

INTRODUCTION

This study evaluates the effectiveness of reduced wastewater inputs to the Bay

The Palo Alto Regional Water Quality Control Plant (PARWQCP) receives waste from industrial and residential sources

Following the passage of the Clean Water Act and subsequent treatment upgrades, the facilities at PARWQCP reduced contaminant loads.

A monitoring program was adopted using. Samples from effluents, sediments and a bioindicator clam species were used to establish links between discharge, bioaccumulation and effects.

Questions

What are the long-term (1977-2002) trends of metals in the sediments and clams near the outfall of the Palo Alto Regional Water Quality Control Plant (PARWQCP)?

Can point-source inputs be distinguished from non-point-source contributions?

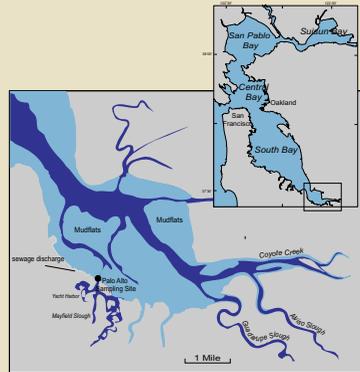
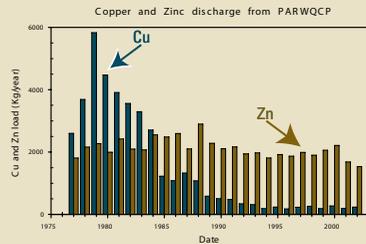
Is reproductive activity of *Macoma balthica* influenced by metal concentrations in real world

Sampling has been conducted on a near monthly basis since 1974

Near-monthly samples of surface sediments and the deposit feeding clam *Macoma balthica* have been collected since 1977 near the PARWQCP.

Fine grain sediments and clam soft tissues have been analyzed for metals (Ag, Cu, Fe, Mn, Zn from 1977 - present; Al, Cd, Cr, Ni and V added in 1991)

Reproductive stage was determined for *M. Balthica*.



TRACE METALS

Copper

Copper in sediments:

- Copper (Cu) concentration was observed to increase then decrease in response to loads from PARWQCP.
- Concentrations follow a seasonal cycle.
- Copper concentrations are generally above the effects range low guideline (ERL), but seasonally drop below ERL.
- Cu concentrations are approaching the regional background concentrations of 34 ug/g.

Copper in clams

- Cu concentrations in clams are seasonal.
- Cu concentrations have decreased in clams.
- From 1977 to 1989, yearly average concentrations of Cu correlate strongly with discharge from PARWQCP.
- After 1989, yearly average concentrations of Cu correlate more strongly with precipitation than with PARWQCP discharge.

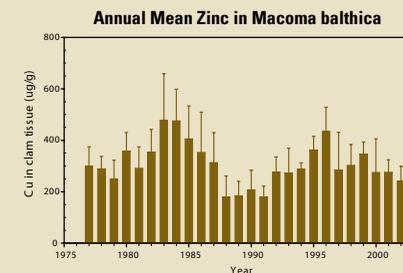
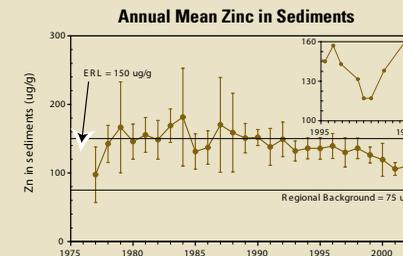
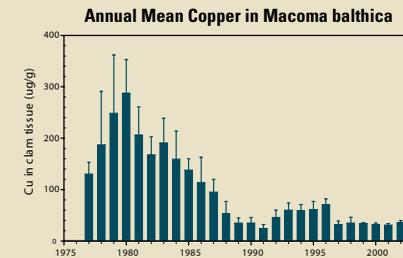
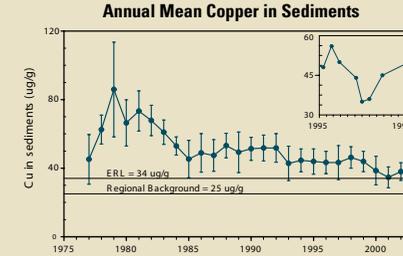
Zinc and other metals

Zinc:

- Concentrations of zinc (Zn) in sediments and clams follow a seasonal cycle
- Zn concentrations have remained below the ERL for the last 5 years.
- Average concentration of Zn in clams correlate more strongly with annual precipitation than with PARWQCP discharge.

Other trace metals:

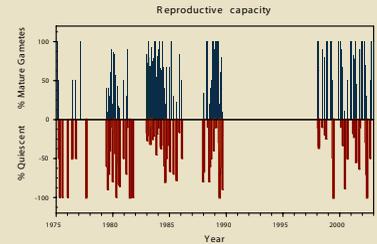
- Trace metals mercury (Hg), selenium (Se) and silver (Ag) have been found at concentrations above regional background concentrations.
- Ag showed similar temporal trends as Cu. Similarity was observed for sediments and clams on both annual and decadal scales.
- Hg and Se concentrations do not correlate with discharge or annual precipitation.



Reproduction

Reproductively active Individuals:

- Reproduction correlates strongly with copper concentrations.
- Reproduction was inhibited prior to 1983, when metal concentrations were highest.
- As metal concentrations have decreased, the proportion of individuals with mature gametes has increased.



SUMMARY & CONCLUSIONS

- Concentrations of Ag and Cu in sediments and clams have decreased in response to PARWQCP discharge reduction.
- The correlation Zn concentrations with precipitation suggest that environmental contamination is from nonpoint sources.
- The change in correlation from discharge to precipitation for Cu shows that Cu contamination was associated with PARWQCP but has now shifted to more diffuse sources.
- During periods of highest metal concentrations, reproduction *Macoma balthica* appeared to be

FUTURE WORK

- Monitoring program is expected to continue.
- In 2004, reproductive tissues of *M. balthica* will be isolated and analyzed for metal.
- The occurrence of additional contaminants such as flame retardants (PBDEs) is being explored at PA.
- Time series analysis will be used to further examine temporal trends.



REFERENCES

- Hornberger, M.I., Luoma, S.N., Cain, D.J., Parchaso, F., Brown, C.L., Bouse, R.M., Wellise, C., and Thompson, J., 2000. Linkage of bioaccumulation and biological effects to changes in pollutant loads in South San Francisco Bay. *Environmental Science and Technology*, 34:2401-2409.
- Moon, E., David, C.P.C., Luoma, S.N., Cain, D.J., Hornberger, M.I. and Lavigne, I.R. 2002. Near Field Receiving Water Monitoring of Trace Metals in Clams (*Macoma Balthica*) and Sediments Near the Palo Alto Water Quality Control Plant in South San Francisco Bay, California: 1999-2001. U. S. Geological Survey Open File Report 02-453. Menlo Park, California. 50pp.