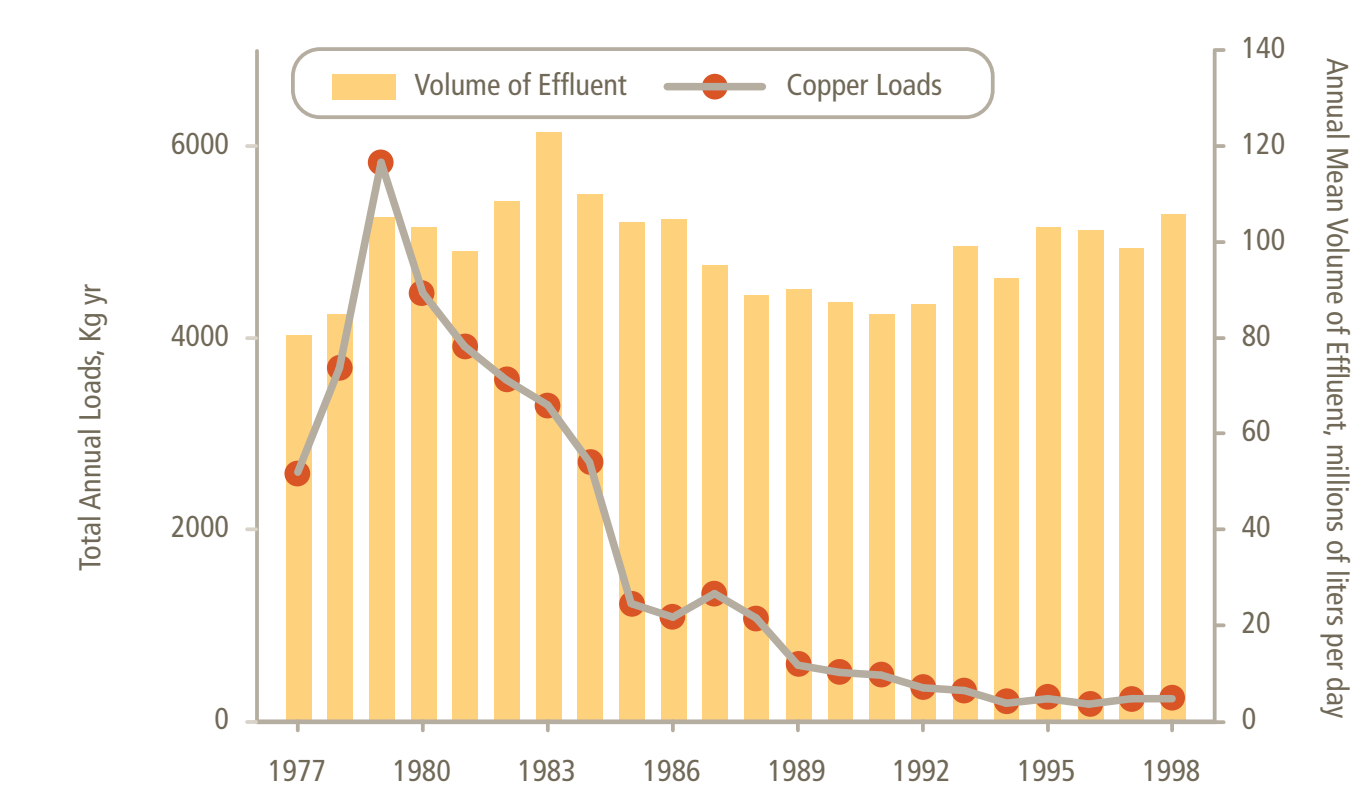


Figure 11  
Palo Alto copper loads 1977-1998



### PCBS

Concentrations of PCBs in cores from Central Bay showed similar patterns as metal pollutants, with a strong peak in wetland cores and much weaker signals in Bay cores (Figure 12a-b).

Figure 12a  
PCBs in Central Bay wetland core

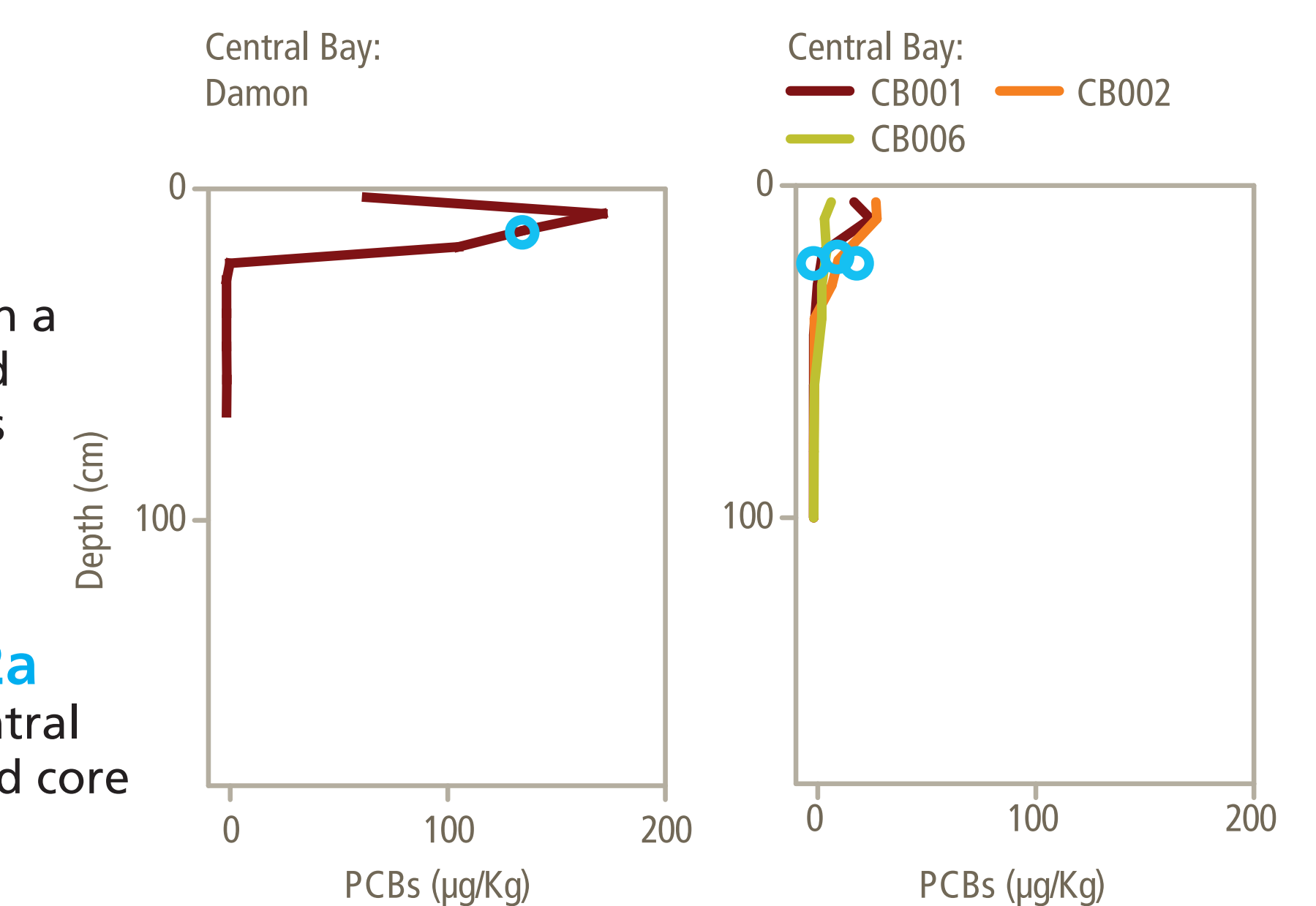
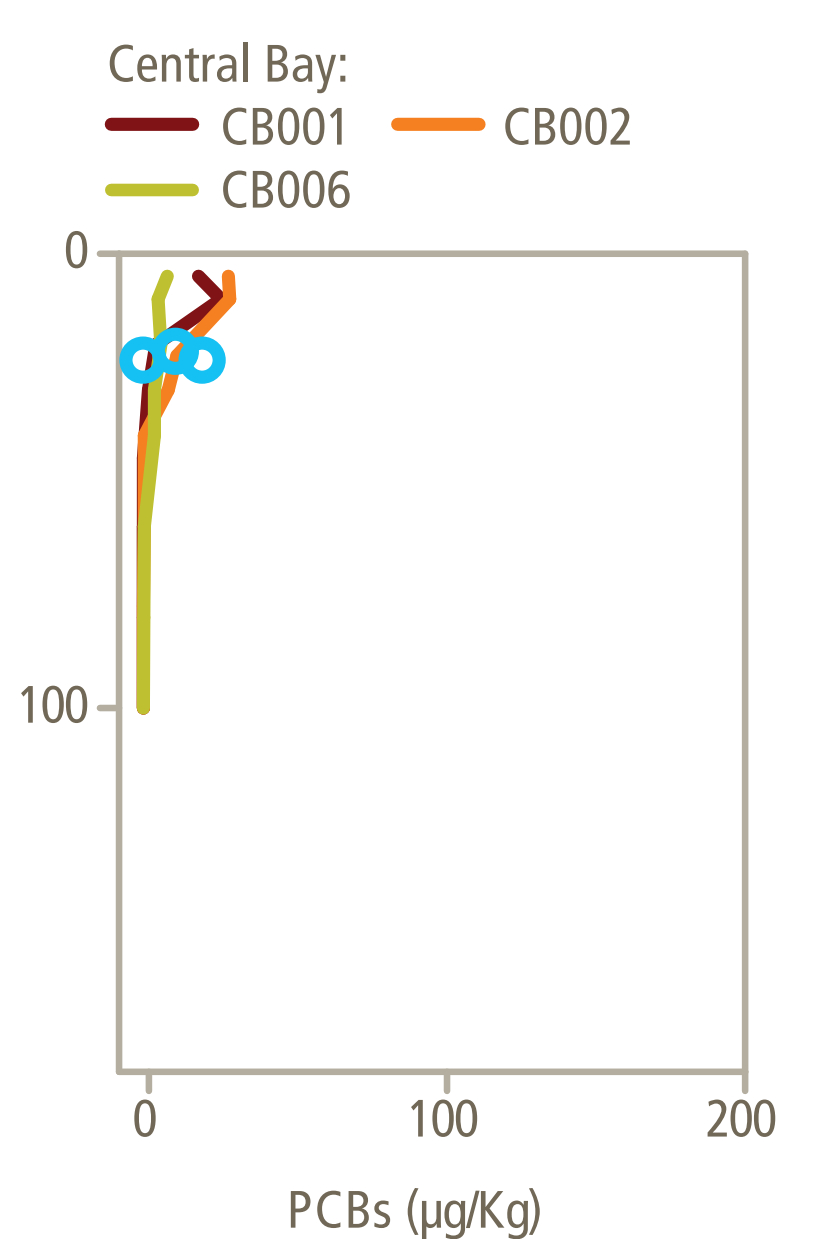


Figure 12b  
PCBs in Central Bay subtidal cores



## Conclusions

Wetland cores recorded sharp peaks in concentrations for several pollutants. Maximum copper and PCBs were generally seen in layers from around 20 years previous, corresponding to periods of expected maximum loads. Maximum mercury peaks were found in layers from ~1960, long after mines in the New Almaden Mining District closed. Although this may indicate slow mercury transport from the upper watershed, a similar peak in Oakland distant from known large mines suggests urban sources.

Bay cores showed less distinct or no peaks in these pollutants. This indicates dispersion, mixing, and other loss processes dilute and disperse pollutants as polluted sediment is transported from its (mostly landward) sources, resulting in nearly uniform concentrations similar to those in Bay surface sediments.



## Recommendations

The contrast between Bay and wetland sediments highlights the importance of controlling pollutants near their sources, preventing their release or taking action to control their spread early, as once pollutants are dispersed and diluted, much more sediment needs to be treated or removed to achieve the same amount of pollutant removal.

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