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: 2002

U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT 03-339

Prepared in cooperation with the
CITY OF PALO ALTO, CALIFORNIA

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2003	**N/A**	**-**

4. TITLE AND SUBTITLE
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: 2002

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Department of the Interior U.S. Geological Survey 1849 C. Street, NW Washington, DC 20240

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**78**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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Menlo Park, California

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Abstract

This report presents trace element concentrations analyzed on samples of fine-grained sediments and clams (*Macoma balthica*) collected from a mudflat one kilometer south of the discharge of the Palo Alto Regional Water Quality Control Plant in South San Francisco Bay. This report serves as a continuation of the Near Field Receiving Water Monitoring Study, which was started in 1994. The data for 2002, herein, are interpreted within that context. Metal concentrations in both sediments and clam tissue samples have been within the range of values produced by seasonal variability. However, copper and zinc, display continued decreases. Copper in sediment was observed to drop below the ERL (Effects Range-Low) concentration for the third consecutive year and zinc concentrations never exceeded the ERL. Yearly average concentrations of copper, zinc and silver in *Macoma balthica* for 2002 are some of the lowest recorded since monitoring began in 1975. Mercury and selenium concentrations in sediments and clams at Palo Alto were similar concentrations observed elsewhere in the San Francisco Bay.

Introduction

Sampling sediments and benthic organisms in an estuary is a common method used to determine spatial distributions and temporal trends of metal contamination. Sediment particles strongly bind metals, effectively removing them from solution. As a result, sediments may retain metals released to the environment. Thus, concentrations of metals in sediments serve as a record of metal exposure in an estuary, with at least some integration over time. Fluctuations in the record may be indicative of changes in anthropogenic releases of metals into the environment.

Metals in sediments are also indicative of the level of metal exposure of benthic animals in contact with bottom sediments and suspended particulate materials. However, the route through which organisms assimilate bioavailable sediment-bound metal is not well understood. In order to better estimate bioavailable metal exposures, the tissues of the organisms themselves may be analyzed for trace metals. Benthic organisms concentrate most metals to levels higher than those that occur in solution, and therefore, the record of tissue metal concentrations can be a more sensitive indicator of anthropogenic metal inputs than the sediment record. Different species concentrate metals to different degrees. If one species is analyzed consistently, the results can be employed to indicate trace element exposures to the local food web. For example, silver (Ag), copper (Cu) and selenium (Se) contamination, originally observed in clams (*Macoma balthica*) at the Palo Alto mudflat, was later also found in diving ducks, snails, and mussels from that area (Luoma et al., USGS, unpublished data).

Because of the proven value of the above approaches for monitoring near field receiving waters, the California Regional Water Quality Control Board (RWQCB) has described a Self Monitoring Program, with its re-issuance of the National Pollutant Discharge Elimination System (NPDES) permits for South San Francisco Bay dischargers, that includes specific receiving water monitoring requirements. One of the requirements is for inshore monitoring of metals and other specified parameters using the clam *M. balthica* and fine-grained sediments. The monitoring protocols should be compatible with or complement the Board's Regional Monitoring Program. Monitoring efforts are to be coordinated with the U. S. Geological Survey's (USGS) 24 years of previous data collected from the site south of the Palo Alto discharge site.

Purpose

The purpose of this study is to present trace metal concentrations observed in sediments and clams at an inshore location in South San Francisco Bay. These data and those collected in earlier studies (Luoma et al., 1991; 1992; 1993; 1995; 1996; 1997; 1998; Wellise et al., 1999; David et al., 2002) will be used to meet the following objectives:

- Provide data to assess seasonal and year-to-year trends in trace element concentrations in sediments and clams in receiving waters near the Palo Alto Regional Water Quality Control Plant (PARWQCP) as designated in the RWQCB's Self-Monitoring Program guidelines.
- Present the data within the context of historical changes inshore in South San Francisco Bay and within the context of other locations in San Francisco Bay published in the international literature.
- Coordinate inshore receiving water monitoring programs for PARWQCB and provide data compatible with relevant aspects of the Regional Monitoring Program. The near field data will augment the Regional Monitoring Program as suggested by the RWQCB.
- Provide data, which could support other South San Francisco Bay issues or programs such as development of sediment quality standards.

Study Site

The Palo Alto site (PA) is located one kilometer south of the intertidal discharge point of the PA RWQCP (Figure 1). Spatial distributions of metal concentrations near the PARWQCP site were described by Thomson et al. (1984) (also reported by Luoma et al., 1991; 1992; 1993; 1995; 1996; 1997; 1998; Wellise et al., 1999; David et al., 2002). The PARWQCP appeared to be the primary source of the elevated metal concentrations at the PA site in the spring of 1980, based upon spatial and temporal trends of Cu, Ag and zinc (Zn) in clams and sediments (Thomson *et al.*, 1984; Cain and Luoma, 1990). Metal concentrations in sediments and clams (*M. balthica*), especially Cu and Ag, have declined substantially since the original studies as more efficient treatment processes and source control were employed that significantly reduced metal discharges from the treatment plant (Hornberger et al., 2000). However, frequent sampling within a year was necessary to characterize those trends since there was significant seasonal variability (Cain and Luoma, 1990; Luoma et al., 1985). This report characterizes data for the year 2002, employing the methods described in the succeeding section.

Previous reports (Luoma et al., 1995; 1996; 1997; 1998; Wellise et al., 1999) included a study area in addition to the Palo Alto sampling site. This area was located in a region that was influenced by discharge from the San Jose/Santa Clara Water Pollution Control Plant (SJ). Samples were collected from this site from 1994 to September 1999. Used as a reference, the SJ site allowed differentiation of local and regional long-term metal trends.

Methods

The PA site samples were collected from the exposed mudflat at low tide, with hand and shovel between January and December 2002. Samples collected in the field included surface water, sediment, and the deposit-feeding clam *M. balthica*.

Sediment

Sediment samples were scraped from the oxidized surface layers (1-2 cm) of mud. Thus, samples represent recently deposited sediments, or sediments affected by recent chemical reaction with the water column. Sediment samples were immediately taken to the laboratory and sieved through a 100 mm polyethylene mesh with distilled water to remove large grains that might bias interpretation of concentrations. The mesh size was chosen to match the largest grains typically found in the digestive tract of *Macoma balthica*. To provide a measure of bulk sediment characteristics at a site (and thus provide some comparability with bulk sediment determination such as those employed in the Regional Monitoring Program – San Francisco Estuary Institute (SFEI), 1997), the percent of the sediment mass that passed through the sieve was determined. This fraction is termed percent silt/clay in the following discussion. Previous studies have shown little difference between metal concentrations in sieved and unsieved sediments when silt/clay type sediment is dominant at a station. However, where sand-size particles dominate the bed sediment, differences can be substantial. Spatially and temporally, sediments in extreme South San Francisco Bay can vary in their sand content (Luoma et al., 1995; 1996; 1997; 1998; Wellise et al., 1999; David et al., 2002; also see SFEI, 1997). Where sand content varies, sieving reduces the likelihood that differences in metal concentration are the result of sampling sediments of different character. All sediment data reported herein were determined from the fraction that passed through the sieve (< 100 mm). Some differences between the USGS and the Regional Monitoring Program results (SFEI, 1997) reflected the bias of particle size on the latter's data.

The fraction of sediment that did not pass through the sieve was weighed and the percentage of the bulk sample was determined to assess percent sand and percent silt/clay in the sediment (Appendix A). The <100 mm fraction was dried at 60º C, weighed, and then measured into 0.4 to 0.6 gram aliquots in replicates for analysis. The samples were again dried at 60º C before re-weighing and extraction. The replicate sub samples were digested for near-total metal analysis by refluxing in 10 ml of concentrated nitric acid until the digest was clear. This method is comparable with the recommended procedures of US Environmental Protection Agency and with the procedures employed in the Regional Monitoring Program. It also provides data comparable to the historical data available on San Francisco Bay sediments. While near-total analysis does not result in 100% recovery of all metals, recent comparisons between this method and more rigorous complete decomposition show that trends in the two types of data are very similar (Hornberger et al., 1999). After decomposition, samples were evaporated until dry and reconstituted in dilute hydrochloric acid for analysis. The hydrochloric acid matrix was specifically chosen because it mobilizes silver (Ag) into solution through the creation of Ag-chloro complexes. Sediment samples were also subjected to a partial weak acid extraction in 0.6 N Hydrochloric acid (HCl), as a crude chemical estimate of bioavailable metal. These sub samples were extracted for 2 hours with 12 ml of acid at room temperature. The extract was pressure filtered through a 0.45 mm membrane filter before analysis. Percent organic carbon, percent organic nitrogen, d13C, d15N were determined using a continuous flow isotope ratio mass spectrometer (IRMS) (Appendix A). Prior to analysis, samples were acidified with concentrated HCl vapor to remove inorganic carbon.

Clams

More than 60 individuals of *M. balthica* were collected on each sampling occasion. When possible, the range of sizes (shell length) was maximized by intensive field sampling. Salinity was determined for surface water and the mantle water of clams at the time of collection using a refractometer. Mantle water and surface water salinity were typically within 1 ppt (‰) of each other. Only surface water values are reported. Clams were returned to the laboratory and held for 48 hours in ocean water diluted to the ambient salinity at the time of sampling, to depurate undigested material from their digestive tracts. After depuration, the individual clams were separated into 1 mm size classes. Soft tissues from all of the individuals in a size class were collected to constitute a single sample for analysis. Samples for each date were thus composed of six to thirteen replicate composites, with each composite consisting of 3 to 15 clams of a similar shell length. Calm tissue samples were dried, weighed and refluxed in concentrated nitric acid until the digest was clear. Digests were then dried and reconstituted in dilute 0.6 N hydrochloric acid for trace metal analysis.

Metals Analysis

Metals analysis was conducted by using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) (Appendix B and C). Mercury (Hg) and Se were determined in both sediment and clam tissues by Hydride Atomic Absorption Spectrophotometry (Appendix D). Mercury subsamples were digested at 100º C in aqua regia, re-digested in 10 percent nitric acid plus potassium dichromate and then reduced at the time of the hydride analysis.

All glassware and field collection apparatus used were acid washed, thoroughly rinsed in ultra-clean deionized water, dried in a dust-free positive pressure environment, sealed and stored in a dust free cabinet. Quality control was maintained by frequent analysis of blanks, analysis of National Institute of Standards and Technology (NIST) standard reference materials (tissues and sediments) with each analytical run, and internal comparisons with prepared quality control standards. A full QA/QC plan is available upon request. Analyses of NIST reference materials (oyster tissue, San Joaquin soils) were within an acceptable range of certified values reported by NIST or were consistent where the nitric acid digest did not completely decompose the sediment samples (Appendix E). High recoveries for cadmium (Cd) have been observed for the sediment standard. As a result, Cd in the sediments for 2002 is not presented in this report. When this instrument interference is corrected or the samples are re-run with conventional atomic absorption spectrometry (AAS) the data for 2002 will be added to the previous dataset (Appendix F).

Results and Discussion

Salinity

Surface water salinity values show a seasonal pattern governed by wet and dry seasons (Figure 2, Table 1). Salinities were low during the winter rainy season and salinities were high summer dry season. Overall high salinities for 2002 were recorded indicating relatively low runoff during the previous winter. Salinity did not go below 21 ppt during the winter of 2002, representing the highest wintertime salinity in eight years. The peak salinity for 2002 was the highest recorded maximum during the 9 years of this study.

Sediments

Percent silt/clay in sediments indicates particle size distributions before sediments were sieved. At Palo Alto, percent silt/clay typically varied from 50 - 100% by weight (Figure 3). Aluminum (Al) and iron (Fe) concentrations changed directly with the proportion of clay-size (very fine) particles within the 100 mm fraction of the sediment after sieving (Figure 3, Table 1). Percent silt/clay, Al and Fe tended to follow a seasonal cycle of relative increases early in the year then declining to a minimum by September or October. The seasonal trend, especially for Al and Fe concentrations, was typical of that reported earlier for this site by Thompson-Becker et al. (1985). Those authors suggested that fine sediments, accompanied by high Al and Fe concentrations, are dominant during the period of freshwater input (low salinities through April), reflecting annual terrigenous sediment inputs from runoff. Coarser sediments dominated later in the year because the seasonal diurnal winds progressively winnow the fine sediments into suspension through the summer. The total organic carbon content of the sediments remains generally constant throughout the year with an average of 1.18% (Table 1).

The trace metals chromium (Cr), nickel (Ni) and vanadium (V) in sediments show a seasonal cycle (Figure 4, Table 2). The pattern of seasonal change for these metals in 2002 was typical of earlier years, with the highest concentrations early in the year (winter maximum) and the lowest concentrations in September-November. These metals are strongly enriched in some geologic formations within the watershed. In North San Francisco Bay, studies of sediment cores indicated that concentrations of these elements similar to that reported here were derived from natural geologic inputs (Hornberger et al., 1999). However, Cr and Ni also occur in the effluents of the PARWQCP. The seasonal variability and the similarities among Cr, Ni and V continued to suggest that hydrogeologic processes were the predominant influence on concentrations of these elements.

Copper exhibits a seasonal cycling signature (Figure 5, Table 2). Seasonal minima concentrations of near-total Cu in 2002 dropped below the effects range-low (ERL) guidelines set by the National Oceanic and Atmospheric Administration (Long et al., 1995). However, this drop was not as large as that observed in 2000 and 2001 (David et al., 2002). Long et al. (1995) defined values between ERL (Effects Range-Low) and ERM (Effects Range-Median) as concentrations that are occasionally associated with adverse effects (21 - 47% of the time for different metals). Values greater than the ERM were frequently associated with adverse effects (42% - 93% of the time for different metals). It must be remembered, however, that these effects levels were derived mostly from bioassay data and are not accurate estimates of sediment toxicity. The continued decrease in near-total Cu in sediments was also reflected in the partial-extractable trend (Figure 5). In 2002, the wintertime maximum was the lowest ever observed.

This maximum was similar to the minima of previous years. The summertime minimum concentration of 2002 matched the previously recorded low in 2001.

Zinc concentrations continued to show a decreasing trend (Figure 6). In 2002, the winter maximum for total extractable Zn, again fell below the Zn ERL. For partial-extractable Zn the lowest winter maximum and summer minimum were observed.

Concentrations of partial-extractable Ag in sediments did not show the decrease and maintained the range of concentration that was perceived to be attributable to seasonal cycling of the element (Figure 7, Table 2). This range was above the established concentration for uncontaminated sediments in San Francisco Bay (Hornberger et al., 1999) but well below the Ag ERL.

Mercury concentrations in Palo Alto sediment remained consistent with earlier years at an enrichment level typical of San Francisco Bay as a whole (0.2 - 0.4 µg/g) (Figure 8 and Table 2).

Concentrations of Se in sediments showed a maximum in February 1999 that was more elevated than the corresponding seasonal maxima in previous years. (Figure 8 and Table 2) This maximum was followed by relatively low concentrations in 2000 and 2001. In 2002 the relatively low concentrations of Se continued. The maximum Se concentration observed in PA sediment in February 1999 was comparable to the highest concentrations observed in sediments anywhere in the San Francisco Bay (Hornberger et al., 1999).

Clams

Exposures to Cu and Ag, as reflected in clam tissues, have been of special interest due to the high concentrations that these metals recorded in the 1970s and 1980s (Figures 9&10, Tables 3&4, respectively). Trends in these two metals at Palo Alto were lower throughout the 1990s than in the years prior to 1988. The previous minimum concentrations were observed in 1991, but a five-year period of slightly increased concentrations followed. Concentrations declined in 1997 and have remained relatively constant through 2002. Concentrations for the last five years are among the lowest observed during the 20-year period of study.

Intra-annual variations in Cu concentrations in clam soft tissues display a consistent seasonal signal, with fall/winter maxima and spring/summer minima (Figure 11). Winter maxima have declined over the last five years. This trend seemed to have started in mid-1997 wherein the range of Cu concentrations decreased to only 17-48 µg/g as opposed to 21-100 µg/g in previous years. Silver also displayed a seasonal signal and the same depressed winter maxima which started in 1997 (Figure 12).

Seasonal cycles were also exhibited in Cr (Figure 13, Table 2), Ni (Figure 14, Table 2) and Zn (Figure 15, Table 2). Wellise et al. (1999) observed that the trends of these metals Cr, Ni and Zn in Palo Alto clam samples were similar to those from the San Jose site, suggesting that regional-scale processes may be more important than treatment plant inputs in controlling seasonality and bioavailability of these elements. The seasonality signal continued in 2002 wherein the lowest Cr, Ni, and Zn concentrations were observed during summer (June-September), and the maxima typically occurred during winter (December-March). The lowest Cr concentration ever observed occurred in September of 2002. However for Ni, the winter concentrations were higher than those observed in the last 3 years and the December 2002 value was the highest seen in 5 years. For Zn there appears to be a general decreasing trend in winter maxima concentrations since 1996. In 2002, the lowest winter maximum Zn concentration was recorded.

In 1996, there was a decrease in mercury concentrations (Figure 16). Since 1996, lower levels of Hg have persisted. In 2002, Hg concentrations continued to be lower than the pre-1996 decrease (Figure 16).

Selenium concentrations in clam tissue and sediments showed similar trends (Figure 17). The average sediment concentrations in 2001 and 2002 were lower than previous years. In 2002, concentrations in clams had the lowest average values recorded to date (<3 μg/g to 4 μg/g).

Condition index (CI) is a measure of physiological "fatness", the tissue weight of a clam of a given for a given length. It is an index of the clams' well-being and is linked to the seasonal reproductive cycle. Seasonally, a clam of a given shell length will increase in weight as a part of growth and during the early stages of reproduction. This weight is then lost during and after reproduction. Other stressors such as pollutant exposure, salinity extremes or lack of food can also reduce condition index.

The condition index for 2002 was greater than many previous years (Figure 18). The high CI in 2002 at PA coincided with reduced concentrations of Cu and Ag. Moreover, while CI maxima were typically within the range of values observed in previous years, the annual minima for 2002 are among the highest in the 15-year dataset. This may be suggestive of further improvement in clam physiology, however, further investigation is necessary to understand the dynamics of food availability and condition to interpret this observation. A simple correlation between maximum condition index and the preceding months' maximum metal exposure was not significant (Figure 19). Still, the data distribution raised the possibility that Cu concentrations above 80 - 90 μg/g might affect growth in the bivalves.

Conclusion

Frequent sampling is essential for characterizing ambient metal concentrations in the environments in the vicinity of the outfall. Monitoring studies could not always unambiguously determine the causes of the trends in metals concentrations in either sediments or clams. The value of monitoring was to describe trends, identify previously undocumented phenomena, and raise otherwise unrecognized hypotheses that might guide detailed explanatory studies. The interpretation of time series data allows the separation of signals from anthropogenic sources and natural annual and inter annual variability. For many elements of regulatory interest, including Cr, V, Ni, and Zn, regional scale factors appeared to influence sedimentary and bioavailable concentrations, although this may not be completely accurate in all years. The decrease in Cu and Ag concentrations in clam and sediment samples reflected the continued decrease in the loading of these metals from the treatment plant. Other variables that may contribute to this decline in concentration such as a decrease in precipitation for 2002 should still be investigated.

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Figures

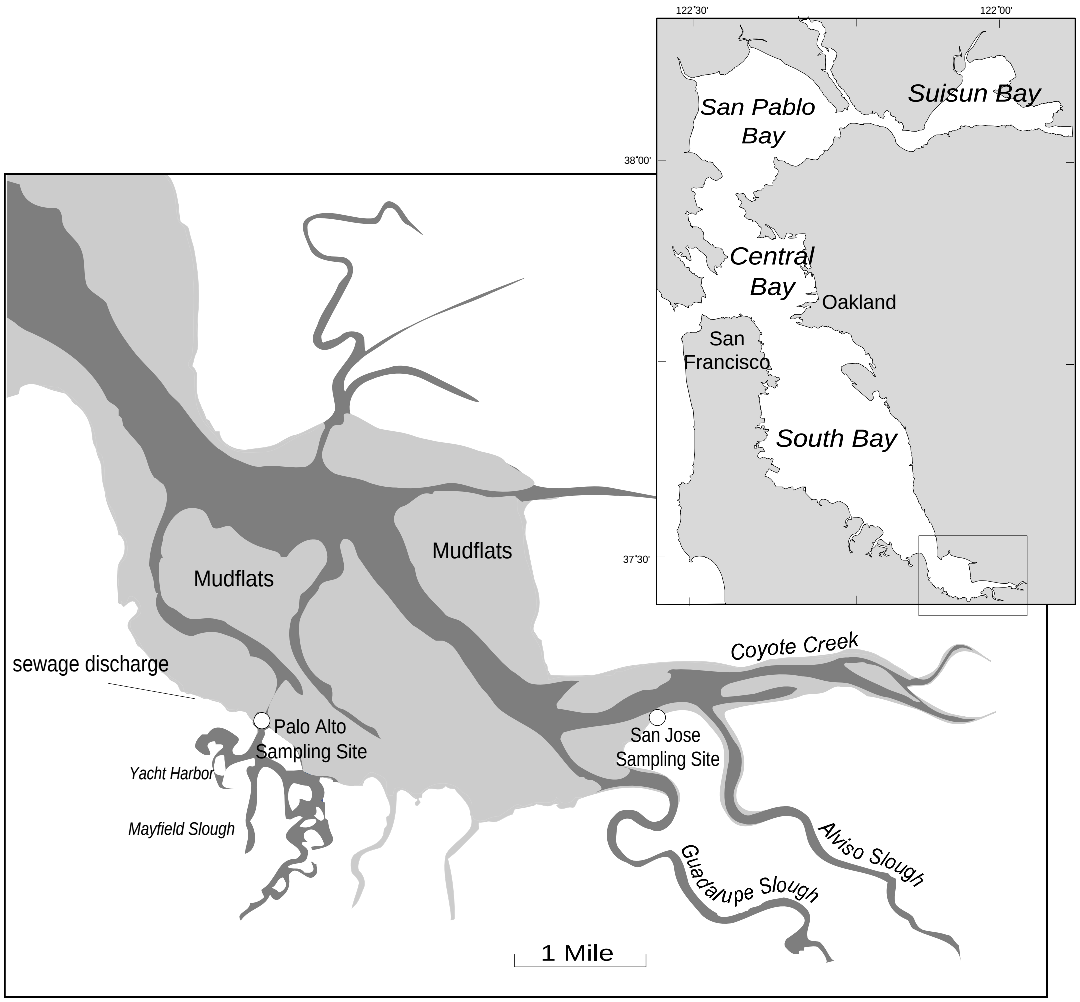


Figure 1. Location of the Palo Alto sampling station in South San Francisco Bay.

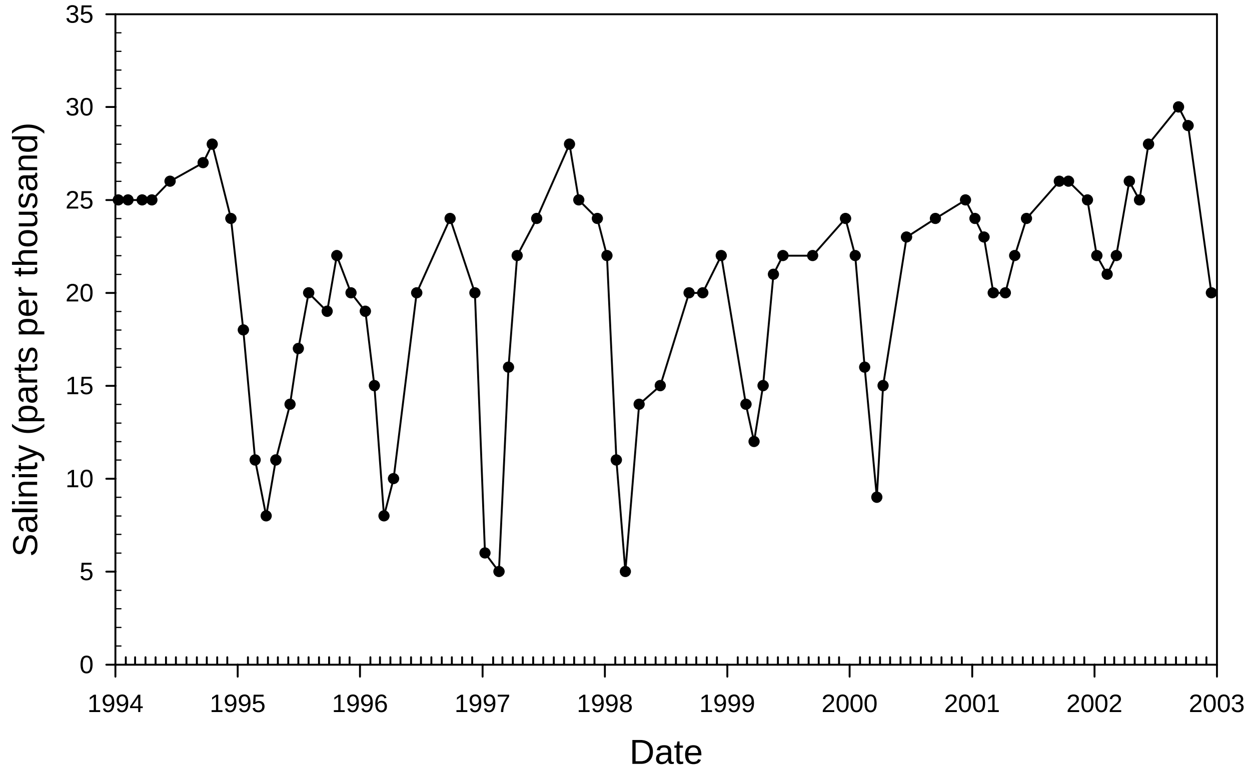


Figure 2. Water column salinity at Palo Alto from 1994 through 2002.

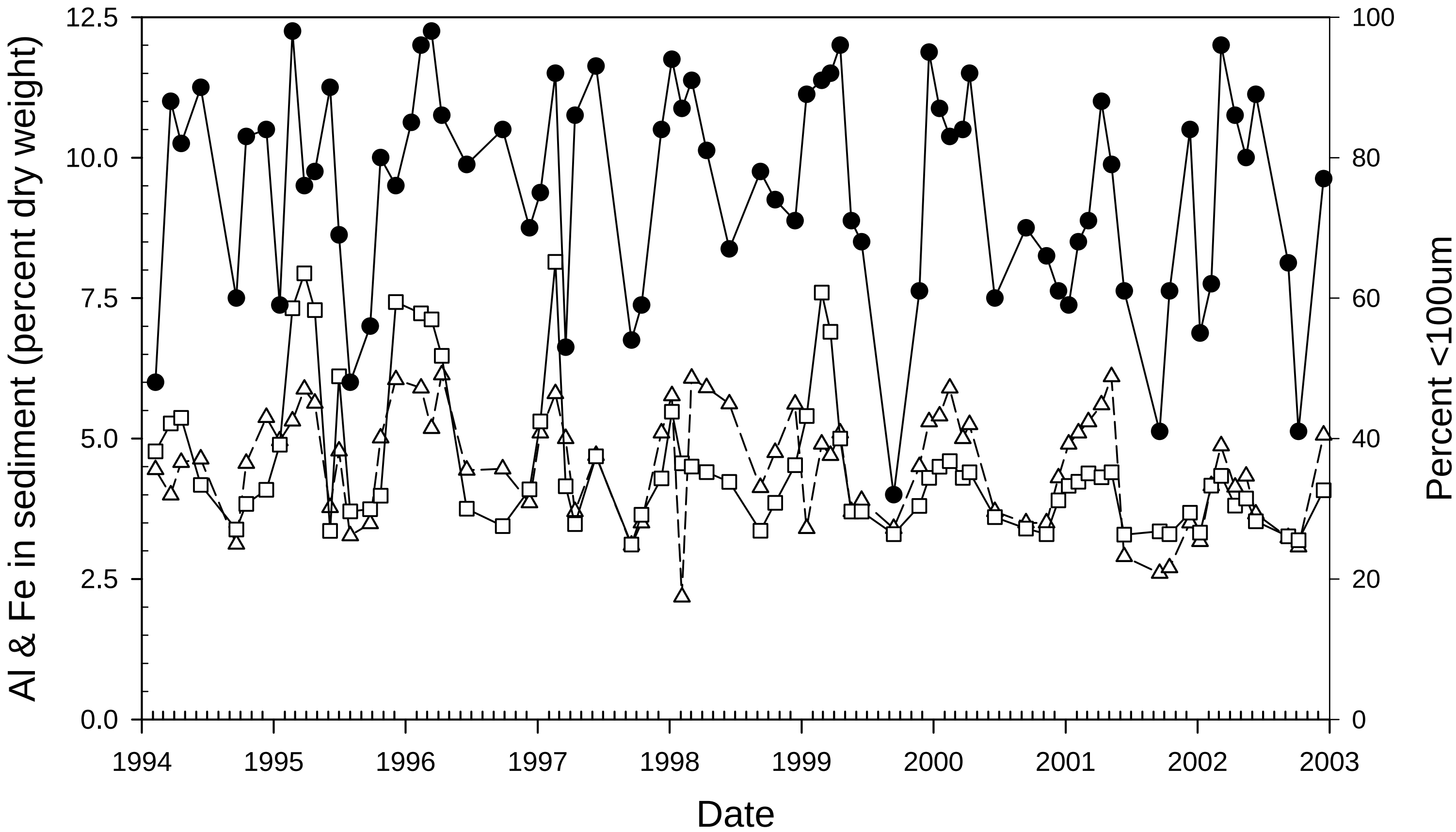


Figure 3. Percent aluminum (△), iron (□) and silt/clay (●) in sediments at Palo Alto from 1994 through 2002.

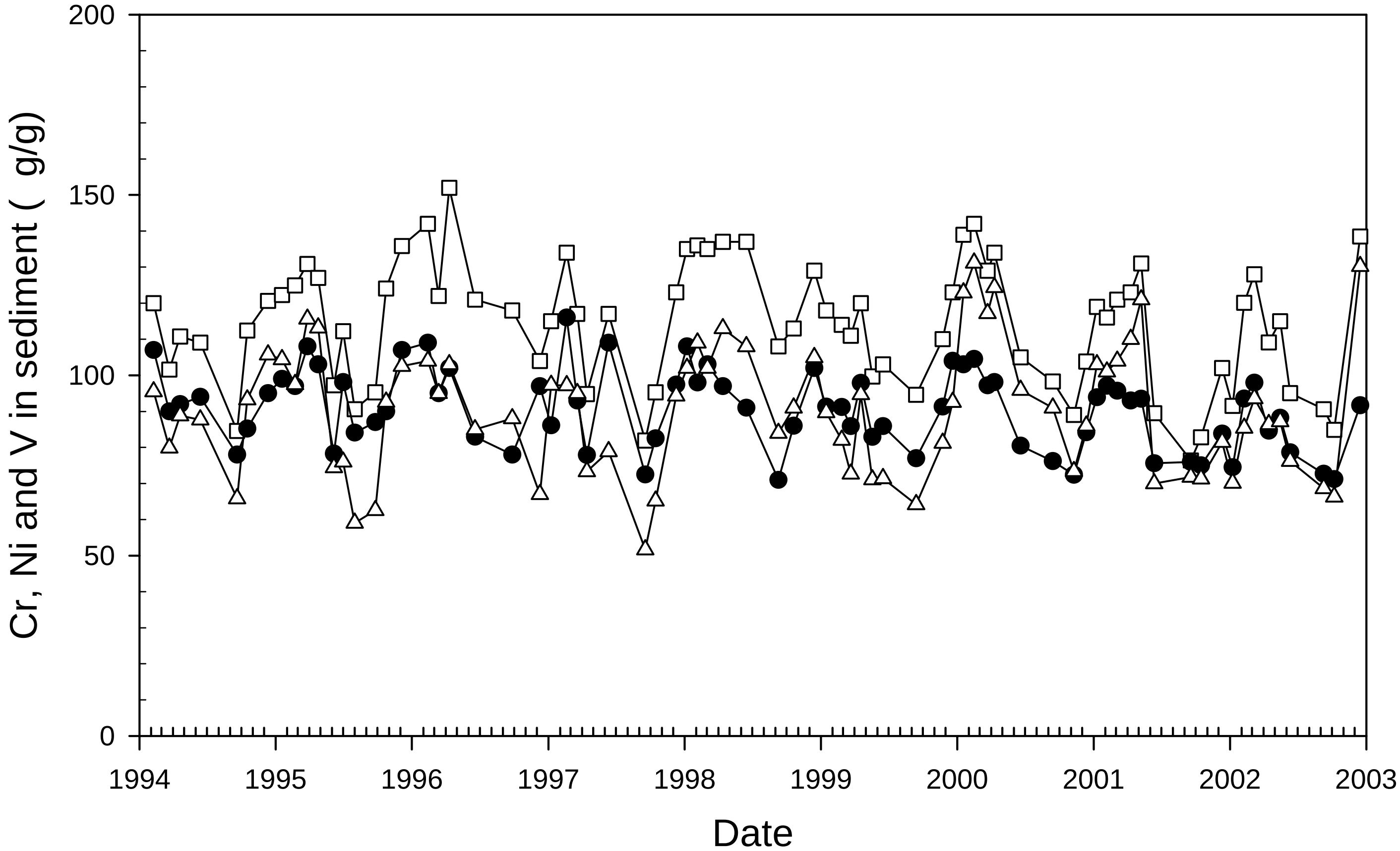


Figure 4. Near-total extraction concentrations of chromium (Cr) (□), nickel (Ni) (●) and vanadium (V) (△) in sediments at Palo Alto from 1994 through 2002.

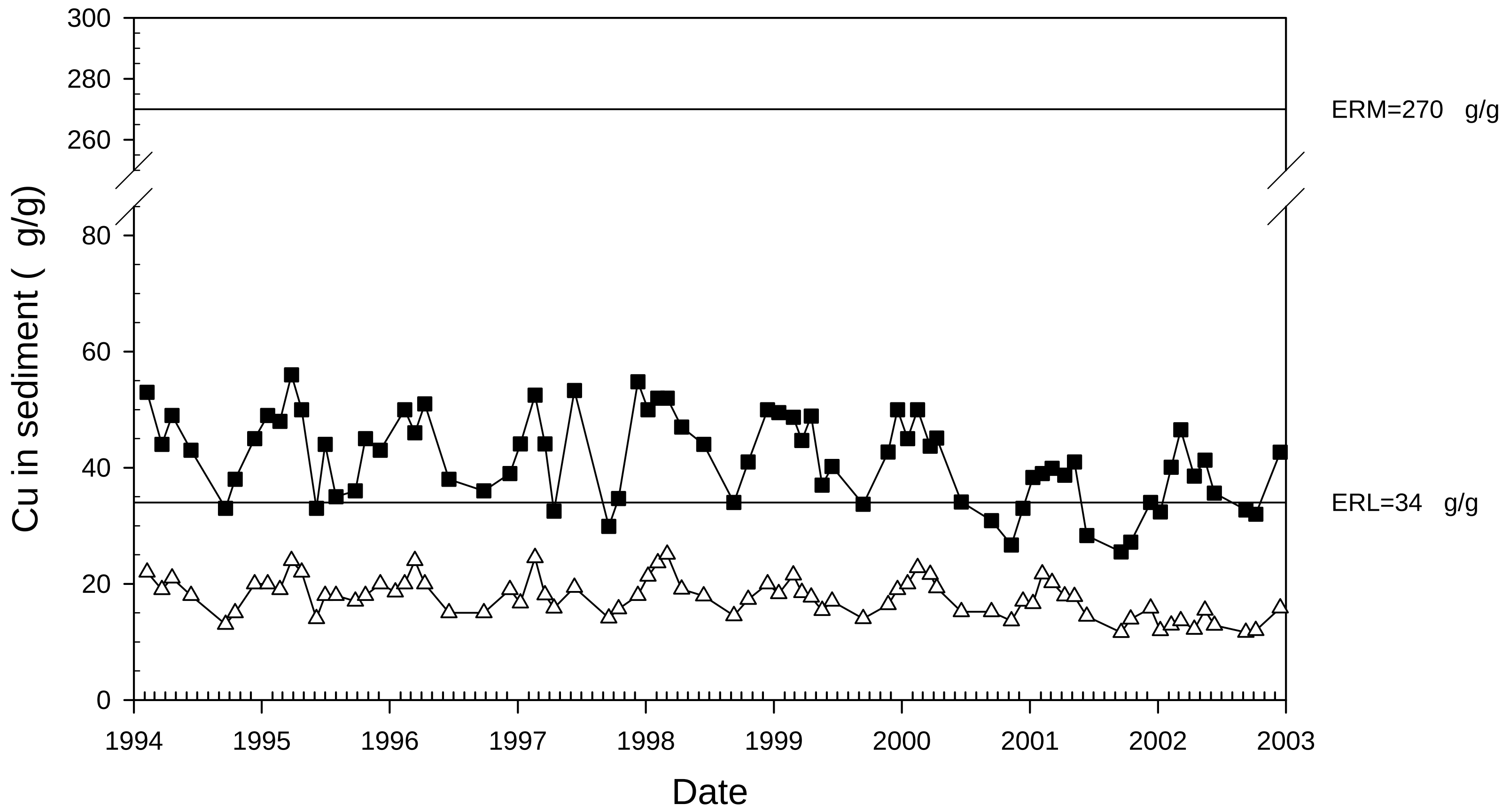


Figure 5. Near-total (■) and partial-extractable (△) copper concentrations in sediments at Palo Alto from 1994 through 2002.

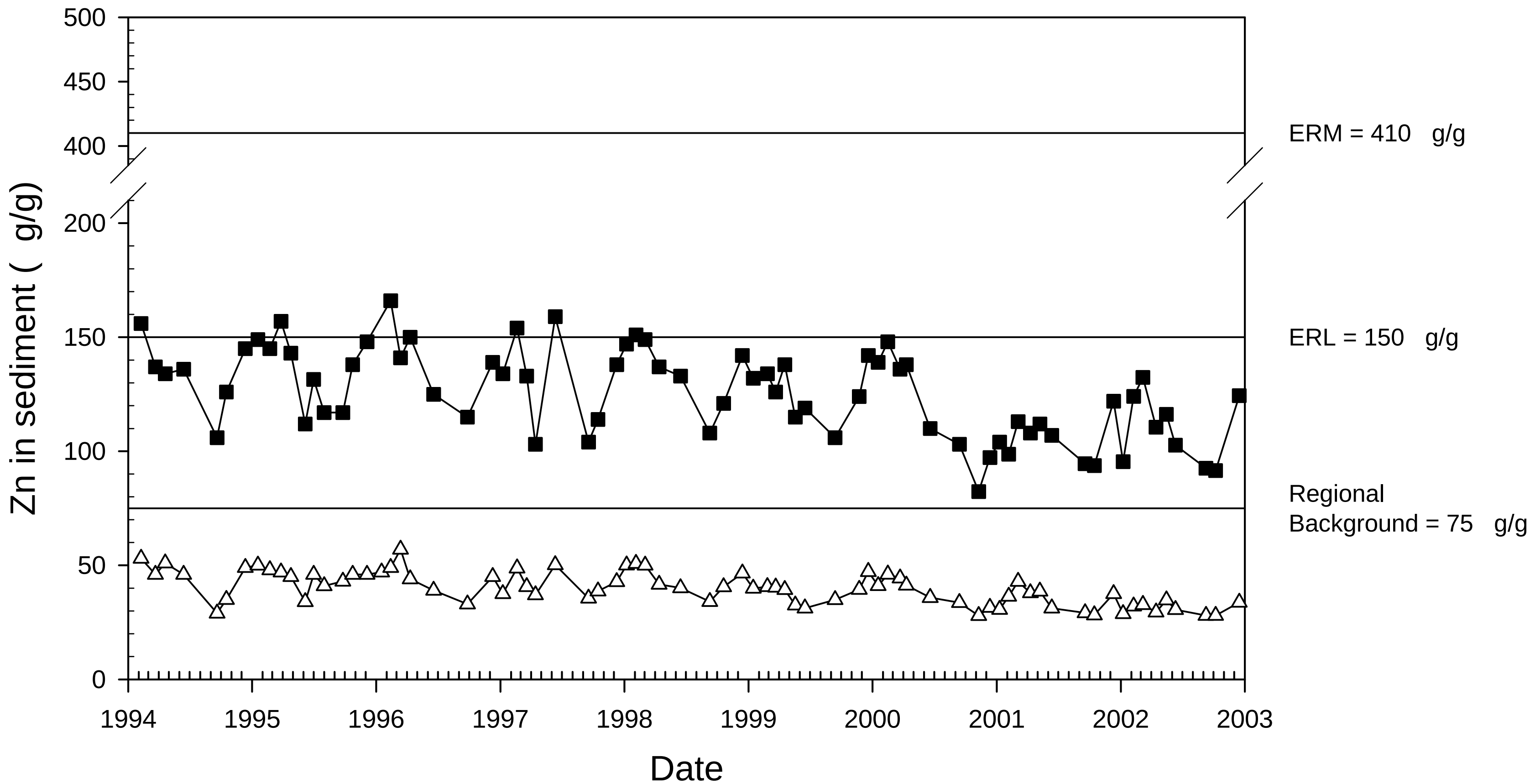


Figure 6. Near-total (■) and partial-extractable (△) zinc concentrations in sediments at Palo Alto from 1994 through 2002.

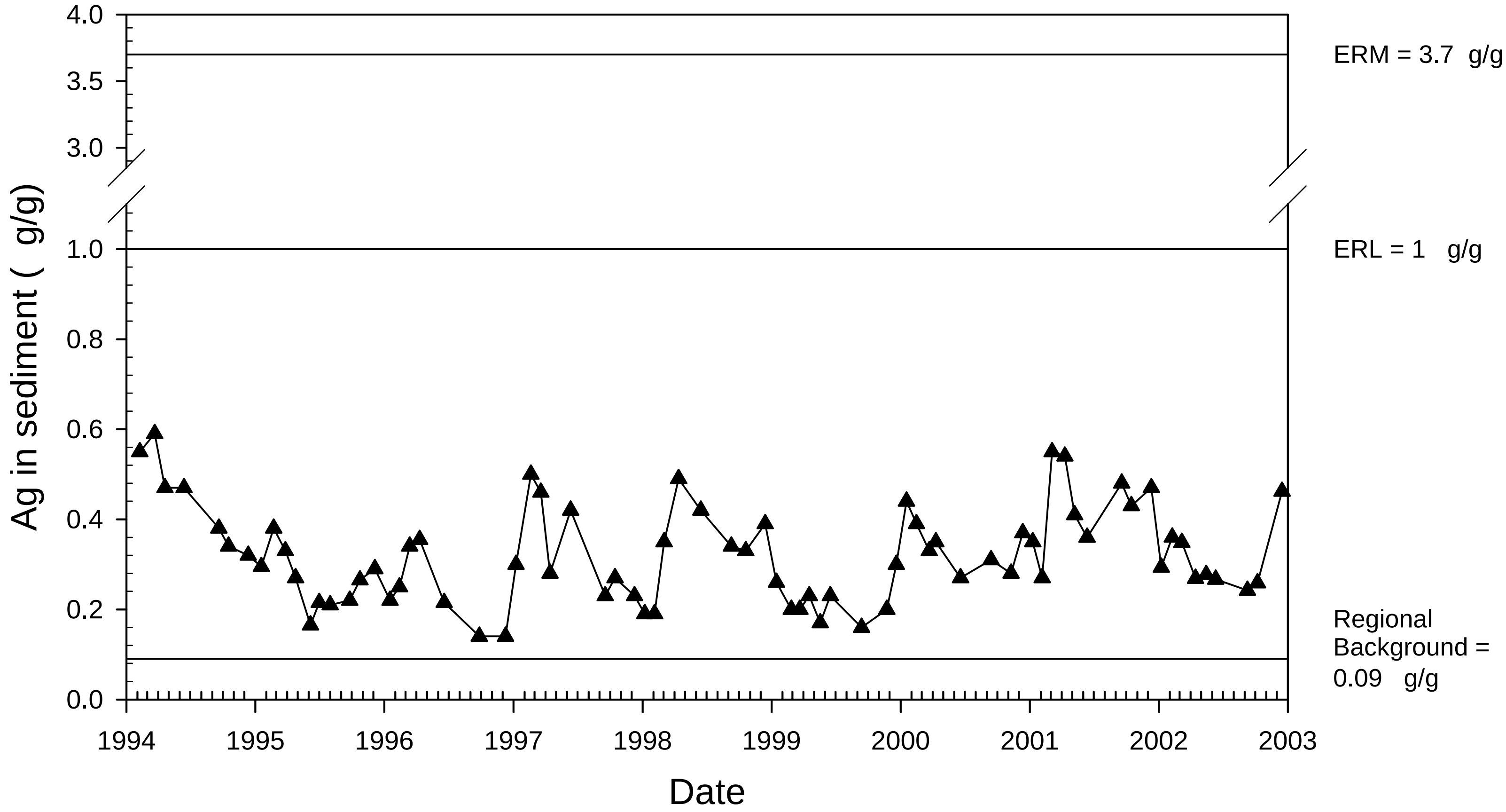


Figure 7. Acid-extractable silver concentrations in sediments at Palo Alto from 1994 through 2002.

Extractions were conducted with 0.6 N hydrochloric acid.

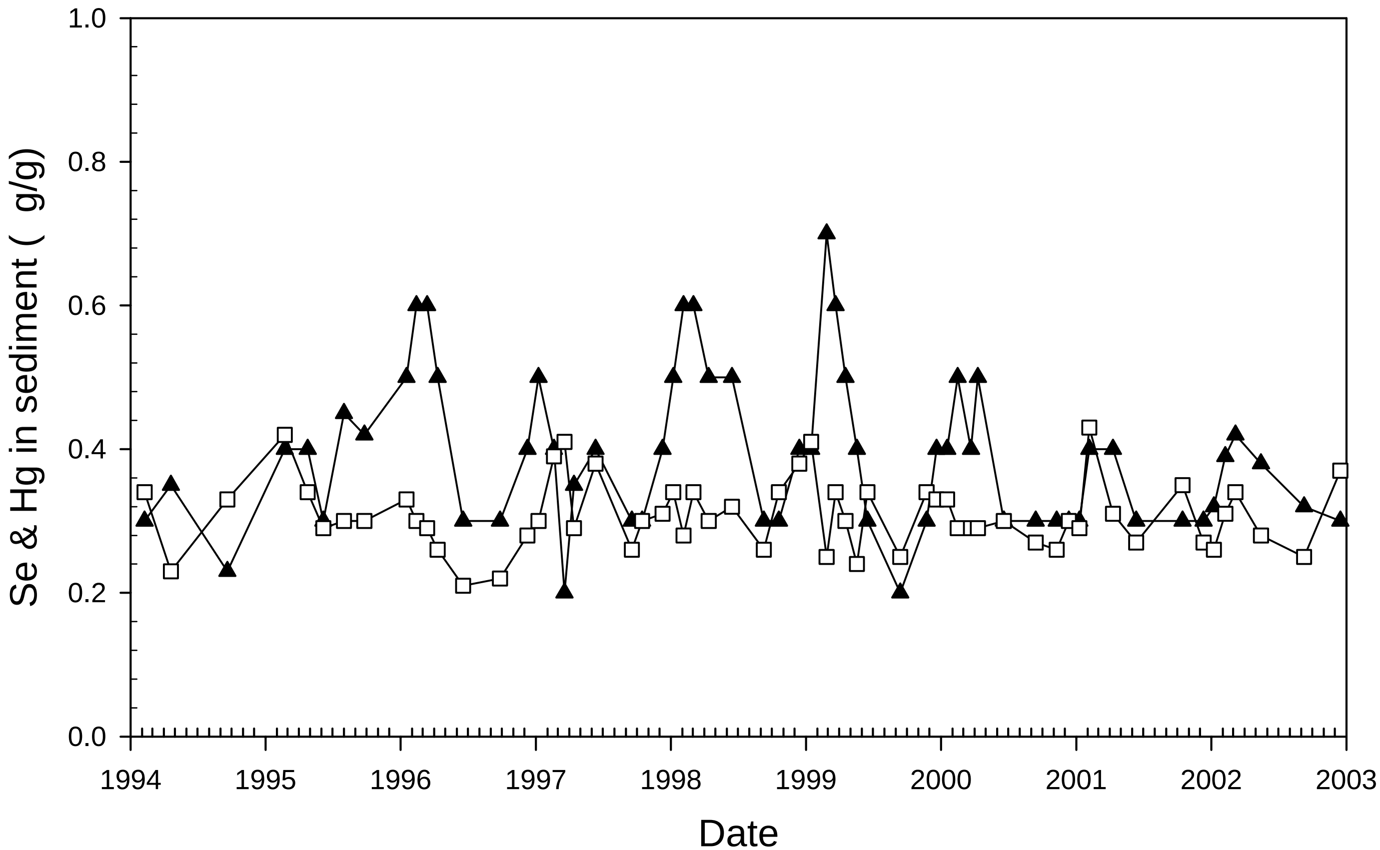


Figure 8. Concentrations of selenium (▲) and mercury (☐) in sediments at Palo Alto from 1994 through 2002.

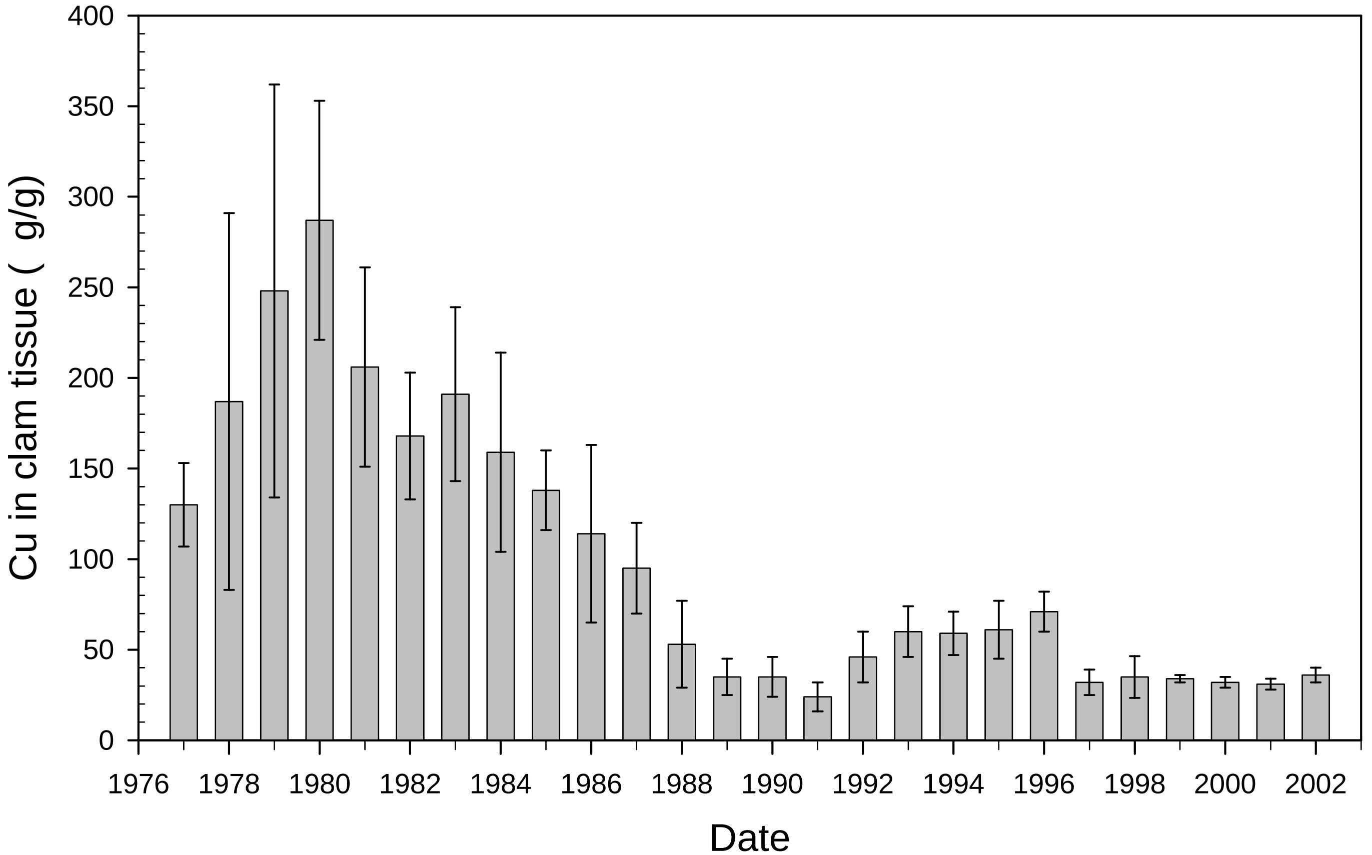


Figure 9. Annual mean concentrations of copper in *Macoma balthica* at Palo Alto from 1977 through 2002.

Error bars are the standard error of the mean (SEM).

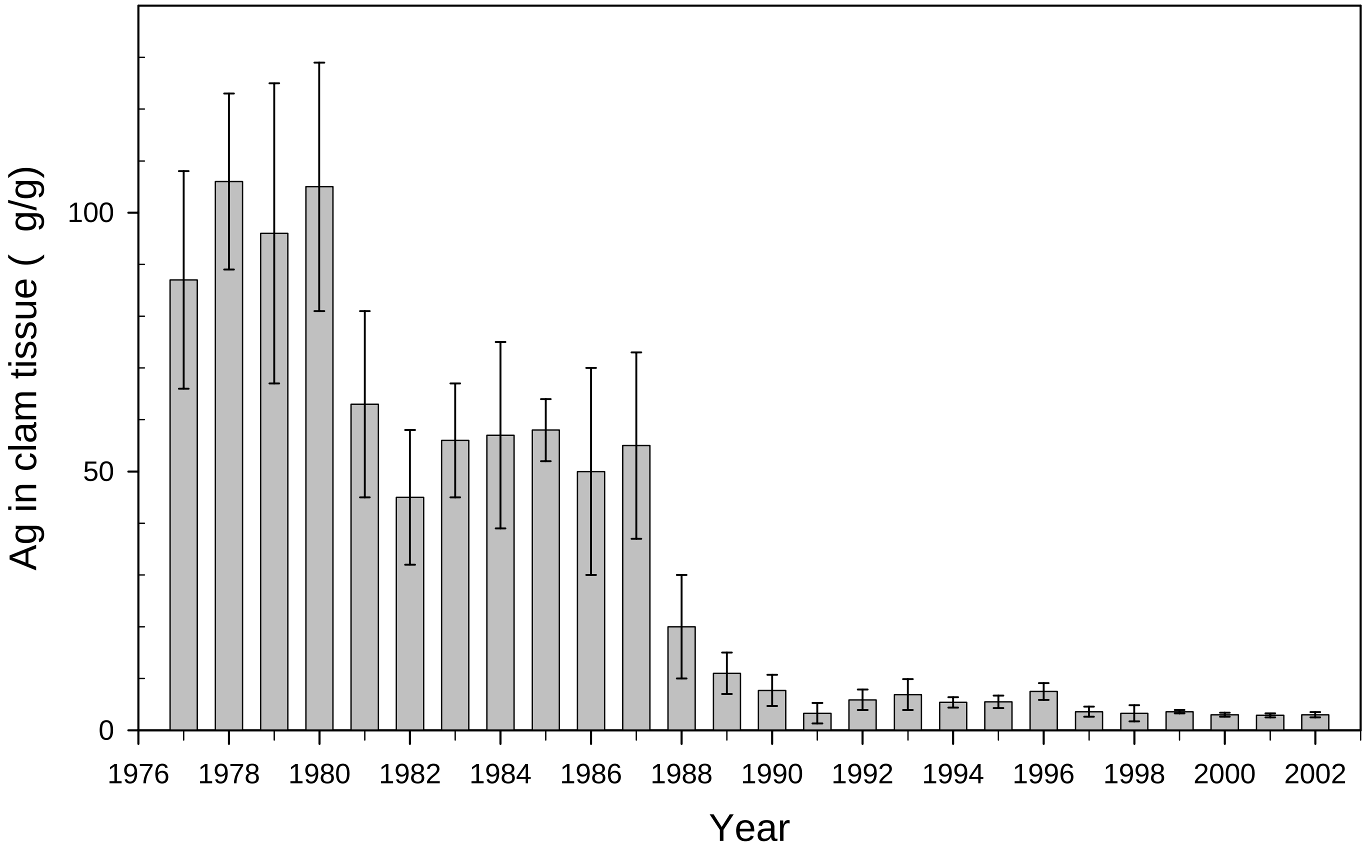


Figure 10. Annual mean concentrations of silver in *Macoma balthica* at Palo Alto from 1977 through 2002.
Error bars are the standard error of the mean (SEM).

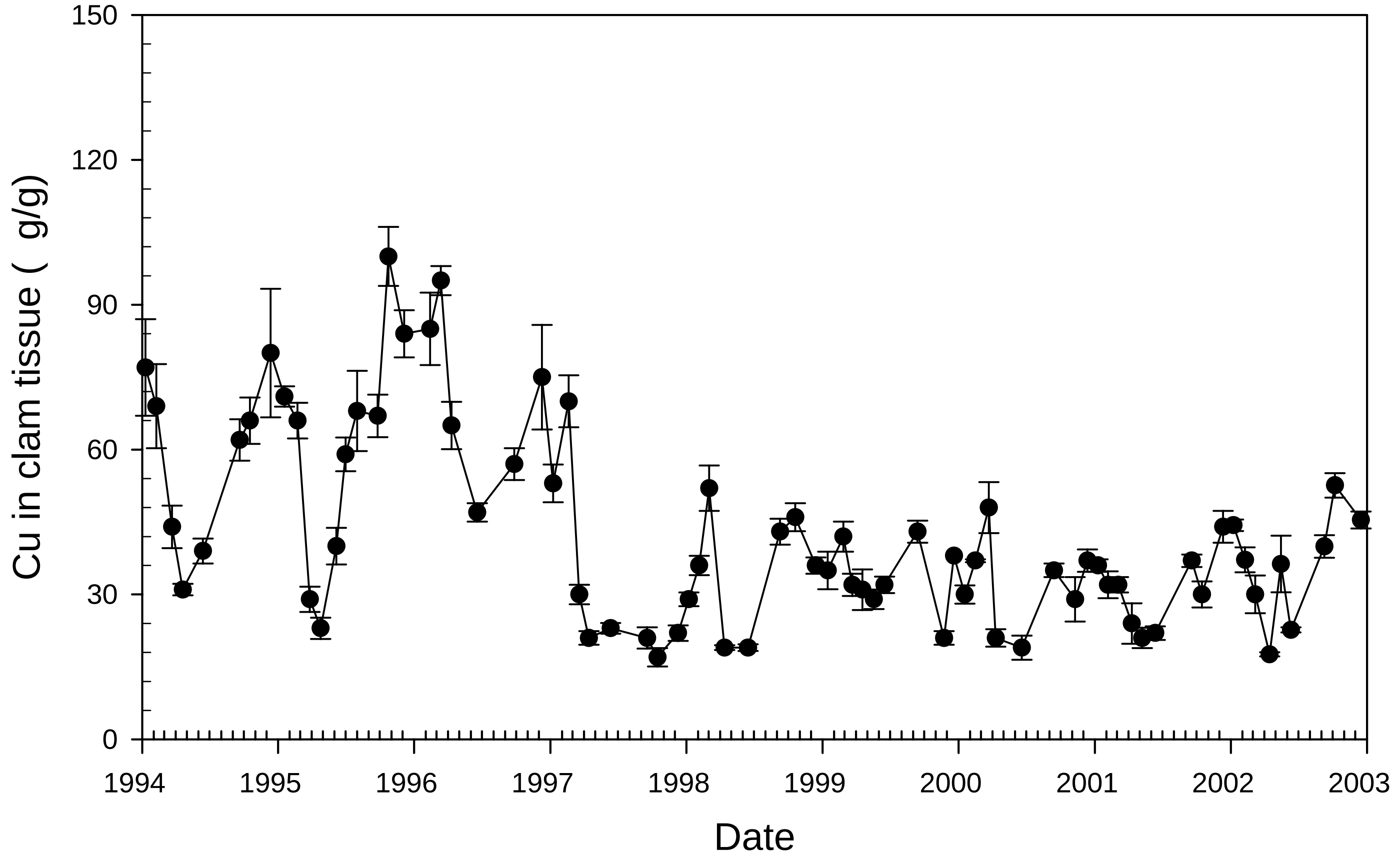


Figure 11. Concentrations of copper in *Macoma balthica* at Palo Alto from 1994 through 2002.

Error bars are the standard error of the mean (SEM).

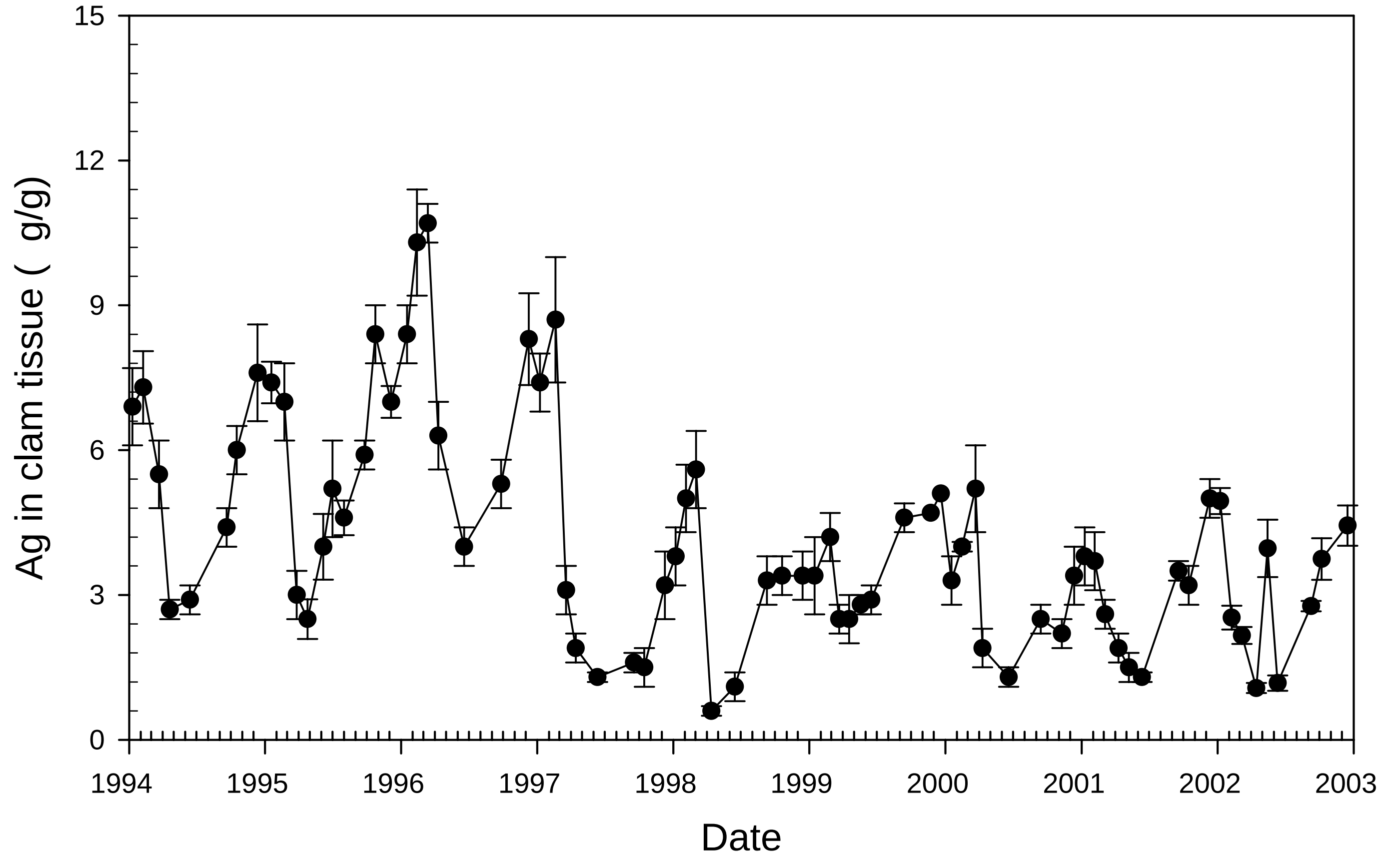


Figure 12. Concentrations of silver in *Macoma balthica* at Palo Alto from 1994 through 2002.

Error bars are the standard error of the mean (SEM).

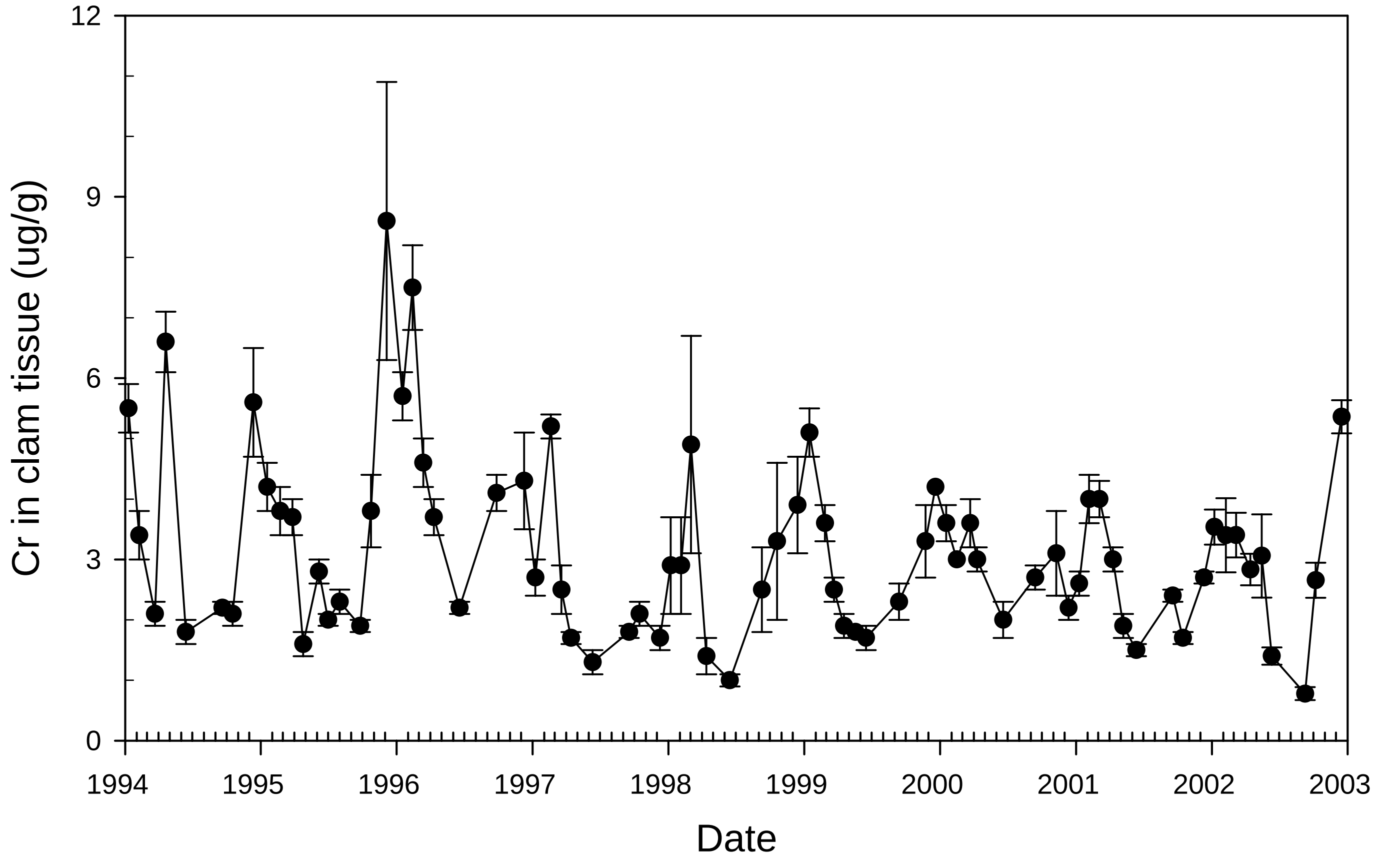


Figure 13. Concentrations of chromium in *Macoma balthica* at Palo Alto from 1994 through 2002.

Error bars are the standard error of the mean (SEM).

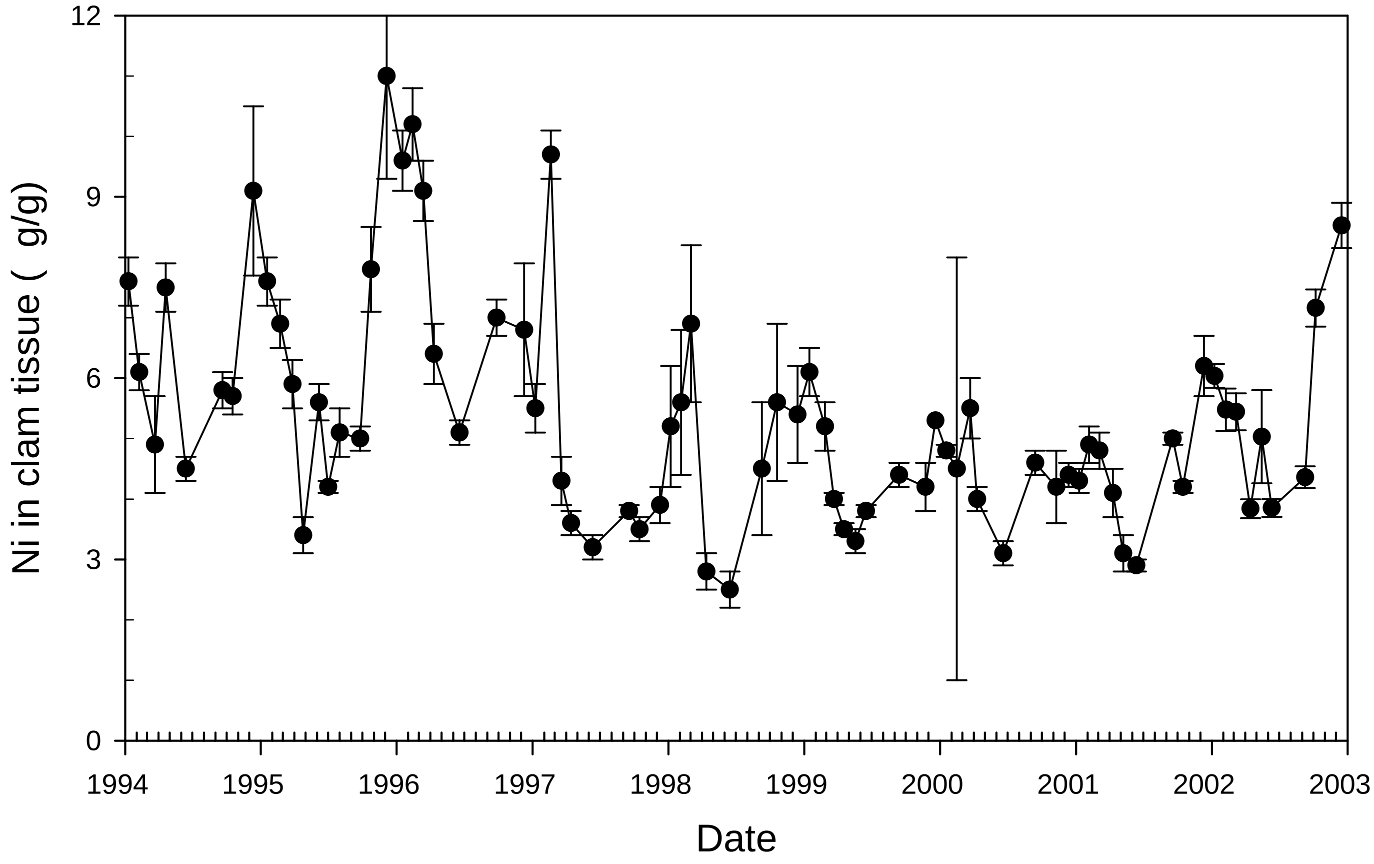


Figure 14. Concentrations of nickel in *Macoma balthica* at Palo Alto from 1994 through 2002.

Error bars are the standard error of the mean (SEM).

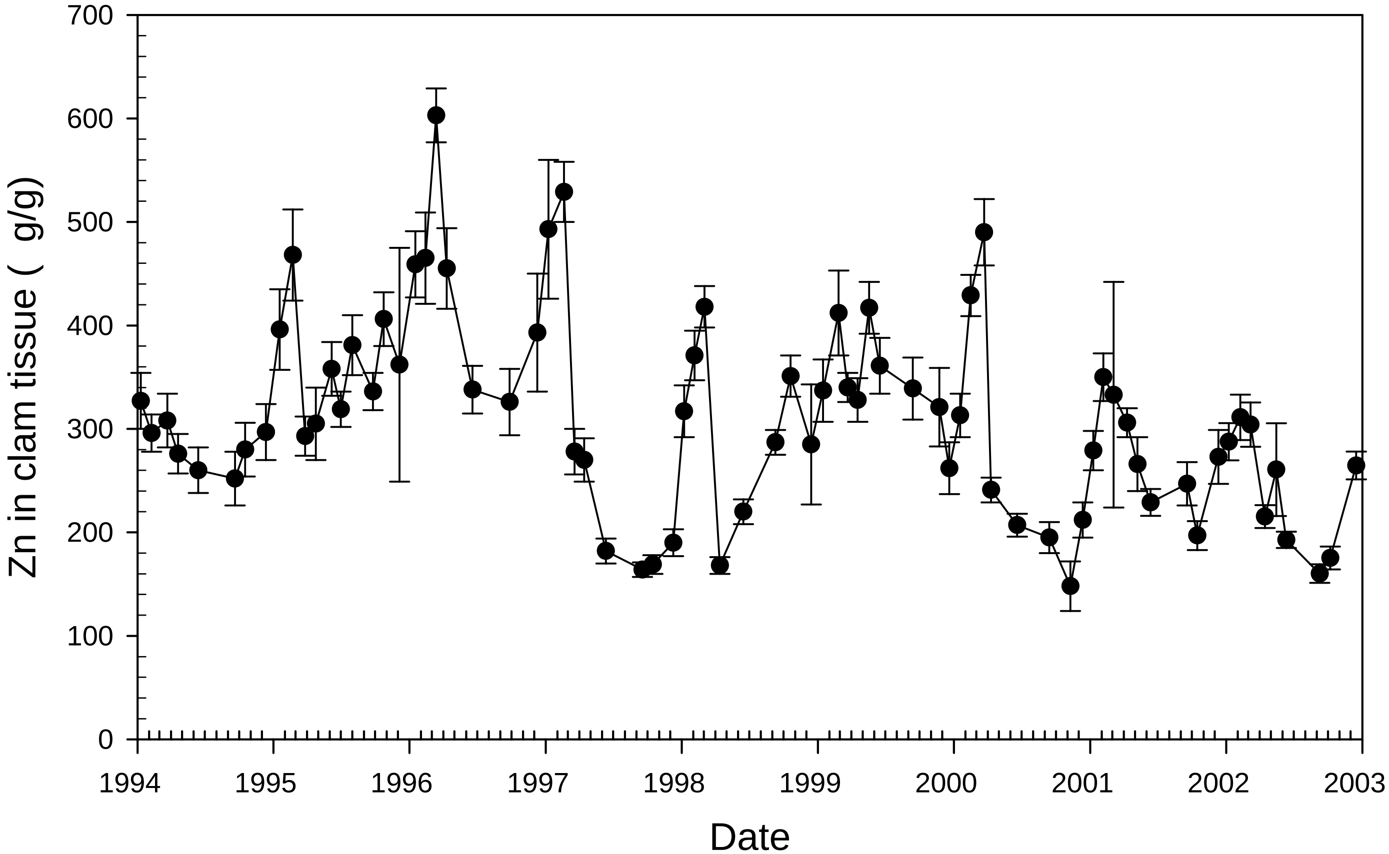


Figure 15. Concentrations of zinc in *Macoma balthica* at Palo Alto from 1994 through 2002.

Error bars are the standard error of the mean (SEM).

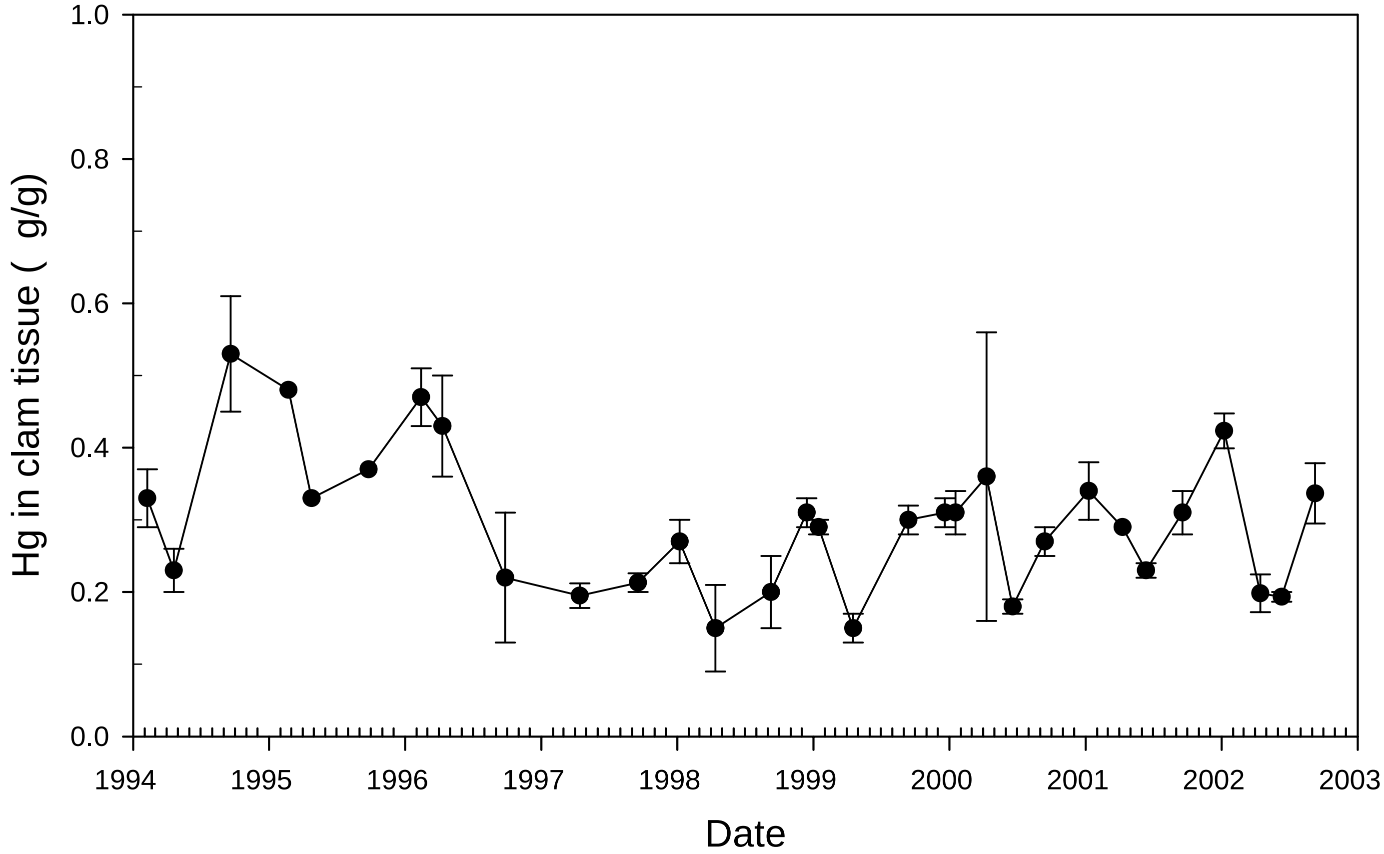


Figure 16. Concentrations of mercury in *Macoma balthica* at Palo Alto from 1994 through 2002.
Error bars are the standard error of the mean (SEM).

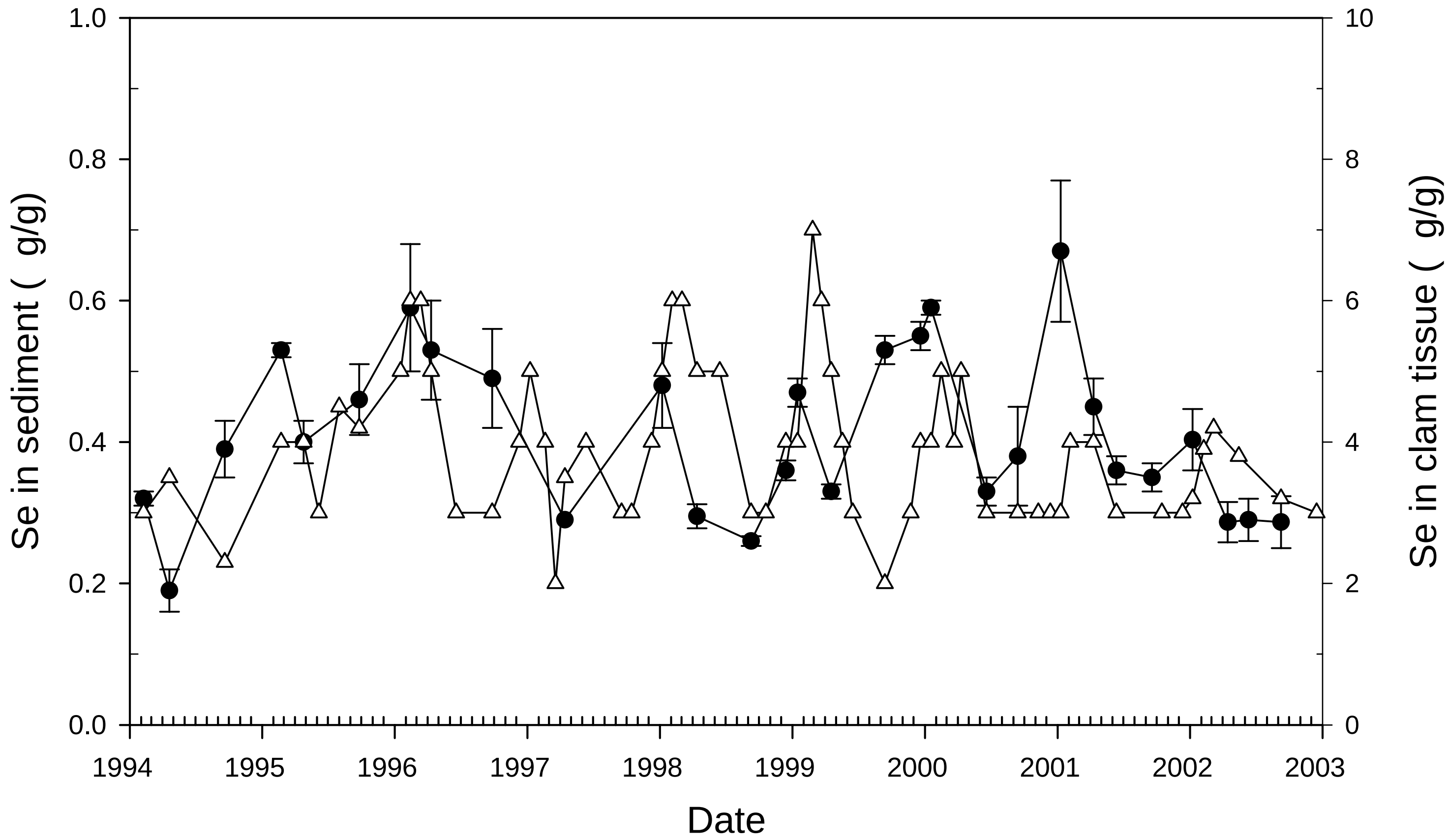


Figure 17. Concentrations of selenium in sediments (△) and in *Macoma balthica* (●) at Palo Alto from 1994 through 2002.
Error bars are the standard error of the mean (SEM).

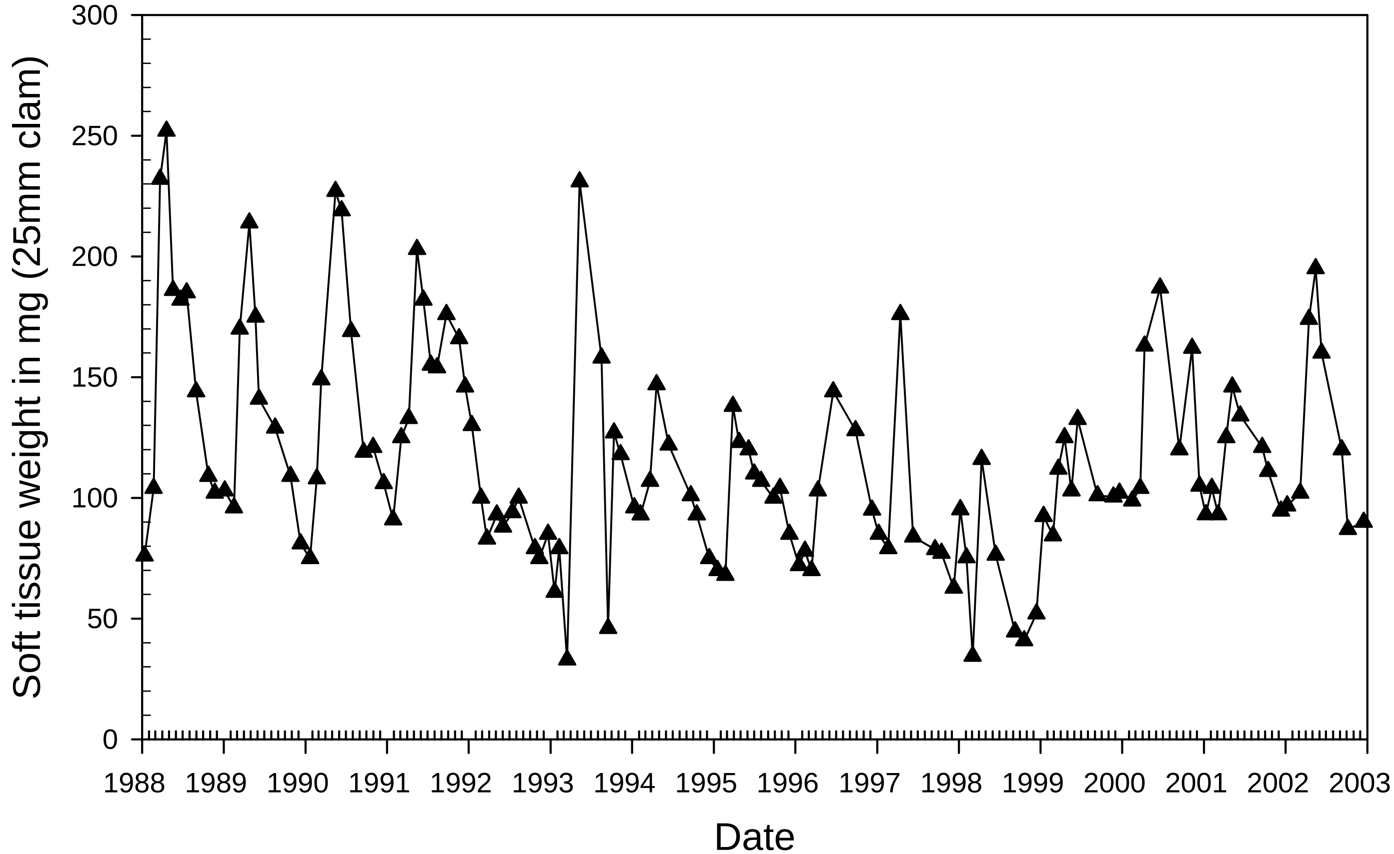


Figure 18. Condition index (CI) of *Macoma balthica* as determined between 1988 through 2002.

Condition index is defined as total weight of soft tissues of *Macoma balthica* having a shell length of 25 mm.

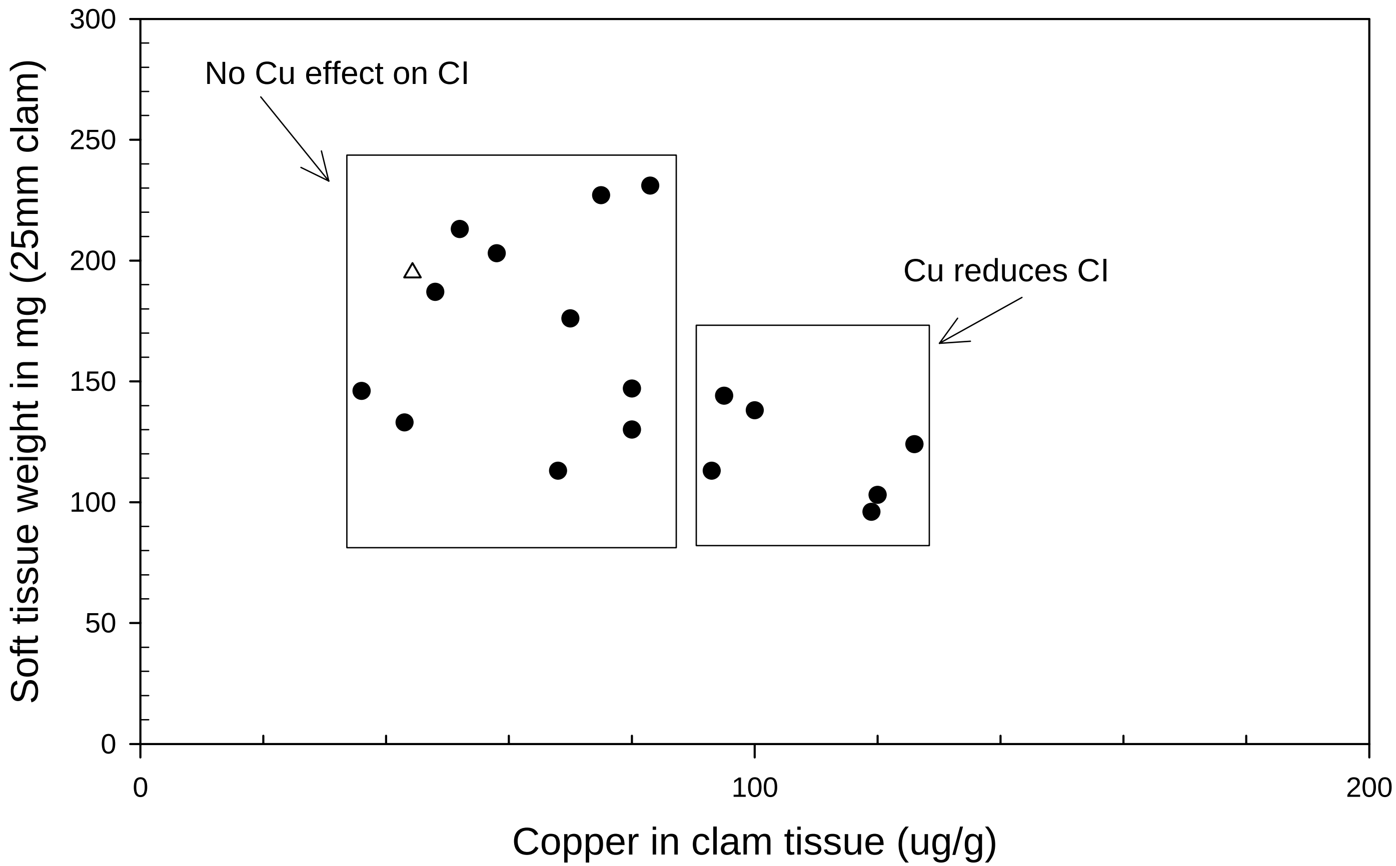


Figure 19. Correlation of maximum condition index (CI) *in Macoma balthica* vs. maximum copper concentrations in the months preceding the determination of maximum condition.

Data from Palo Alto sites is for the period from 1990 through 2001 (●) and 2002 (△).

Tables

Table 1. Sediment and environmental characteristics at the Palo Alto mudflat in 2002.

Units are microgram per gram dry weight. STD is standard deviation of the two samples. SEM is standard error of the means for the year.

Date	**Al** (percent)		**Fe** (percent)		**Organic** (percent)	**Sand** (percent)	**Salinity** (ppt)
	mean	std	mean	std			
January 8, 2002	3.2	0.3	3.33	0.001	1.0	45	22
February 8, 2002	4.16	0.02	4.16	0.05	1.3	38	21
March 7, 2002	4.9	0.1	4.34	0.07	1.5	4	22
April 15, 2002	4.1	0.3	3.81	0.07	1.2	14	26
May 15, 2002	4.33	0.05	3.93	0.01	1.3	20	25
June 11, 2002	3.7	0.2	3.5	0.1	1.2	11	28
September 9, 2002	3.2	0.2	3.26	0.04	0.9	35	30
October 7, 2002	3.1	0.1	3.19	0.02	0.9	59	29
December 16, 2002	5.1	0.1	4.08	0.02	1.3	23	20
Annual Mean:	**4.0**		**3.7**		**1.18**	**28**	**25**
SEM:	*0.2*		*0.1*		*0.07*	*6*	*1*

Table 2. Concentrations, standard deviations and annual means of trace elements in sediments in 2002 at the Palo Alto mudflat.

All concentrations except for silver are for near-total extracts. Silver values are partial extracts. Units are microgram per gram dry weight. STD is standard deviation of the two samples. SEM is standard error of the means for the year.

Date	**Ag**		**Cr**		**Cu**		**Hg**	**Ni**		**Se**	**V**		**Zn**	
	mean	*STD*	*mean*	*STD*	*mean*	*STD*	*mean*	*mean*	*STD*	*mean*	*mean*	*STD*	*mean*	*STD*
January 8, 2002	0.29	0.01	92	2	32	0.9	0.26	74	0.2	0.32	70	9	95	2
February 8, 2002	0.36	0.01	120	1	40	0.2	0.31	94	0.5	0.39	85	3	124	0.1
March 7, 2002	0.35	0.01	128	4	47	0.8	0.34	98	1.0	0.42	94	2	132	3
April 15, 2002	0.27	0.03	109	5	39	2		85	2		86	5	111	4
May 15, 2002	0.28	0.00	115	1	41	0.6	0.28	88	0.2	0.38	87	2	116	1
June 11, 2002	0.27	0.02	95	10	36	2		79	2.1		76	5	103	3
September 9, 2002	0.24	0.01	91	3	33	0.4	0.25	73	0.04	0.32	69	6	93	3
October 7, 2002	0.26	0.00	85	2	32	0.3		71	0.1		66	4	92	6
December 16, 2002	0.46	0.01	138	3	43	0.3	0.4	92	0.2	0.30	130	3	124	0.2
Annual Mean:	**0.31**		**108**		**38**		**27**	**84**		**0.4**	**85**		**110**	
SEM:	***0.02***		***6***		***2***		**1**	***3***		**0.1**	***6***		***5***	

Table 3. Concentrations, standard error of means and annual means of trace elements in the soft tissues of the clam Macoma balthica in 2002 at the Palo Alto mudflat.

All units microgram per gram soft tissue dry weight. Condition index is the soft tissue weight in milligrams of a 25 mm shell length clam. SEM is standard errors of the means from 6-14 replicate analyses of composite samples.

Date		Ag	Cr	Cu	Hg	Ni	Se	Zn	Condition Index
January 8, 2002	*mean*	4.9	3.5	44	0.42	6.0	4.0	288	97
	**SEM*	0.3	0.3	1	0.02	0.2	0.4	18	
February 8, 2002	*mean*	2.5	3.4	37		5.5		311	93
	**SEM*	0.2	0.6	3		0.4		22	
March 7, 2002	*mean*	2.2	3.4	30		5.4		304	102
	**SEM*	0.2	0.4	4		0.3		21	
April 15, 2002	*mean*	1.1	2.8	18	0.20	3.8	2.9	215	174
	**SEM*	0.1	0.3	0	0.03	0.2	0.3	11	
May 15, 2002	*mean*	4.0	3.1	36		5.0		261	195
	**SEM*	0.6	0.7	6		0.8		45	
June 11, 2002	*mean*	1.2	1.4	23	0.19	3.9	2.9	193	160
	**SEM*	0.2	0.1	1	0.01	0.1	0.3	8	
September 9, 2002	*mean*	2.8	0.8	40	0.34	4.4	2.9	160	120
	**SEM*	0.1	0.1	2	0.04	0.2	0.4	9	
October 7, 2002	*mean*	3.7	2.7	53		7.2		175	87
	**SEM*	0.4	0.3	3		0.3		11	
December 16, 2002	*mean*	4.4	5.4	45		8.5		265	90
	**SEM*	0.4	0.3	2		0.4		14	
Annual Mean:		3.0	2.9	36	0.29	5.5	3.2	241	124
SEM:		0.5	0.4	4	0.06	0.5	0.3	19	14

Table 4. Annual mean copper (Cu) concentrations in clams and sediments at Palo Alto: January 1977 through December 2002.

Values are annual means from 7 to 12 collections per year and standard errors of those means for the year. Means are calculated between January and December. Units are microgram per gram dry weight of soft tissue for clams (Macoma balthica) and microgram per gram dry weight for sediment.

	Copper in sediment		Copper
Year	**HCl**	**Total**	**in clams**
1977	28±6	45±13	130±23
1978	42±11	57±13	187±104
1979	55±13	86±18	248±114
1980	47±5	66±9	287±66
1981	48±7	57±22	206±55
1982	35±4	34±24	168±35
1983	22±9	38±21	191±48
1984	26±10	40±16	159±55
1985	27±3	45±7	138±22
1986	24±3	49±9	114±49
1987	21±3	47±6	95±25
1988	27±3	53±5	53±24
1989	23±6	44±13	35±10
1990	23±2	51±4	35±11
1991	25±2	52±5	24±8
1992	27±6	52±5	46±14
1993	21±3	43±7	60±14
1994	19±2	45±4	59±12
1995	19±2	44±5	61±16
1996	19±2	43±4	71±11
1997	18±1	43±3	32±7
1998	20±1	46±2	35±4
1999	18±1	44±2	34±2
2000	18±1	39±3	32±3
2001	17±1	35±2	31±3
2002	13±1	38±2	36±4

Table 5. Annual mean silver concentrations in clams and sediments at Palo Alto, January 1977 through December 2002.

Values are annual means from 7 to 12 collections per year and standard errors ofthose means for the year. Means are calculated between January and December. Units are microgram per gram dry weight of soft tissue for clams (Macoma balthica) and microgram per gram dry weight for sediment.

Year	Silver in sediment	Silver in clams
1977	0.65 ± 0.59	87 ± 21
1978	1.39 ± 0.35	106 ± 17
1979	1.62 ± 0.28	96 ± 29
1980	1.28 ± 0.38	105 ± 24
1981	1.41 ± 0.15	63 ± 18
1982	0.74 ± 0.21	45 ± 13
1983	0.56 ± 0.26	56 ± 11
1984	0.64 ± 0.20	57 ± 18
1985	0.78 ± 0.14	58 ± 6
1986	0.61 ± 0.14	50 ± 20
1987	ND	55 ± 18
1988	ND	20 ± 10
1989	ND	11 ± 4
1990	0.39 ± 0.09	7.7 ± 3.4
1991	0.25 ± 0.07	3.3± 2.0
1992	0.35 ± 0.11	5.9 ± 1.9
1993	0.36± 0.09	6.9 ± 3.2
1994	0.46 ± 0.07	5.4 ± 1.1
1995	0.27 ± 0.05	5.5 ± 1.2
1996	0.24 ± 0.06	7.5 ± 1.6
1997	0.34 ± 0.04	3.6 ± 1.0
1998	0.34 ± 0.04	3.3 ± 0.6
1999	0.22 ± 0.01	3.6 ± 0.3
2000	0.34 ± 0.02	3.0 ± 0.4
2001	0.43 ± 0.03	3.0 ± 0.4
2002	0.31 ± 0.02	3.0 ± 0.5

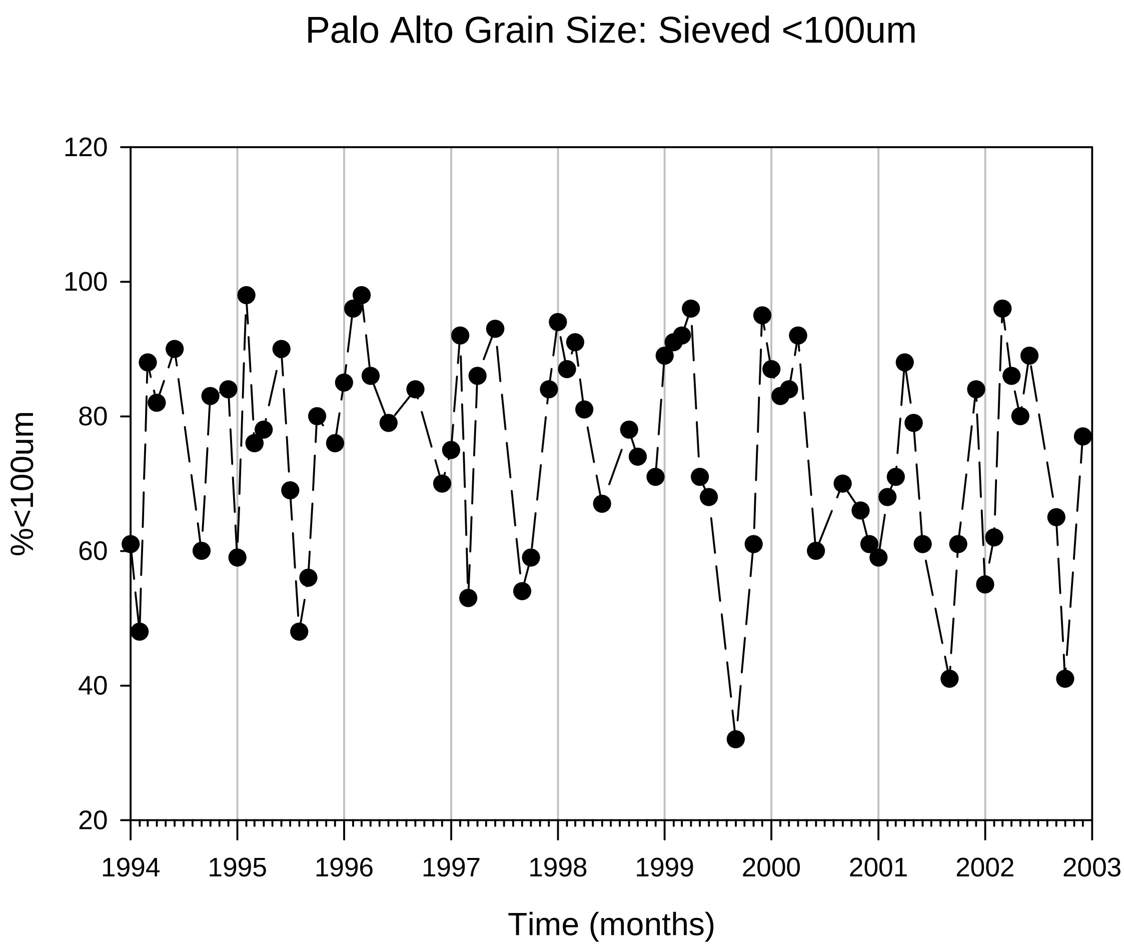
Appendix A.

Grain size (p. A-2) and total organic carbon (p. A-4) data. Concentrations of Hg and Se in surface sediments (p. 63) are reported in separate summary tables.

PALTO ALTO GRAIN SIZE DATA: <100um

Year	Date	%<100um
1994	01/10/94	61
	02/08/94	48
	03/22/94	88
	04/20/94	82
	06/13/94	90
	09/20/94	60
	10/17/94	83
	12/12/94	84
1995	01/18/95	59
	02/22/95	98
	03/27/95	76
	04/25/95	78
	06/06/95	90
	07/01/95	69
	08/01/95	48
	09/25/95	56
	10/24/95	80
	12/05/95	76
1996	01/17/96	85
	02/13/96	96
	03/13/96	98
	04/10/96	86
	06/18/96	79
	09/26/96	84
	12/09/96	70
1997	01/08/97	75
	02/19/97	92
	03/19/97	53
	04/14/97	86
	06/11/97	93
	09/17/97	54
	10/15/97	59
	12/09/97	84
1998	01/07/98	94
	02/04/98	87
	03/03/98	91
	04/13/98	81
	06/15/98	67
	09/09/98	78
	10/20/98	74
	12/14/98	71

Year	Date	%<100um
1999	01/15/99	89
	02/26/99	91
	03/22/99	92
	04/18/99	96
	05/19/99	71
	06/16/99	68
	09/13/99	32
	11/23/99	61
	12/20/99	95
2000	01/18/00	87
	02/15/00	83
	03/22/00	84
	04/10/00	92
	06/19/00	60
	09/13/00	70
	11/09/00	66
	12/12/00	61
2001	01/09/01	59
	02/05/01	68
	03/05/01	71
	04/10/01	88
	05/08/01	79
	06/12/01	61
	09/18/01	41
	10/15/01	61
	12/11/01	84
2002	01/08/02	55
	02/08/02	62
	03/07/02	96
	04/15/02	86
	05/15/02	80
	06/11/02	89
	09/09/02	65
	10/07/02	41
	12/16/02	77


Palo Alto Grain Size: Sieved <100um
%<100um
120
100
80
60
40
20
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Time (months)

Carbon and Nitrogen analysis for 2002 Palo Alto surface sediments

Date	%C	%N	d13C	d15N
January 8, 2002	1.0	0.2	-23.9	-8.1
February 8, 2002	1.3	0.3	-23.5	-8.0
March 7, 2002	1.5	0.4	-23.6	-11.9
April 15, 2002	1.2	0.2	-23.2	-8.1
May 15, 2002	1.3	0.2	-23.0	-5.0
June 11, 2002	1.2	0.2	-23.0	-9.2
September 9, 2002	0.9	0.2	-23.7	-8.5
October 7, 2002	0.9	0.2	-73.6	-12.8
December 16, 2002	1.3	0.2	-23.5	-7.1

Appendix B.

Metal concentrations determined by ICP-OES in sediments collected at the Palo Alto mudflat. Each monthly collection is reported on a separate page. Concentrations observed in the reconstituted samples or extracts (in micrograms per milliliter or µg/ml) are reported at the top of each page, along with the sediment weight and dilution factor. The latter are used to calculate concentrations in sediments (reported as microgram per gram dry sediment or µg/g). Replicate subsamples were analyzed from each collection. Mean and standard deviation for the replicate samples are reported for the near-total and hydrochloric acid extracts.

Palo Alto Total Extracts: 2002

1/08/2002: 55% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5477	10	10	186	0.51	0.18	182	5.1	0.41	0.13	0.42	0.51
Tot2	0.5626	10	10	165	0.51	0.18	187	5.3	0.42	0.13	0.36	0.55
				33957	93	33	33263	931	74	24	76	94
				29378	90	32	33244	937	75	23	64	97
			Average	**31667**	**92**	**32**	**33253**	**934**	**74**	**24**	**70**	**95**
			Std	**3238**	**1.66**	**0.86**	**14**	**4.8**	**0.15**	**0.55**	**8.9**	**2.4**

2/08/2002: 62% < 100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5621	10	10	233	0.68	0.22	232	7.5	0.52	0.17	0.47	0.70
Tot2	0.5463	10	10	228	0.65	0.22	229	7.4	0.51	0.16	0.48	0.68
				41488	121	40	41289	1336	93	30	83	124
				41769	119	40	41975	1346	94	30	88	124
			Average	**41629**	**120**	**40**	**41632**	**1341**	**94**	**30**	**85**	**124**
			Std	**199**	**1.1**	**0.15**	**485**	**6.8**	**0.54**	**0.07**	**3.1**	**0.12**

3/7/2002: 96% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5534	10	10	266	0.69	0.25	237	8.0	0.54	0.18	0.51	0.72
Tot2	0.5673	10	10	280	0.74	0.27	249	8.3	0.56	0.18	0.54	0.76
				48001	125	46	42889	1439	97	32	92	130
				49417	131	47	43844	1463	99	32	95	134
			Average	**48709**	**128**	**47**	**43366**	**1451**	**98**	**32**	**94**	**132**
			Std	**1001**	**3.8**	**0.83**	**675**	**17.0**	**0.98**	**0.22**	**2.48**	**2.8**

4/15/2002: 86% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5454	10	10	216	0.57	0.20	205	4.3	0.46	0.14	0.45	0.59
Tot2	0.5585	10	10	241	0.63	0.22	215	4.5	0.48	0.16	0.50	0.63
				39553	105	37	37532	794	84	26	83	108
				43170	113	40	38575	811	86	28	90	113
			Average	**41362**	**109**	**39**	**38054**	**802**	**85**	**27**	**86**	**111**
			Std	**2558**	**5.3**	**2.30**	**737**	**12**	**1.54**	**1.20**	**5.1**	**3.6**

5/15/2002: 80% < 100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5781	10	10	249	0.66	0.24	228	4.7	0.51	0.16	0.50	0.68
Tot2	0.5804	10	10	253	0.67	0.24	228	4.7	0.51	0.16	0.51	0.67
				42990	114	41	39415	811	88	28	86	117
				43643	116	42	39215	809	88	28	88	115
			Average	**43317**	**115**	**41**	**39315**	**810**	**88**	**28**	**87**	**116**
			Std	**462**	**1.2**	**0.62**	**142**	**1.1**	**0.21**	**0.23**	**1.6**	**1.3**

6/11/2002: 89% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5353	10	10	203	0.55	0.20	193	3.7	0.43	0.14	0.43	0.56
Tot2	0.5887	10	10	208	0.52	0.20	204	4.0	0.45	0.14	0.43	0.59
				37845	102	37	35976	700	80	25	80	105
				35283	88	34	34581	676	77	24	73	101
			Average	**36564**	**95**	**36**	**35279**	**688**	**79**	**25**	**76**	**103**
			Std	**1811**	**10**	**2.1**	**986**	**17.05**	**2.1**	**0.79**	**5.0**	**2.8**

9/09/2001: 65% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.6072	10	10	206	0.56	0.20	200	4.44	0.44	0.14	0.44	0.58
Tot2	0.5971	10	10	184	0.53	0.19	193	4.32	0.43	0.14	0.38	0.54
				33870	93	33	32889	731	73	23	73	95
				30878	88	32	32304	724	73	23	64	90
			Average	**32374**	**91**	**33**	**32597**	**727**	**73**	**23**	**69**	**93**
			Std	**2116**	**3.1**	**0.45**	**414**	**4.7**	**0.04**	**0.03**	**6.0**	**3.3**

10/07/2002: 41% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5378	10	10	170	0.46	0.17	172	3.75	0.38	0.11	0.37	0.52
Tot2	0.5378	10	10	160	0.45	0.17	171	3.73	0.38	0.11	0.34	0.47
				31684	86	32	32029	698	71	21	69	96
				29715	84	32	31794	693	71	21	63	87
			Average	**30700**	**85**	**32**	**31911**	**695**	**71**	**21**	**66**	**92**
			Std	**1392**	**1.8**	**0.28**	**166**	**3.5**	**0.06**	**0.13**	**4.3**	**6.4**

12/17/2002: 77% <100 µm

Sample	Weight (g)	Recon. (ml)	Dil. Factor	AL	CR	CU	FE	MN	NI	PB	V	ZN
Tot1	0.5081	10	10	262	0.71	0.22	208	6.85	0.47	0.16	0.67	0.63
Tot2	0.5106	10	10	254	0.70	0.22	207	6.88	0.47	0.16	0.65	0.64
				51471	141	43	40938	1348	92	31	132	124
				49758	136	42	40606	1347	92	31	128	124
			Average	**50614**	**138**	**43**	**40772**	**1348**	**92**	**31**	**130**	**124**
			Std	**1211**	**2.9**	**0.32**	**235**	**0.87**	**0.21**	**0.26**	**3.1**	**0.16**

Palo Alto HCl Extracts: 2002

01/08/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5374	12		0.013	62	0.09	0.52	150	27	0.23	0.69	0.31	1.2
HCL2	0.5645	12		0.014	68	0.11	0.57	165	30	0.26	0.77	0.34	1.4
				0.28	1389	2.0	12	3339	613	5.2	15	7.02	28
				0.30	1450	2.3	12	3499	636	5.5	16	7.31	30
			Average	**0.29**	**1419**	**2.1**	**12**	**3419**	**625**	**5.3**	**16**	**7.16**	**29**
			Std	**0.010**	**31**	**0.16**	**0.26**	**80**	**12**	**0.12**	**0.42**	**0.15**	**1.0**

02/08/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5573	12		0.017	79	0.13	0.64	174	43	0.26	0.87	0.44	1.5
HCL2	0.5301	12		0.015	69	0.11	0.53	155	38	0.24	0.78	0.39	1.4
				0.37	1692	2.8	14	3749	924	5.6	19	9.5	33
				0.35	1571	2.4	12	3519	856	5.5	18	8.9	31
			Average	**0.36**	**1631**	**2.6**	**13**	**3634**	**890**	**5.5**	**18**	**9.2**	**32**
			Std	**0.011**	**60**	**0.20**	**0.82**	**115**	**34**	**0.05**	**0.62**	**0.32**	**1.2**

03/07/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5716	12		0.017	79	0.14	0.65	175	42	0.26	0.79	0.42	1.6
HCL2	0.5539	12		0.016	69	0.10	0.63	149	40	0.22	0.75	0.38	1.4
				0.36	1663	2.9	14	3675	877	5.5	17	8.9	34
				0.34	1498	2.3	14	3227	866	4.9	16	8.3	31
			Average	**0.35**	**1580**	**2.6**	**14**	**3451**	**871**	**5.2**	**16**	**8.6**	**33**
			Std	**0.009**	**82**	**0.33**	**0.08**	**224**	**5.5**	**0.30**	**0.20**	**0.30**	**1.5**

04/15/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5208	12		0.010	55	0.07	0.47	128	16	0.21	0.61	0.27	1.2
HCL2	0.5245	12		0.013	63	0.09	0.59	143	20	0.23	0.74	0.33	1.4
				0.24	1257	1.6	11	2956	379	4.8	14	6.3	27
				0.30	1439	2.0	13	3262	458	5.3	17	7.5	32
			Average	**0.27**	**1348**	**1.8**	**12**	**3109**	**419**	**5.0**	**15**	**6.9**	**29**
			Std	**0.027**	**91**	**0.17**	**1.3**	**153**	**39**	**0.26**	**1.4**	**0.57**	**2.1**

05/15/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5413	12		0.013	69	0.10	0.69	163	21	0.25	0.77	0.35	1.6
HCL2	0.562	12		0.013	70	0.10	0.73	162	22	0.25	0.81	0.36	1.6
				0.28	1540	2.3	15	3616	455	5.6	17	7.8	35
				0.28	1499	2.1	16	3458	463	5.4	17	7.8	35
			Average	**0.28**	**1519**	**2.2**	**15**	**3537**	**459**	**5.5**	**17**	**7.8**	**35**
			Std	**0.001**	**20**	**0.10**	**0.13**	**79**	**4.1**	**0.10**	**0.13**	**0.02**	**0.2**

06/11/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5709	12		0.012	64	0.09	0.57	158	17	0.24	0.67	0.31	1.4
HCl2	0.5781	12		0.014	70	0.10	0.66	168	19	0.26	0.75	0.34	1.5
				0.25	1337	1.9	12	3323	356	5.1	14	6.4	29
				0.28	1449	2.1	14	3494	388	5.3	16	7.0	32
			Average	**0.27**	**1393**	**2.0**	**13**	**3409**	**372**	**5.2**	**15**	**6.7**	**31**
			Std	**0.016**	**56**	**0.08**	**0.80**	**85**	**16**	**0.11**	**0.78**	**0.27**	**1.1**

09/09/01

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.6005	12		0.013	64	0.09	0.61	161	21	0.26	0.72	0.30	1.4
HCl2	0.6093	12		0.012	63	0.09	0.57	161	19	0.25	0.67	0.29	1.4
				0.25	1285	1.8	12	3224	413	5.1	14	6.0	28
				0.23	1238	1.8	11	3161	384	5.0	13	5.7	28
			Average	**0.24**	**1261**	**1.8**	**12**	**3193**	**399**	**5.1**	**14**	**5.8**	**28**
			Std	**0.013**	**24**	**0.01**	**0.50**	**32**	**15**	**0.06**	**0.52**	**0.16**	**0.4**

10/07/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5451	12		0.012	59	0.08	0.56	155	19	0.25	0.64	0.28	1.3
HCl2	0.521	12		0.011	56	0.07	0.50	148	18	0.24	0.59	0.26	1.2
				0.26	1307	1.8	12	3412	419	5.6	14	6.2	28
				0.26	1289	1.7	12	3414	425	5.5	14	6.0	28
			Average	**0.26**	**1298**	**1.8**	**12**	**3413**	**422**	**5.6**	**14**	**6.1**	**28**
			Std	**0.000**	**8.6**	**0.04**	**0.32**	**1.1**	**3.1**	**0.027**	**0.30**	**0.07**	**0.4**

12/17/02

Sample	Weight (g)	Recon. (ml)		AG	AL	CR	CU	FE	MN	NI	PB	V	ZN
HCl1	0.5138	12		0.019	74	0.11	0.68	149	38	0.24	0.81	0.37	1.5
HCl2	0.5295	12		0.021	74	0.11	0.70	146	38	0.23	0.84	0.37	1.5
				0.45	1731	2.5	16	3489	876	5.7	19	8.5	34
				0.47	1674	2.4	16	3319	851	5.3	19	8.3	33
			Average	**0.46**	**1703**	**2.5**	**16**	**3404**	**864**	**5.5**	**19**	**8.4**	**34**
			Std	**0.012**	**29**	**0.01**	**0.04**	**85**	**13**	**0.17**	**0.05**	**0.10**	**0.6**

Appendix C.

Metal concentrations in the clam *Macoma balthica* collected at the Palo Alto Mudflat. Each monthly collection is reported on two pages. The first page contains summary statistics:

- Mean concentrations in microgram per gram dry tissue weight (µg/g).
- STD is the standard deviation of the mean.
- SEM is the standard error of the mean.
- CV percent is the coefficient of variation.
- r wt x [] is the correlation coefficient for the concentration versus weight correlation for each element.
- X 100mg is the concentration interpolated from the above regression for a 100 mg animal.
- r l x [] is the correlation coefficient for the concentration versus shell length regression.
- X 20 mm and X 25 mm are concentrations interpolated from the regression for 20mm and 25 mm animals.

Content (a measure of metal bioaccumulation that is standardized to tissue mass) is also shown for 20 and 25 mm animals, as is the weight determined for animals of 15 mm and 20 mm shell length.

The second page shows the analysis of each composite within the sample, the number of animals in each composite, concentration as calculated from sample dry weight and the dilution factor and the metal content for each composite.

Station: Palo Alto Statistical Summary

Date: 01/09/01

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	4.947	0.458	3.536	44.328	6.036	1.301	3.755	287.564
STD	0.766	0.064	0.820	3.407	0.554	0.140	0.480	50.974
SEM	0.271	0.023	0.290	1.205	0.196	0.050	0.170	18.022
CV%	15.488	14.036	23.204	7.686	9.171	10.794	12.774	17.726
n	8	8	8	8	8	8	8	8
r wt x [ ]	0.344	0.486	0.112	0.276	0.096	0.609	0.208	0.516
X 100mg	5.438	0.400	3.707	46.080	5.938	1.142	3.569	238.568
r l x [ ]	0.513	0.496	0.078	0.348	0.108	0.582	0.223	0.551
X 15mm	4.229	0.516	3.418	42.164	5.928	1.450	3.950	338.896
X 20mm	4.927	0.460	3.532	44.268	6.033	1.305	3.760	289.002
X 25mm	5.625	0.403	3.647	46.372	6.139	1.160	3.571	239.108

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.083	0.010	0.066	0.834	0.117	0.029	0.079	6.950
20mm	0.238	0.022	0.166	2.147	0.292	0.063	0.181	13.752
25mm	0.538	0.039	0.343	4.472	0.594	0.113	0.345	23.349

Estimated weight for 15mm clam

0.020 gm
19.943 mg

Estimated weight for 20mm clam

0.049 gm
48.555 mg

Estimated weight for 25mm clam

0.097 gm
96.826 mg

Station: Palo Alto

Date: 01/09/01

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
					Concentration (ug/ml) - Blank Corrected from ICP-AES							
Mb1	16.50	0.338	0.0282	11	0.1351	0.0169	0.1345	1.2804	0.1820	0.0445	0.1371	8.9639
Mb2	17.16	0.2621	0.0291	11	0.1150	0.0118	0.0787	1.1665	0.1492	0.0344	0.0891	8.8208
Mb3	18.21	0.3241	0.0405	11	0.1295	0.0126	0.0962	1.1427	0.1466	0.0349	0.0993	8.3378
Mb4	19.64	0.1706	0.0427	11	0.0606	0.0058	0.0277	0.6727	0.0977	0.0200	0.0478	4.0466
Mb5	20.84	0.3051	0.0509	11	0.1478	0.0131	0.1040	1.2080	0.1721	0.0343	0.1088	9.2457
Mb6	21.44	0.2965	0.0593	11	0.1522	0.0143	0.1161	1.1833	0.1837	0.0401	0.1180	8.2161
Mb7	22.64	0.3291	0.0658	11	0.1876	0.0129	0.1183	1.4537	0.1864	0.0360	0.1074	6.1008
Mb8	24.72	0.3187	0.1062	11	0.1390	0.0113	0.1026	1.3271	0.1616	0.0324	0.1013	7.3188
				LOD	0.0006	0.0004	0.0018	0.0006	0.0030	0.0396	0.0283	0.0009
				LOQ	0.0020	0.0017	0.0064	0.0023	0.0084	0.1099	0.0767	0.0037

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	4.3967	0.5503	4.3761	41.6701	5.9214	1.4466	4.4605	291.723
	Mb2	4.8277	0.4936	3.3040	48.9572	6.2626	1.4454	3.7390	370.198
	Mb3	4.3959	0.4283	3.2648	38.7831	4.9756	1.1828	3.3699	282.987
	Mb4	3.9100	0.3727	1.7862	43.3714	6.3021	1.2876	3.0821	260.919
	Mb5	5.3295	0.4712	3.7502	43.5524	6.2038	1.2370	3.9234	333.344
	Mb6	5.6469	0.5298	4.3086	43.9006	6.8167	1.4873	4.3785	304.813
	Mb7	6.2718	0.4298	3.9536	48.5878	6.2317	1.2046	3.5885	203.916
	Mb8	4.7980	0.3883	3.5424	45.8049	5.5780	1.1173	3.4971	252.611

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.1238	0.0155	0.1233	1.1737	0.1668	0.0407	0.1256	8.2169
	Mb2	0.1406	0.0144	0.0962	1.4257	0.1824	0.0421	0.1089	10.7810
	Mb3	0.1781	0.0174	0.1323	1.5712	0.2016	0.0479	0.1365	11.4645
	Mb4	0.1668	0.0159	0.0762	1.8498	0.2688	0.0549	0.1315	11.1282
	Mb5	0.2710	0.0240	0.1907	2.2146	0.3155	0.0629	0.1995	16.9505
	Mb6	0.3349	0.0314	0.2555	2.6033	0.4042	0.0882	0.2596	18.0754
	Mb7	0.4128	0.0283	0.2602	3.1980	0.4102	0.0793	0.2362	13.4218
	Mb8	0.5097	0.0413	0.3763	4.8660	0.5926	0.1187	0.3715	26.8357

Station: Palo Alto

Statistical Summary

Date: 02/08/02

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	2.533	0.350	3.400	37.168	5.477	0.917	2.965	311.288
STD	0.553	0.104	1.375	5.747	0.785	0.241	0.893	48.972
SEM	0.247	0.046	0.615	2.570	0.351	0.108	0.400	21.901
CV%	21.819	29.567	40.434	15.461	14.332	26.266	30.127	15.732
n	5	5	5	5	5	5	5	5
r wt x [ ]	0.785	0.918	0.594	0.752	0.881	0.836	0.978	0.293
X 100mg	5.018	0.375	2.935	38.646	4.842	1.337	3.527	294.693
r l x [ ]	0.669	0.847	0.372	0.748	0.774	0.720	0.938	0.060
X 15mm	2.469	0.267	2.413	32.757	3.737	1.048	2.311	275.058
X 20mm	3.629	0.318	2.615	35.642	4.247	1.180	2.897	278.574
X 25mm	4.790	0.370	2.817	38.528	4.758	1.313	3.482	282.089

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.073	0.007	0.063	0.850	0.099	0.028	0.062	7.106
20mm	0.184	0.017	0.137	1.897	0.226	0.063	0.154	14.421
25mm	0.375	0.033	0.248	3.534	0.428	0.118	0.314	24.969

Estimated weight for 15mm clam

0.026 gm
25.549 mg

Estimated weight for 20mm clam

0.053 gm
52.910 mg

Estimated weight for 25mm clam

0.093 gm
93.064 mg

Station: Palo Alto

Date: 02/08/02

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
					Concentration (ug/ml) - Blank Corrected from ICP-AES							
Mb1	--	0.1744		9	0.0341	0.0054	0.0753	0.6735	0.1008	0.0151	0.0454	5.5667
Mb2	--	0.111		9	0.0301	0.0049	0.0406	0.3758	0.0798	0.0131	0.0454	3.3884
Mb3	--	0.2207		9	0.0595	0.0099	0.0950	1.0350	0.1389	0.0214	0.0799	8.9242
Mb4	--	0.2442		9	0.0746	0.0125	0.1305	0.9312	0.1551	0.0338	0.1033	7.2140
Mb5	--	0.1637		9	0.0597	0.0038	0.0208	0.8019	0.0788	0.0114	0.0317	6.6324

		Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
	LOD	0.0010	-0.0001	0.0023	-0.0009	0.0004	0.0053	0.0004	0.0025
	LOQ	0.0025	0.0001	0.0086	0.0010	0.0018	0.0205	0.0008	0.0085
	Sample #								
Concentration (ug/g) ==>	Mb1	1.7618	0.2792	3.8861	34.7580	5.1998	0.7787	2.3413	287.270
	Mb2	2.4430	0.3989	3.2888	30.4678	6.4711	1.0605	3.6811	274.731
	Mb3	2.4276	0.4053	3.8758	42.2061	5.6626	0.8731	3.2566	363.924
	Mb4	2.7505	0.4596	4.8093	34.3210	5.7158	1.2450	3.8064	265.872
	Mb5	3.2817	0.2073	1.1417	44.0891	4.3334	0.6290	1.7412	364.641
	Sample #								
Content (ug) ==>	Mb1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mb2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mb3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mb4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Mb5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Station: Palo Alto

Date: 03/07/02

Statistical Summary

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	2.162	0.365	3.402	30.017	5.443	0.915	3.168	304.144
STD	0.466	0.076	0.978	10.367	0.806	0.219	0.775	56.257
SEM	0.176	0.029	0.369	3.918	0.305	0.083	0.293	21.263
CV%	21.569	20.831	28.730	34.536	14.804	23.937	24.453	18.497
n	7	7	7	7	7	7	7	7
r wt x [ ]	0.366	0.654	0.708	0.927	0.829	0.741	0.783	0.608
X 100mg	2.566	0.483	5.042	52.777	7.026	1.300	4.605	385.126
r l x [ ]	0.533	0.715	0.740	0.967	0.863	0.755	0.810	0.629
X 15mm	2.154	0.364	3.381	29.724	5.423	0.911	3.150	303.109
X 20mm	2.408	0.419	4.120	39.958	6.133	1.080	3.790	339.236
X 25mm	2.662	0.475	4.859	50.193	6.843	1.249	4.431	375.363

Estimated content (µg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.061	0.010	0.096	0.841	0.156	0.026	0.090	8.630
20mm	0.146	0.025	0.241	2.343	0.359	0.063	0.222	19.516
25mm	0.286	0.048	0.492	5.188	0.687	0.127	0.449	36.752

Estimated weight for 15mm clam

0.028 gm
28.465 mg

Estimated weight for 20mm clam

0.059 gm
58.515 mg

Estimated weight for 25mm clam

0.102 gm
102.331 mg

Station: Palo Alto

Date: 03/07/02

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
					Concentration (ug/ml) - Blank Corrected from ICP-AES							
Mb1	9.09	0.1436	0.0080	9	0.0211	0.0043	0.0334	0.3074	0.0689	0.0089	0.0320	4.4479
Mb2	10.74	0.1672	0.0129	9	0.0330	0.0064	0.0642	0.3319	0.0995	0.0192	0.0604	4.5995
Mb3	13.08	0.177	0.0197	9	0.0510	0.0059	0.0505	0.4734	0.0895	0.0144	0.0509	5.4779
Mb4	15.39	0.2633	0.0293	11	0.0593	0.0081	0.0647	0.7486	0.1290	0.0223	0.0656	8.5407
Mb5	16.46	0.3621	0.0362	11	0.0841	0.0160	0.1514	1.2356	0.2014	0.0341	0.1294	11.5125
Mb6	17.29	0.2981	0.0426	11	0.0584	0.0104	0.1064	0.9069	0.1578	0.0240	0.0940	6.4913
Mb7	23.93	0.2719	0.0906	11	0.0558	0.0107	0.1104	1.1528	0.1618	0.0304	0.1037	9.3449
				LOD	0.0006	0.0020	0.0013	0.0010	-0.0001	-0.0016	0.0004	0.0014
				LOQ	0.0011	0.0056	0.0060	0.0055	0.0001	-0.0016	0.0016	0.0037

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	1.3218	0.2689	2.0961	19.2689	4.3164	0.5597	2.0075	278.768
	Mb2	1.7747	0.3467	3.4584	17.8658	5.3575	1.0340	3.2485	247.578
	Mb3	2.5927	0.2995	2.5684	24.0704	4.5514	0.7317	2.5861	278.538
	Mb4	2.4787	0.3367	2.7028	31.2758	5.3889	0.9312	2.7406	356.809
	Mb5	2.5539	0.4873	4.5994	37.5344	6.1194	1.0359	3.9319	349.730
	Mb6	2.1535	0.3830	3.9245	33.4651	5.8232	0.8867	3.4675	239.530
	Mb7	2.2554	0.4341	4.4669	46.6396	6.5474	1.2287	4.1941	378.057

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.0105	0.0021	0.0167	0.1537	0.0344	0.0045	0.0160	2.2240
	Mb2	0.0228	0.0045	0.0445	0.2298	0.0689	0.0133	0.0418	3.1842
	Mb3	0.0510	0.0059	0.0505	0.4734	0.0895	0.0144	0.0509	5.4779
	Mb4	0.0725	0.0099	0.0791	0.9150	0.1577	0.0272	0.0802	10.4386
	Mb5	0.0925	0.0176	0.1665	1.3591	0.2216	0.0375	0.1424	12.6637
	Mb6	0.0917	0.0163	0.1671	1.4251	0.2480	0.0378	0.1477	10.2005
	Mb7	0.2044	0.0393	0.4049	4.2271	0.5934	0.1114	0.3801	34.2645

Station: Palo Alto | Statistical Summary

Date: 04/15/02

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	1.073	0.236	2.835	17.611	3.840	0.995	2.467	215.315
STD	0.296	0.040	0.738	1.260	0.441	0.479	0.625	31.092
SEM	0.105	0.014	0.261	0.445	0.156	0.169	0.221	10.993
CV%	27.589	16.969	26.038	7.153	11.492	48.124	25.330	14.440
n	8	8	8	8	8	8	8	8
r wt x [ ]	0.633	0.304	0.210	0.091	0.356	0.363	0.207	0.279
X 100mg	1.259	0.224	2.682	17.724	3.996	0.823	2.339	223.884
r l x [ ]	0.744	0.346	0.317	0.220	0.296	0.509	0.315	0.366
X 15mm	1.027	0.239	2.885	17.553	3.813	1.046	2.508	212.899
X 20mm	1.285	0.223	2.611	17.877	3.966	0.761	2.278	226.245
X 25mm	1.543	0.207	2.337	18.202	4.119	0.476	2.047	239.591

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.037	0.009	0.103	0.648	0.141	0.035	0.090	7.846
20mm	0.114	0.019	0.225	1.583	0.346	0.066	0.196	19.930
25mm	0.271	0.036	0.411	3.164	0.697	0.107	0.360	41.071

Estimated weight for 15mm clam

0.037 gm
36.982 mg

Estimated weight for 20mm clam

0.088 gm
88.437 mg

Estimated weight for 25mm clam

0.174 gm
173.912 mg

Station: Palo Alto

Date: 04/15/02

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
					Concentration (ug/ml) - Blank Corrected from ICP-AES							
Mb1	10.81	0.2249	0.0132	11	0.0171	0.0062	0.0898	0.3503	0.0862	0.0437	0.0783	4.2261
Mb2	12.88	0.2988	0.0230	11	0.0222	0.0059	0.0683	0.4890	0.0972	0.0275	0.0618	5.3071
Mb3	13.29	0.3303	0.0275	11	0.0243	0.0071	0.0829	0.4729	0.1179	0.0284	0.0679	6.5277
Mb4	14.66	0.3782	0.0344	11	0.0279	0.0083	0.0946	0.5972	0.1167	0.0253	0.0794	6.5032
Mb5	15.32	0.3474	0.0386	11	0.0359	0.0058	0.0600	0.5840	0.1135	0.0196	0.0570	5.7537
Mb6	16.57	0.3594	0.0513	11	0.0440	0.0073	0.0815	0.5618	0.1085	0.0254	0.0696	8.0370
Mb7	19.37	0.3157	0.0789	11	0.0446	0.0081	0.0947	0.5745	0.1313	0.0270	0.0826	7.8890
Mb8	24.34	0.3186	0.1593	11	0.0371	0.0058	0.0743	0.4905	0.1193	0.0228	0.0651	6.1073
				LOD	0.0012	0.0000	0.0228	0.0009	0.0388	0.0014	0.0016	0.0000
				LOQ	0.0030	0.0005	0.0702	0.0033	0.1114	0.0095	0.0039	0.0001

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	0.8349	0.3047	4.3913	17.1324	4.2166	2.1354	3.8302	206.703
	Mb2	0.8173	0.2168	2.5127	18.0017	3.5798	1.0131	2.2733	195.373
	Mb3	0.8079	0.2368	2.7608	15.7488	3.9271	0.9445	2.2609	217.394
	Mb4	0.8103	0.2400	2.7524	17.3706	3.3939	0.7359	2.3082	189.146
	Mb5	1.1358	0.1846	1.9007	18.4906	3.5923	0.6212	1.8058	182.183
	Mb6	1.3461	0.2234	2.4956	17.1945	3.3208	0.7777	2.1290	245.984
	Mb7	1.5530	0.2819	3.3000	20.0186	4.5739	0.9415	2.8784	274.879
	Mb8	1.2820	0.2009	2.5669	16.9346	4.1190	0.7872	2.2470	210.861

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.0110	0.0040	0.0581	0.2267	0.0558	0.0283	0.0507	2.7346
	Mb2	0.0188	0.0050	0.0578	0.4138	0.0823	0.0233	0.0523	4.4906
	Mb3	0.0222	0.0065	0.0760	0.4335	0.1081	0.0260	0.0622	5.9838
	Mb4	0.0279	0.0083	0.0946	0.5972	0.1167	0.0253	0.0794	6.5032
	Mb5	0.0438	0.0071	0.0734	0.7137	0.1387	0.0240	0.0697	7.0323
	Mb6	0.0691	0.0115	0.1281	0.8828	0.1705	0.0399	0.1093	12.6295
	Mb7	0.1226	0.0222	0.2605	1.5800	0.3610	0.0743	0.2272	21.6948
	Mb8	0.2042	0.0320	0.4089	2.6977	0.6562	0.1254	0.3579	33.5901
	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Station: Palo Alto

Statistical Summary

Date: 05/15/02

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	3.964	0.410	3.058	36.303	5.030	1.141	3.285	260.651
STD	1.458	0.200	1.685	14.386	1.892	0.505	1.592	109.755
SEM	0.595	0.082	0.688	5.873	0.772	0.206	0.650	44.807
CV%	36.772	48.955	55.097	39.626	37.605	44.254	48.452	42.108
n	6	6	6	6	6	6	6	6
r wt x [ ]	0.749	0.805	0.705	0.888	0.822	0.849	0.769	0.863
X 100mg	-4.550	-0.849	-6.212	-63.299	-7.105	-2.202	-6.264	-478.428
r l x [ ]	0.682	0.771	0.678	0.829	0.772	0.808	0.742	0.789
X 15mm	2.994	0.259	1.944	24.671	3.605	0.743	2.132	176.152
X 20mm	-0.592	-0.298	-2.174	-18.307	-1.661	-0.728	-2.128	-136.044
X 25mm	-4.179	-0.855	-6.291	-61.285	-6.927	-2.199	-6.388	-448.240

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.111	0.010	0.071	0.951	0.139	0.029	0.082	6.634
20mm	0.138	0.009	0.065	0.969	0.161	0.028	0.081	6.539
25mm	0.163	0.009	0.061	0.984	0.180	0.028	0.080	6.467

Estimated weight for 15mm clam

0.038 gm
38.220 mg

Estimated weight for 20mm clam

0.096 gm
95.626 mg

Estimated weight for 25mm clam

0.195 gm
194.766 mg

Station: Palo Alto

Date: 05/15/01

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
					Concentration (ug/ml) - Blank Corrected from ICP-AES							
Mb1	11.75	0.2479	0.0177	11	0.1351	0.0169	0.1345	1.2804	0.1820	0.0445	0.1371	8.9639
Mb2	12.63	0.2607	0.0201	11	0.1150	0.0118	0.0787	1.1665	0.1492	0.0344	0.0891	8.8208
Mb3	13.23	0.351	0.0270	11	0.1295	0.0126	0.0962	1.1427	0.1466	0.0349	0.0993	8.3378
Mb4	14.05	0.4069	0.0339	11	0.0606	0.0058	0.0277	0.6727	0.0977	0.0200	0.0478	4.0466
Mb5	14.68	0.4287	0.0357	11	0.1478	0.0131	0.1040	1.2080	0.1721	0.0343	0.1088	9.2457
Mb6	15.54	0.4858	0.0405	11	0.1522	0.0143	0.1161	1.1833	0.1837	0.0401	0.1180	8.2161
				LOD	0.0006	-0.0001	-0.0020	0.0010	0.0005	0.0025	0.0058	0.0014
				LOQ	0.0007	0.0003	-0.0010	0.0055	0.0010	0.0130	0.0090	0.0051

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	5.9948	0.7503	5.9666	56.8152	8.0736	1.9724	6.0817	397.751
	Mb2	4.8536	0.4962	3.3217	49.2201	6.2962	1.4532	3.7591	372.186
	Mb3	4.0590	0.3955	3.0146	35.8108	4.5943	1.0922	3.1117	261.299
	Mb4	1.6393	0.1563	0.7489	18.1842	2.6423	0.5399	1.2922	109.395
	Mb5	3.7929	0.3354	2.6690	30.9957	4.4151	0.8804	2.7922	237.236
	Mb6	3.4465	0.3233	2.6297	26.7940	4.1604	0.9078	2.6723	186.038

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.1062	0.0133	0.1057	1.0060	0.1430	0.0349	0.1077	7.0430
	Mb2	0.0973	0.0100	0.0666	0.9871	0.1263	0.0291	0.0754	7.4638
	Mb3	0.1096	0.0107	0.0814	0.9669	0.1240	0.0295	0.0840	7.0551
	Mb4	0.0556	0.0053	0.0254	0.6166	0.0896	0.0183	0.0438	3.7094
	Mb5	0.1355	0.0120	0.0953	1.1073	0.1577	0.0315	0.0998	8.4753
	Mb6	0.1395	0.0131	0.1065	1.0847	0.1684	0.0367	0.1082	7.5314

Station: Palo Alto

Statistical Summary

Date: 6/11/2002

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	1.176	0.171	1.402	22.664	3.851	0.937	1.368	192.851
STD	0.476	0.027	0.425	1.610	0.441	0.160	0.276	23.666
SEM	0.159	0.009	0.142	0.537	0.147	0.053	0.092	7.889
CV%	40.497	15.929	30.353	7.102	11.452	17.095	20.202	12.272
n	9	9	9	9	9	9	9	9
r wt x [ ]	0.796	0.186	0.072	0.372	0.296	0.508	0.244	0.481
X 100mg	2.448	0.154	1.299	24.669	4.288	0.665	1.142	231.020
r l x [ ]	0.736	0.059	0.059	0.315	0.381	0.402	0.127	0.589
X 15mm	0.974	0.172	1.387	22.371	3.754	0.975	1.388	184.783
X 20mm	1.801	0.168	1.446	23.569	4.150	0.822	1.305	217.712
X 25mm	2.628	0.165	1.505	24.768	4.547	0.670	1.223	250.641

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.030	0.005	0.042	0.708	0.118	0.030	0.043	5.805
20mm	0.130	0.013	0.111	1.837	0.325	0.065	0.101	17.200
25mm	0.400	0.026	0.235	3.846	0.714	0.116	0.197	39.945

Estimated weight for 15mm clam

0.032 gm
31.639 mg

Estimated weight for 20mm clam

0.079 gm
78.712 mg

Estimated weight for 25mm clam

0.160 gm
159.610 mg

Station: Palo Alto

Date: 6/11/2002

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Concentration (ug/ml) - Blank Corrected from ICP-AES Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mb1	12.58	0.3207	0.0178	11	0.0299	0.0047	0.0307	0.6844	0.1041	0.0288	0.0377	4.4481
Mb2	14.72	0.4811	0.0301	11	0.0497	0.0069	0.0642	1.0283	0.1367	0.0385	0.0578	7.9597
Mb3	15.05	0.3812	0.0318	11	0.0268	0.0060	0.0474	0.7517	0.1351	0.0348	0.0432	7.0289
Mb4	15.42	0.3609	0.0361	11	0.0208	0.0050	0.0304	0.6518	0.1240	0.0289	0.0404	5.5937
Mb5	16.15	0.4059	0.0406	11	0.0267	0.0068	0.0631	0.7705	0.1369	0.0359	0.0600	7.1485
Mb6	16.64	0.4151	0.0415	11	0.0391	0.0088	0.0868	0.8434	0.1809	0.0485	0.0750	8.4503
Mb7	17.30	0.4559	0.0507	11	0.0616	0.0074	0.0613	0.9812	0.1672	0.0379	0.0536	8.3075
Mb8	18.53	0.4947	0.0618	11	0.0833	0.0075	0.0599	1.1253	0.1745	0.0363	0.0567	10.1278
Mb9	19.64	0.4425	0.0738	11	0.0773	0.0055	0.0394	0.9457	0.1556	0.0285	0.0421	7.4213
				LOD	0.0013	0.0001	-0.0022	0.0003	0.0004	-0.0004	0.0025	0.0019
				LOQ	0.0035	0.0006	-0.0022	0.0032	0.0013	0.0045	0.0026	0.0068

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	1.0263	0.1602	1.0517	23.4732	3.5696	0.9861	1.2945	152.570
	Mb2	1.1354	0.1582	1.4670	23.5118	3.1249	0.8791	1.3225	181.992
	Mb3	0.7728	0.1726	1.3683	21.6924	3.8991	1.0036	1.2472	202.826
	Mb4	0.6328	0.1527	0.9264	19.8651	3.7791	0.8818	1.2298	170.491
	Mb5	0.7236	0.1848	1.7104	20.8806	3.7100	0.9721	1.6271	193.727
	Mb6	1.0367	0.2327	2.3010	22.3497	4.7930	1.2844	1.9867	223.929
	Mb7	1.4860	0.1790	1.4794	23.6756	4.0342	0.9154	1.2925	200.443
	Mb8	1.8527	0.1663	1.3320	25.0219	3.8804	0.8063	1.2617	225.199
	Mb9	1.9216	0.1355	0.9783	23.5100	3.8683	0.7075	1.0475	184.484

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.0183	0.0029	0.0187	0.4182	0.0636	0.0176	0.0231	2.7183
	Mb2	0.0341	0.0048	0.0441	0.7070	0.0940	0.0264	0.0398	5.4723
	Mb3	0.0245	0.0055	0.0435	0.6891	0.1239	0.0319	0.0396	6.4431
	Mb4	0.0228	0.0055	0.0334	0.7169	0.1364	0.0318	0.0444	6.1530
	Mb5	0.0294	0.0075	0.0694	0.8475	0.1506	0.0395	0.0660	7.8634

Station: Palo Alto

Statistical Summary

Date: 9/9/2002

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	2.770	0.213	0.779	39.952	4.359	1.185	1.641	160.181
STD	0.304	0.059	0.301	6.575	0.511	0.370	0.454	25.269
SEM	0.107	0.021	0.107	2.325	0.181	0.131	0.161	8.934
CV%	10.962	27.964	38.676	16.458	11.724	31.263	27.686	15.775
n	8	8	8	8	8	8	8	8
r wt x [ ]	0.214	0.866	0.698	0.389	0.489	0.810	0.702	0.584
X 100mg	2.512	0.009	-0.053	29.834	3.371	-0.003	0.379	101.777
r l x [ ]	0.194	0.941	0.763	0.451	0.605	0.894	0.811	0.635
X 15mm	2.818	0.258	0.967	42.368	4.611	1.454	1.942	173.258
X 20mm	2.697	0.144	0.498	36.328	3.981	0.780	1.191	140.562
X 25mm	2.577	0.030	0.029	30.289	3.352	0.106	0.440	107.866

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.059	0.005	0.019	0.881	0.096	0.029	0.039	3.584
20mm	0.150	0.009	0.027	2.004	0.224	0.047	0.070	7.891
25mm	0.312	0.013	0.035	3.792	0.432	0.068	0.109	14.556

Estimated weight for 15mm clam

0.021 gm
20.910 mg

Estimated weight for 20mm clam

0.056 gm
55.946 mg

Estimated weight for 25mm clam

0.120 gm
120.034 mg

Station: Palo Alto

Date: 9/9/2002

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Concentration (ug/ml) - Blank Corrected from ICP-AES Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mb1	13.10	0.1474	0.0134	9	0.0500	0.0053	0.0183	0.7744	0.0892	0.0318	0.0416	3.3067
Mb2	14.97	0.1854	0.0206	9	0.0490	0.0057	0.0218	0.9219	0.0962	0.0311	0.0430	3.1812
Mb3	15.67	0.2178	0.0242	9	0.0679	0.0052	0.0264	0.9263	0.0975	0.0258	0.0398	3.5641
Mb4	16.26	0.2243	0.0280	9	0.0741	0.0053	0.0171	0.9697	0.0993	0.0300	0.0349	4.6452
Mb5	17.62	0.2444	0.0349	9	0.0673	0.0050	0.0184	1.0122	0.1055	0.0280	0.0345	4.4688
Mb6	18.38	0.2001	0.0400	9	0.0719	0.0038	0.0114	0.7374	0.0998	0.0208	0.0330	2.9380
Mb7	19.75	0.2718	0.0544	11	0.0674	0.0039	0.0068	1.2147	0.1036	0.0242	0.0293	4.1070
Mb8	20.26	0.3051	0.0610	11	0.0696	0.0045	0.0225	0.8541	0.1160	0.0225	0.0421	3.5653
				LOD	0.0002	0.0002	0.0026	0.0027	0.0003	0.0018	0.0018	0.0004
				LOQ	0.0005	0.0010	0.0069	0.0075	0.0011	0.0114	0.0022	0.0033

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	3.0517	0.3230	1.1197	47.2851	5.4470	1.9423	2.5382	201.899
	Mb2	2.3806	0.2772	1.0567	44.7547	4.6675	1.5092	2.0864	154.427
	Mb3	2.8037	0.2132	1.0920	38.2774	4.0269	1.0657	1.6450	147.278
	Mb4	2.9728	0.2143	0.6880	38.9103	3.9856	1.2037	1.4020	186.389
	Mb5	2.4768	0.1852	0.6767	37.2724	3.8858	1.0304	1.2705	164.561
	Mb6	3.2343	0.1687	0.5146	33.1652	4.4865	0.9337	1.4843	132.142
	Mb7	2.7277	0.1578	0.2742	49.1606	4.1908	0.9810	1.1850	166.213
	Mb8	2.5083	0.1608	0.8117	30.7936	4.1830	0.8127	1.5186	128.541

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.0409	0.0043	0.0150	0.6336	0.0730	0.0260	0.0340	2.7054
	Mb2	0.0490	0.0057	0.0218	0.9219	0.0962	0.0311	0.0430	3.1812
	Mb3	0.0679	0.0052	0.0264	0.9263	0.0975	0.0258	0.0398	3.5641
	Mb4	0.0834	0.0060	0.0193	1.0909	0.1117	0.0338	0.0393	5.2259
	Mb5	0.0865	0.0065	0.0236	1.3013	0.1357	0.0360	0.0444	5.7455

Station: Palo Alto

Statistical Summary

Date: 10/7/2002

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	3.745	0.361	2.656	52.595	7.160	2.058	3.520	175.270
STD	1.049	0.079	0.709	6.199	0.753	0.411	0.747	27.140
SEM	0.428	0.032	0.289	2.531	0.308	0.168	0.305	11.080
CV%	27.998	21.824	26.690	11.787	10.522	19.985	21.221	15.484
n	6	6	6	6	6	6	6	6
r wt x [ ]	0.027	0.458	0.270	0.675	0.258	0.441	0.111	0.405
X 100mg	3.414	-0.065	0.397	3.168	4.868	-0.084	2.545	45.288
r l x [ ]	0.112	0.461	0.248	0.676	0.205	0.448	0.128	0.451
X 15mm	3.790	0.375	2.723	54.189	7.219	2.128	3.557	179.931
X 20mm	3.409	0.257	2.154	40.639	6.719	1.532	3.247	140.322
X 25mm	3.027	0.140	1.584	27.090	6.218	0.936	2.937	100.712

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.062	0.006	0.045	0.913	0.122	0.035	0.059	3.014
20mm	0.132	0.012	0.089	1.796	0.287	0.070	0.137	6.178
25mm	0.237	0.019	0.150	3.038	0.557	0.118	0.262	10.780

Estimated weight for 15mm clam

0.017 gm
16.957 mg

Estimated weight for 20mm clam

0.043 gm
42.546 mg

Estimated weight for 25mm clam

0.087 gm
86.846 mg

Station: Palo Alto

Date: 10/7/2002

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Concentration (ug/ml) - Blank Corrected from ICP-AES Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mb1	13.70	0.1406	0.0128	9	0.0756	0.0075	0.0484	0.8869	0.1235	0.0434	0.0678	3.3116
Mb2	14.52	0.1591	0.0159	9	0.0651	0.0056	0.0479	1.0210	0.1115	0.0323	0.0536	3.3454
Mb3	15.13	0.1616	0.0180	9	0.0552	0.0056	0.0381	0.9291	0.1265	0.0295	0.0547	2.4932
Mb4	15.62	0.1566	0.0174	9	0.0725	0.0058	0.0387	1.0137	0.1221	0.0361	0.0510	3.2773
Mb5	16.48	0.1359	0.0227	9	0.0311	0.0066	0.0577	0.6457	0.1237	0.0337	0.0695	2.2650
Mb6	18.09	0.16	0.0320	9	0.0827	0.0051	0.0348	0.8584	0.1154	0.0319	0.0563	3.0790
				LOD	0.0010	0.0000	0.0011	0.0036	0.0000	-0.0040	0.0116	0.0005
				LOQ	0.0030	0.0013	0.0097	0.0095	0.0017	-0.0024	0.0140	0.0020

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	4.8367	0.4826	3.0981	56.7698	7.9060	2.7794	4.3425	211.977
	Mb2	3.6849	0.3162	2.7101	57.7562	6.3062	1.8266	3.0304	189.245
	Mb3	3.0731	0.3119	2.1240	51.7461	7.0474	1.6441	3.0459	138.852
	Mb4	4.1678	0.3328	2.2262	58.2558	7.0172	2.0718	2.9316	188.349
	Mb5	2.0570	0.4344	3.8223	42.7595	8.1947	2.2331	4.6053	150.002
	Mb6	4.6519	0.2863	1.9580	48.2832	6.4901	1.7938	3.1663	173.196

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.0618	0.0062	0.0396	0.7256	0.1011	0.0355	0.0555	2.7095
	Mb2	0.0586	0.0050	0.0431	0.9189	0.1003	0.0291	0.0482	3.0109
	Mb3	0.0552	0.0056	0.0381	0.9291	0.1265	0.0295	0.0547	2.4932
	Mb4	0.0725	0.0058	0.0387	1.0137	0.1221	0.0361	0.0510	3.2773
	Mb5	0.0466	0.0098	0.0866	0.9685	0.1856	0.0506	0.1043	3.3975

Station: Palo Alto

Date: 12/16/2002

Statistical Summary

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mean(ug/g)	4.437	0.474	5.361	45.431	8.527	3.084	6.018	264.693
STD	1.101	0.052	0.721	4.710	0.995	0.498	0.799	35.788
SEM	0.416	0.020	0.273	1.780	0.376	0.188	0.302	13.527
CV%	24.804	10.982	13.449	10.367	11.669	16.155	13.273	13.521
n	7	7	7	7	7	7	7	7
r wt x [ ]	0.213	0.341	0.610	0.387	0.448	0.083	0.051	0.701
X 100mg	5.463	0.552	7.288	37.437	10.483	2.902	5.839	154.752
r l x [ ]	0.017	0.325	0.560	0.504	0.327	0.250	0.188	0.666
X 15mm	4.426	0.465	5.132	46.777	8.343	3.154	6.103	278.203
X 20mm	4.457	0.492	5.785	42.937	8.869	2.953	5.860	239.655
X 25mm	4.488	0.519	6.438	39.096	9.396	2.751	5.616	201.107

Estimated content (μg) for 15mm, 20mm and 25mm clam

	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
15mm	0.086	0.009	0.102	0.923	0.166	0.062	0.120	5.453
20mm	0.198	0.023	0.265	1.992	0.406	0.135	0.269	11.189
25mm	0.376	0.046	0.557	3.617	0.813	0.246	0.501	19.542

Estimated weight for 15mm clam

0.020 gm
19.869 mg

Estimated weight for 20mm clam

0.047 gm
46.533 mg

Estimated weight for 25mm clam

0.090 gm
90.041 mg

Station: Palo Alto

Date: 12/16/2002

Macoma balthica

Sample #-n	Average Length (mm)	Total Dry Wt (gm)	Average Dry Wt (gm)	Recon Amt (ml)	Concentration (ug/ml) - Blank Corrected from ICP-AES Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Mb1	12.02	0.1216	0.0111	9	0.0790	0.0059	0.0664	0.6857	0.1151	0.0504	0.0905	3.7299
Mb2	14.39	0.1322	0.0165	9	0.0593	0.0073	0.0807	0.7005	0.1348	0.0494	0.0978	4.8444
Mb3	15.52	0.1936	0.0215	9	0.0814	0.0106	0.1062	1.0795	0.1690	0.0596	0.1260	5.5813
Mb4	16.83	0.1878	0.0268	9	0.0762	0.0079	0.0869	0.7973	0.1431	0.0494	0.0934	5.6984
Mb5	17.81	0.1967	0.0328	9	0.0644	0.0115	0.1332	0.8866	0.1879	0.0666	0.1333	5.1244
Mb6	19.67	0.2293	0.0459	9	0.1371	0.0118	0.1486	1.1747	0.2205	0.0694	0.1445	6.7078
Mb7	21.02	0.2773	0.0555	9	0.1668	0.0161	0.1876	1.3715	0.3089	0.1105	0.2055	6.6768
				LOD	0.0017	0.0000	-0.0022	0.0040	0.0824	-0.0014	0.0239	0.0000
				LOQ	0.0058	0.0007	0.0017	0.0115	0.2383	0.0037	0.0320	0.0000

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Concentration (ug/g) ==>	Mb1	5.8485	0.4382	4.9173	50.7509	8.5211	3.7273	6.6967	276.059
	Mb2	4.0357	0.4970	5.4906	47.6862	9.1790	3.3624	6.6567	329.798
	Mb3	3.7822	0.4928	4.9369	50.1819	7.8550	2.7716	5.8574	259.462
	Mb4	3.6513	0.3796	4.1634	38.2098	6.8554	2.3650	4.4751	273.088
	Mb5	2.9466	0.5271	6.0946	40.5644	8.5992	3.0468	6.1001	234.467
	Mb6	5.3812	0.4635	5.8324	46.1088	8.6558	2.7255	5.6696	263.279
	Mb7	5.4146	0.5216	6.0895	44.5142	10.0263	3.5873	6.6700	216.699

	Sample #	Ag	Cd	Cr	Cu	Ni	Pb	V	Zn
Content (ug) ==>	Mb1	0.0647	0.0048	0.0544	0.5610	0.0942	0.0412	0.0740	3.0517
	Mb2	0.0667	0.0082	0.0907	0.7880	0.1517	0.0556	0.1100	5.4499
	Mb3	0.0814	0.0106	0.1062	1.0795	0.1690	0.0596	0.1260	5.5813
	Mb4	0.0980	0.0102	0.1117	1.0251	0.1839	0.0635	0.1201	7.3266
	Mb5	0.0966	0.0173	0.1998	1.3298	0.2819	0.0999	0.2000	7.6866

Appendix D.

Concentrations of Hg and Se in surface sediments (D-2) and clams (D-3). Data includes analysis of standard reference materials.

Palo Alto surface sediments, Hg and Se analysis: 2002

Date		mean Hg (μg/g)	mean Se (μg/g)
January 8, 2002		0.26	0.3
February 8, 2002		0.31	0.4
March 7, 2002		0.34	0.4
May 15, 2002		0.28	0.4
September 9, 2002		0.25	0.3
USGS SDO	Found	0.13	1.9
	Accepted	0.19±0.08	1.9 - 6.8

Palo Alto Macoma balthica, Hg analysis: 2002

Sample ID		mean Hg (μg/g)	SEM
January 8, 2002		0.42	0.02
April 15, 2002		0.20	0.03
June 11, 2002		0.19	0.01
September 9, 2002		0.34	0.04
DOLT-2	Found	2.1	
	Accepted	2.0±0.1	
DORM-2	Found	4.4	
	Accepted	4.6±0.03	
SRM 2976	Found	0.05	
	Accepted	0.06±0.004	

Palo Alto *Macoma balthica*, Se analysis: 2002.

Sample ID		mean Se (μg/g)	SEM
January 8, 2002		4.03	0.43
April 15, 2002		2.87	0.29
June 11, 2002		2.90	0.30
September 9, 2002		2.87	0.37
DOLT-2	Found	5.8	
	Accepted	6.1±0.5	
DORM-2	Found	1.3	
	Accepted	1.4±0.1	
SRM 2976	Found	1.7	
	Accepted	0.06±0.004	

Appendix E.

Analysis of (NIST) reference materials. 2002 SRM 2709 (San Joaquin Soil) recoveries (HNO_3 extraction) (E-2). Metal concentrations analyzed (at each sampling) in Standard Reference Material (NIST) 2976 (Mussel tissue) compared to certified mean, maximum and minimum values for that material (E-3)

						Concentration ug/g							
Month	**Rep**	**AG**	**AL**	**AS**	**CD**	**CR**	**CU**	**FE**	**MN**	**NI**	**PB**	**V**	**ZN**
January	1	0	39098	0	0	89.3	32.3	30867	477	77.5	15.5	84.8	83.3
	2	0	34500	0	0	83.6	30.5	29879	471	77.8	13.9	73.9	80.3
February	1	0	35892	0	0	85.8	30.2	29693	465	75.8	15.3	76.7	80.9
	2	0	36986	0	0	85.7	30.8	30245	469	77.5	13.9	80.6	82.4
March	1	0	35607	0	0	85.6	29.5	30360	468	77.1	15.4	77.2	80.2
	2	0	38761	0	0	88.5	31.7	31369	478	78.7	15.7	85.4	84.3
April	1	0	31212	0	0	71.1	27.0	28044	431	71.3	12.7	68.3	73.9
	2	0	35543	0	0	84.0	29.6	31067	478	79.3	14.9	76.8	85.7
May	1	0	36368	0	0	85.2	30.2	31715	486	80.2	15.3	78.9	88.6
	2	0	34633	0	0	80.6	29.8	31870	489	80.8	15.3	76.2	85.0
June	1	0	34773	0	0	77.6	30.1	31403	483	79.9	14.7	76.0	84.1
	2	0	32863	0	0	76.1	28.6	30964	477	78.7	14.5	71.5	83.2
September	1	0	34448	0	0	78.4	29.1	31800	485	80.3	14.1	74.5	84.1
	2	0	35092	0	0	75.2	30.4	32005	488	81.2	15.0	77.0	85.5
October	1	0	36680	0	0	82.4	29.7	31810	486	80.0	14.8	79.5	86.5
	2	0	35801	0	0	81.6	29.9	31539	478	79.3	15.5	77.0	88.2
Certified Value, ug/g		**0.41**	**75000**	**17.70**	**0.38**	**130.00**	**34.60**	**35000**	**538**	**88.0**	**18.9**	**112.0**	**106.0**
Standard Deviation		**0.03**	**0**	**0.80**	**0.01**	**4.00**	**0.70**	**0**	**17**	**5.0**	**0.5**	**5.0**	**3.0**

						Percent Recovery							
Month	**Rep**	**AG**	**AL**	**AS**	**CD**	**CR**	**CU**	**FE**	**MN**	**NI**	**PB**	**V**	**ZN**
January	1	0.0	52	0.00	0.0	68.69	93.42	88	89	88.06	81.98	75.68	78.61
	2	0.0	46	0.00	0.0	64.34	88.25	85	88	88.44	73.73	65.95	75.71
February	1	0.0	48	0.00	0.0	65.99	87.26	85	86	86.12	80.83	68.51	76.33
	2	0.0	49	0.00	0.0	65.91	89.02	86	87	88.07	73.39	72.00	77.77
March	1	0.0	47	0.00	0.0	65.82	85.37	87	87	87.58	81.74	68.90	75.68
	2	0.0	52	0.00	0.0	68.08	91.71	90	89	89.43	82.85	76.29	79.55
April	1	0.0	42	0.00	0.0	54.72	77.95	80	80	81.02	67.07	61.00	69.75
	2	0.0	47	0.00	0.0	64.65	85.67	89	89	90.09	78.82	68.60	80.83
June	1	0.0	48	0.00	0.0	65.56	87.25	91	90	91.11	80.84	70.41	83.62
	2	0.0	46	0.00	0.0	61.96	86.22	91	91	91.87	80.85	68.05	80.22
September	1	0.0	46	0.00	0.0	60.32	84.08	91	90	91.21	74.64	66.53	79.36
	2	0.0	47	0.00	0.0	57.88	87.92	91	91	92.29	79.30	68.73	80.66
October	1	0.0	49	0.00	0.0	63.41	85.85	91	90	90.88	78.42	70.95	81.59
	2	0.0	48	0.00	0.0	62.76	86.38	90	89	90.07	81.89	68.74	83.23
Average % Recovery		**0.0**	**48**	**0.00**	**0.0**	**63.58**	**86.88**	**88**	**88**	**89.02**	**78.31**	**69.31**	**78.78**
Standard Deviation		**0.0**	**3**	**0.00**	**0.0**	**3.85**	**3.58**	**3**	**3**	**2.92**	**4.51**	**3.84**	**3.61**

[All values in micrograms per gram dry weight]

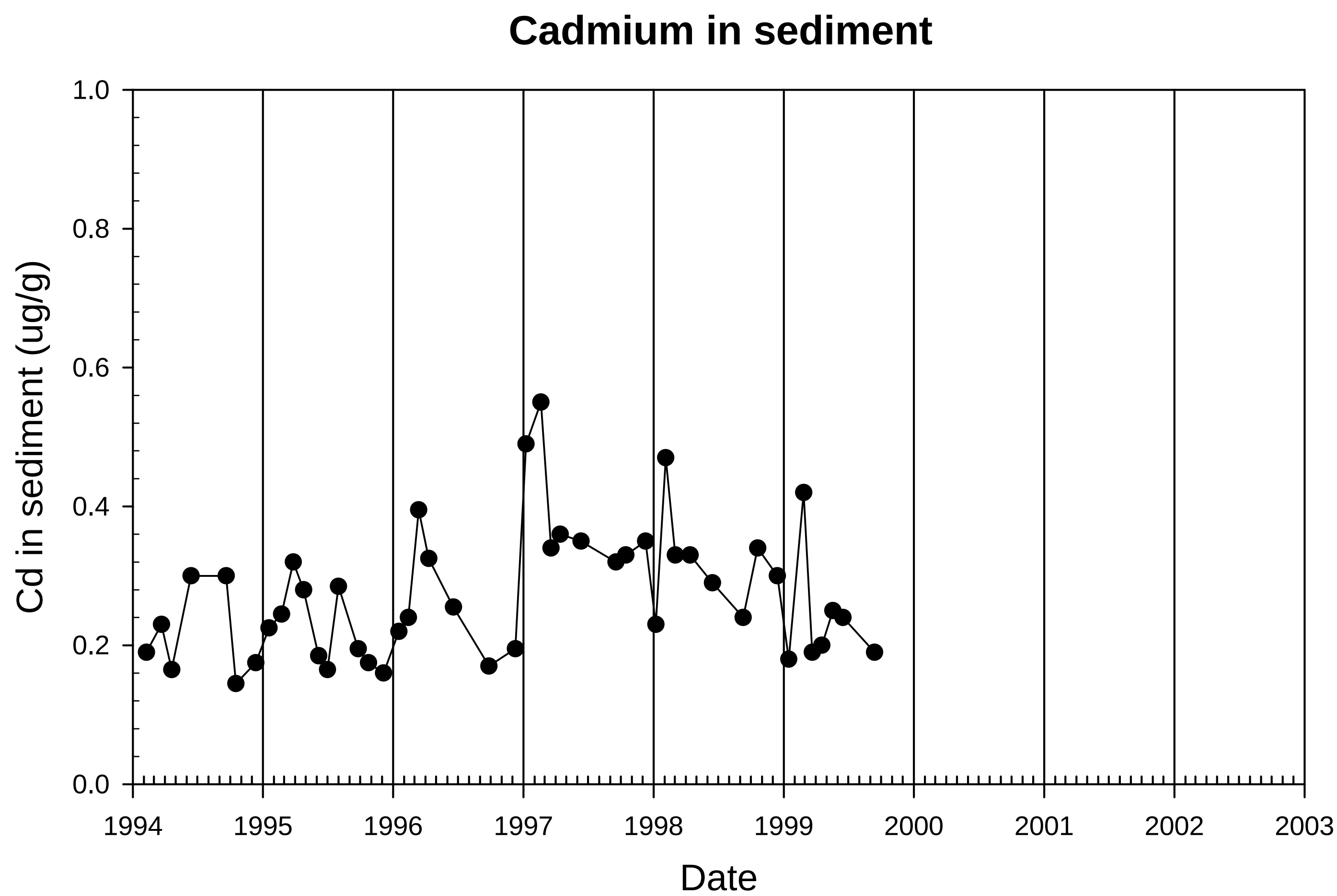
Date	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Vanadium	Zinc
01/08/02	0.71	0.59	3.34	1.01	0.67	0.05	0.90	167
02/08/02	0.64	0.59	2.90	0.42	0.63	0.06	0.77	164
03/07/02	0.67	0.26	3.00	0.85	0.61	0.05	0.68	137
04/15/02	0.86	0.63	3.25	1.12	0.77	0.05	0.80	157
05/15/02	0.78	0.52	3.24	0.98	1.01	0.03	0.89	133
06/11/02	0.79	0.28	2.83	0.86	0.72	0.04	0.77	149
10/07/02	0.83	0.67	3.16	1.08	0.76	0.03	1.07	146
12/16/02	0.78	0.55	3.21	1.33	0.76	0.05	1.15	124
Mean	0.75	0.51	3.11	0.96	0.74	0.04	0.88	147.29
STD	0.08	0.16	0.18	0.27	0.12	0.01	0.16	15.21

Certified Values

Mean	0.82	0.5	4.02	1.19	0.93	0.011		137
Max.	0.98	0.66	4.35	1.37	1.05	0.016		150
Min.	0.66	0.37	3.69	1.01	0.81	0.006		124

Appendix F.

Near-total cadmium concentrations in sediments at Palo Alto from 1994 through 1999. (F-2). Sediment concentrations of cadmium (Cd) were slightly elevated from 1997 through 1999 compared to earlier years; although overall concentrations were lower compared to projected biological effects thresholds (1.2 μg/g) (Long et al., 1995) (Figure 8). Also, there appears to be a general decreasing trend over the last three years (1997-1999).


Cadmium in sediment
1.0
0.8
0.6
0.4
0.2
0.0
Cd in sediment (ug/g)
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Date