Executive Summary of Past Findings

Since 1976, USGS personnel have assessed trace metal concentrations in sediments and sediment-dwelling species and have profiled benthic community structure in the vicinity of the discharge of the Palo Alto Regional Water Quality Control Plant (PARWQCP). Ancillary factors that could affect metal concentrations (body weight in animals; characteristics of sediment, salinity) and benthic community structure (exotic species invasions, pelagic food availability, and weather anomalies) have also been measured during this time. These studies initially found exceptionally high concentrations of copper and silver in mud-dwelling animals from this area and strong seasonal variability in concentrations that confounded some interpretations. Additional studies documented that these contaminants were present in enriched concentrations throughout the food web, including birds from the area. The two metals that were enriched at this site reached levels unprecedented in the literature for such species and the levels were much greater than seen elsewhere in the Bay: annual mean concentrations for copper and silver in clams were 287 μg/g and 105 μg/g respectively, in 1980. During this period of enriched metal concentrations, reproductive activity in the clam being monitored for metals was very low; this pattern is believed to be due to silver inhibition of reproductive tissue development. The benthic community also showed signs of environmental stress during this time. The community was dominated by opportunistic animals (organisms capable of fast invasion and spread in disturbed environments) that lived on the surface of the mud in tubes or as shelled animals, brooded their young, and fed on waterborne particles.

Concentrations of copper and silver declined after 1981, as the PARWQCP improved its waste treatment facilities, in both sediments and clams. The downward trends in copper content of animals correlated with reduced Cu discharges from the PARWQCP. The mudflat environment where these animals live is quite complex and variable from year-to-year; but over a long period of time (the 25 years of this study) it was obvious that there was no unidirectional trend in any environmental factor that might explain metal concentrations, metal effects, or benthic community changes. Particle size in sediment, salinity, organic content of sediment, and other factors varied seasonally and from one year to another, but none of these factors showed long-term trends. The only unidirectional change in an environmental factor during this period was the decline in metal inputs from the waste treatment plant, at least until the 1990's. Coincident with the decline in copper and silver in the sediment and clams, the reproductive activity of the clam greatly increased such that the periods of reproductive activity now exceed the periods with no activity. The benthic community also responded to this changed environment. Opportunistic species became less dominant and now there are more equally dominant, equally persistent, non-opportunistic species. The community, which was previously dominated by surface dwelling, brooding species, is now composed of species with varying life history characteristics. In particular, species that lay their eggs in the mud and feed by burrowing through and consuming the mud, which were previously rare in the community, have increased in abundance. The changes to the benthic community are “young” by the standards used to measure stability in estuarine benthic communities and patterns that are barely visible now may become more apparent in the future.

After a minimum concentration in 1991, copper and silver concentrations in clams increased slightly in the mid-1990's (annual maximum concentrations were ~100 μg/g for Cu and 12 μg/g for Ag). But after mid-1997, concentrations of these contaminants declined once more to about half the mid-90's concentrations. The concentrations in clams in the period 2001-2003 were approaching those seen in almost uncontaminated environments (e.g. Cu varied from 17 – 52 μg/g; typical reference site values are 20 – 30 μg/g).

Other metal contaminants have also been monitored since the early 1990's (including selenium and mercury). For all metals studied, regional influences and year-to-year differences appear to be much more important in determining exposures of bioavailable metals to clams than does the local influence of the PARWQCP (again, when compared to studies at San Jose). The concentrations in clams with the 2001-2003 study period varied from 1-5 μg/g for Ag, .13-.42 μg/g for Hg, and 2.9-6.7 μg/g for Se.

These studies demonstrated the effectiveness of changes in waste discharges that followed passage of the Clean Water Act in 1972. Metals were important pollutants in South Bay in the late 1970's through 1980's, and local discharges were an important source of those metals. That contamination has receded as the local facilities have reduced metal discharges.