Regional Monitoring Program 2001 Results

1.0 INTRODUCTION

1.1 Background

The San Francisco Bay Regional Water Quality Control Board (Regional Board) established the Regional Monitoring Program for Trace Substances (RMP) in 1993. The sampling design began with the Regional Board's Bay Protection and Toxic Cleanup Program (BPTCP) Pilot Studies conducted during 1991 and 1992 (Flegal et al. 1994). Each year the RMP's advisory committee reviews the monitoring plan and makes appropriate adjustments. For example, several new stations were added in 1994 to fill spatial gaps or to monitor near major tributaries at Coyote Creek (BA10), San Bruno Shoal (BB15), Alameda (BB70), Red Rock (BC60), Petaluma River (BD15), and Honker Bay (BF40) (SFEI 1996). Two additional stations were added in the southern-most end of the Estuary in cooperation with the cities of San Jose (C-3-0) and Sunnyvale (C-1-3) and the Regional Board's National Pollutant Discharge Elimination System (NPDES) monitoring. As part of the Estuary Interface Pilot Study that began in 1996, water and sediment monitoring was conducted at two stations located at the bottom of two South Bay watersheds: Standish Dam (BW10) in Coyote Creek and Guadalupe River (BW15) in the Alviso Slough.

External experts review the RMP's technical and administrative structure and performance approximately every five years to ensure that the RMP adapts to scientific and technological advances and continues to be useful to the regulatory and scientific communities. Recommendations proposed during the last review process in 1997 included revising the RMP's objectives (see *RMP Overview*). In 2000 and 2001, a workgroup of experts on environmental monitoring was assembled to design a new monitoring strategy that would address the new RMP objectives and incorporate the current state of knowledge acquired from contaminant monitoring in the Estuary (see *RMP News: Winter 2001/2002* at *http://www.sfei.org/rmp/rmpnews.htm*).

An interim monitoring scheme was designed to incrementally phase in adjustments over two sampling years (2000-2001), with the fully revised RMP Status & Trends monitoring design (including spatially randomized sampling of water and sediment) implemented in 2002. Some of the interim modifications included shifting sampling frequency from seasonal to annual sampling in the dry season to reduce interannual variability; incorporating separate, focused pilot and special studies to evaluate sources, pathways, and loadings of contaminants to the Estuary; and revising the list of analytes measured in samples. The last round of sampling with a fixed station design was conducted in 2001.

San Pablo Bay and Napa River RMP stations were sampled in the wet season of 2000 and 2001 specifically to accommodate a previous agreement for the USEPA Star Grant Project, CISNet (Coastal Intensive Sites Network). The objective of this collaborative project with UC Davis is to develop monitoring indicators for San Pablo Bay and its adjacent tidal marshes and river tributaries.

1.2 2001 Status and Trends Monitoring Design

In 2001, the RMP's activities included the Status and Trends Monitoring component (formerly referred to as the Base Program), several Pilot Studies (Section 1.2.5) and Special Studies (Section 1.2.6). As in prior years, water, sediment, and bivalve tissue samples were collected, and analyses were conducted for: (1) conventional water quality and chemistry, (2) aquatic bioassays, (3) sediment quality and chemistry, (4) sediment bioassays, (5) transplanted bivalve bioaccumulation, survival, condition and chemistry (Table 1.2). A summary of the sample collection methods and analytical procedures is provided in the *Description of Methods*. In addition, data results are available at the end of each section or can be downloaded at *http://www.sfei.org/rmp/data.htm*.

The locations of the 26 sampling stations, including the Southern Slough (C-3-0 and C-1-3) and Estuary Interface (BW10 and BW15) stations, are shown in Figure 1.1. Stations were primarily located in the deeper shipping channels along the "spine" of the Estuary. Sites were selected to monitor background contaminant concentrations and to examine spatial and temporal trends. Table 1.3 lists the station names and codes, target latitude and longitude coordinates, and 2001 sampling dates. Since all parameters were not measured at every station during each sampling period, information on the sampling activities conducted at each station is also provided. Water, sediment, and bioaccumulation sampling sites that have the same station name may have different station codes, as they are situated at slightly different coordinates due to practical considerations, such as sediment type or ability to deploy bivalves. For example, at the South Bay site, BA20 is the water station code and BA21 is the sediment station code.

Several labs are contracted by the RMP to perform sample analysis. The collaborating labs and the principal investigators are listed in Table 1.4. The RMP principal contractor, Applied Marine Sciences, coordinated the 2001 field sampling for water, sediment, and bivalve tissue and the distribution of samples for analysis. Water and sediment samples were collected from the *R/V David Johnston* chartered through the University of California, Santa Cruz during separate sampling cruises (two to eight days in duration). Bivalve sampling required three phases: deployment of transplanted bivalves from reference sites, maintenance, and retrieval. Most of the bivalve monitoring component was conducted aboard the *R/V Questuary*, owned by San Francisco State University, with back-up services provided by the California Department of Water Resources. The Standish Dam and Guadalupe River sites were sampled from shore.

1.2.1 Water Sampling

Sample collection for conventional water quality parameters and trace elements occurred during two sampling events, once during the wet season in January/February and once during the dry season in August. Since most of the trace organic contaminants currently measured are legacy pollutants that degrade slowly, one sampling event per year in the dry season was determined to be sufficient to meet the objectives of evaluating interannual trends and comparing data to regulatory guidelines. In 2001, the Episodic Toxicity Pilot Study was incorporated into the Status and Trends Monitoring program. Water samples were collected and tested for aquatic toxicity in both the winter and summer water cruises for a sub sample of sites.

1.2.2 Sediment Sampling

Sediment sample collection occurred once during the dry season (in August) at all stations and once during the wet season (in February) for a limited number of sites in the Northern Estuary. Sites sampled in February were San Pablo Bay (BD22), Petaluma River (BD15), Napa River (BD50) and Davis Point (BD41). This sampling was done in collaboration with the Coastal Intensive Sites Network (CISNet) San Pablo Bay Project and EPA's Environmental Monitoring Assessment Program (EMAP) (see link: *http://my.engr.ucdavis.edu/~edllab/Projects/CISNet/cisnet.html*). During the August sampling cruise thirteen sites were tested for sediment toxicity.

1.2.3 Bivalve Tissue Sampling

Bivalve tissues were sampled for contaminant bioaccumulation once during the dry season (in September), when Estuary conditions are most consistent on an interannual basis. Some of the new monitoring changes introduced during the 2000 sampling year continued during 2001 including: (1) *Mytilus edulis* were transplanted along with *Mytilus californianus* in order to study survival levels and growth at locations experiencing a variety of salinity regimes, and (2) continued testing of an alternative cage system at seven sampling sites that could eliminate the maintenance cruise. Stations for testing the alternative system included Redwood Creek (BA40), Yerba Buena Island (BC10), Horseshoe Bay (BC21), Coyote Creek (BA10), Red Rock (BC60), Davis Point (BD40) and Napa River (BD50).

1.2.4 USGS Studies

As in prior monitoring years, the United States Geological Survey (USGS) (see link: *http://ca.water.usgs.gov /projects00/*) continued to supplement RMP monitoring by conducting two special studies. A sediment transport study examined the role of several environmental factors controlling suspended sediments in the Estuary, such as tides, winds, storm events (runoff), and wind waves. Another study performed monthly measurements of five water quality parameters to describe the changing spatial patterns of water quality from the lower Sacramento River to the southern limit of the South Bay. These measurements included salinity, temperature, dissolved oxygen, suspended sediments, and phytoplankton biomass.

1.2.5 Pilot Studies

In addition to the Status and Trends Monitoring component, several pilot studies addressed specific topics relating to contamination in the Estuary. In 2001, the mercury-monitoring component of the Air Deposition Pilot Study continued. Data on wet and dry deposition of mercury was gathered at the San Jose sampling station (Figure 1.1). In addition, analysis of PAH and PCB air deposition data continued in 2001. Water and sediment sampling at two southern Estuary sites (Guadalupe River and Standish Dam) also occurred during 2001 as a continuation of the Estuary Interface Pilot Study. The watersheds of these river systems have been identified as sources for PCBs in the Estuary.

1.2.6 Special Studies

Special Studies are designed to augment and improve the Status and Trends Monitoring program and to provide a pro-active approach in attending to management goals and needs. In 2001, special studies included in depth literature reviews on sources, pathways and loadings of contaminants, identifying and analyzing unknown potential chemical contaminants in the Estuary and creating conceptual models that can simulate contaminant pathways in food webs and the fate of particular contaminants in the Estuary.

1.3 References

Flegal, A.R., R.W. Risebrough, B. Anderson, J. Hunt, S. Anderson, J. Oliver, M. Stephenson, and R. Packard. 1994. San Francisco Estuary Pilot Regional Monitoring Program: Sediment Studies. San Francisco Bay Regional Water Quality Control Board, State Water Resources Control Board.

SFEI. 1996. 1994 Annual Report: San Francisco Estuary Regional Monitoring Program for Trace Substances. Prepared by the San Francisco Estuary Institute, Richmond, CA. 339pp.

Table 1.2. Parameters analyzed in water, sediment, and bivalve tissue in 2001.

Conventional Water Quality Parameters
Conductivity
Dissolved Organic Carbon
Dissolved Oxygen
Hardness (when salinity is <5 ‰)
pH (acidity)
Phaeophytin (a chlorophyll degradation product)
Salinity
Temperature
Total Chlorophyll-*a*
Total Suspended Solids
Dissolved Phosphates
Dissolved Silicates
Dissolved Nitrate
Dissolved Nitrite
Dissolved Ammonia

Sediment Quality Parameters
% Clay (<4 µm)
% Silt (4 µm–62 µm)
% Sand (63 µm–2 mm)
% Gravel (>2 mm)
% Solids
Hydrogen Sulfide
pH
Total Ammonia
Total Organic Carbon
Total Sulfide
Total Nitrogen

Bivalve Tissue Parameters
% Lipid
% Moisture
Bivalve % Survival
Condition Index Mean/Standard Error
Gonad Condition Index Mean/Standard Error
Change in Internal Shell Volume
Shell Volume
Dry Flesh Weight

Toxicity
Aquatic Toxicity – (Mysid) % Survival
Sediment Toxicity – (Amphipod) % Survival
Sediment Toxicity – (Bivalve) % Normal Development

Trace Elements

	Water	Sediment	Bivalve Tissue
Aluminum*		•	•
Arsenic	•	•	
Cadmium*	•	•	•
Copper*	•	•	•
Cobalt	•		
Iron*	•	•	
Lead*	•	•	•
Manganese*	•	•	
Mercury**	•	•	
Methylmercury	•	•	
Nickel*	•	•	•
Selenium	•	•	•
Silver*	•	•	•
Zinc*	•	•	•
Dibutyltin (DBT)			•
Monobutyltin (MBT)			•
Tributyltin (TBT)			•
Tetrabutyltin (TTBT)			•

* Near-total rather than total concentrations for water. Near-total metals are extracted with a weak acid (pH < 2) for a minimum of one month, resulting in measurements that approximate bioavailability of these metals to Estuary organisms.

Table 1.2. (continued). Parameters analyzed in water, sediment, and bivalve tissue in 2001.

Polycyclic Aromatic Hydrocarbons (PAH)

	Water	Sediment	Bivalve Tissue
2 rings			
1-Methylnaphthalene	.	.	.
2,3,5-Trimethylnaphthalene	.	.	.
2,6-Dimethylnaphthalene	.	.	.
2-Methylnaphthalene	.	.	.
Biphenyl	.	.	.
Naphthalene	.	.	.
3 rings			
1-Methylphenanthrene	.	.	.
Acenaphthene	.	.	.
Acenaphthylene	.	.	.
Anthracene	.	.	.
Dibenzothiophene	.	.	.
Fluorene	.	.	.
Phenanthrene	.	.	.
4 rings			
Benz(a)anthracene	.	.	.
Chrysene	.	.	.
Fluoranthene	.	.	.
Pyrene	.	.	.
5 rings			
Benzo(a)pyrene	.	.	.
Benzo(e)pyrene	.	.	.
Benzo(b)fluoranthene	.	.	.
Benzo(k)fluoranthene	.	.	.
Dibenz(a,h)anthracene	.	.	.
Perylene	.	.	.
6 rings			
Benzo(ghi)perylene	.	.	.
Indeno(1,2,3-cd)pyrene	.	.	.
Alkylated PAH			
C1-Chrysenes	.	.	.
C2-Chrysenes	.	.	.
C3-Chrysenes	.	.	.
C4-Chrysenes	.	.	.
C1-Dibenzothiophenes	.	.	.
C2-Dibenzothiophenes	.	.	.
C3-Dibenzothiophenes	.	.	.
C1-Fluoranthenes/Pyrenes	.	.	.
C1-Fluorenes	.	.	.
C2-Fluorenes	.	.	.
C3-Fluorenes	.	.	.
C1-Naphthalenes	.	.	.
C2-Naphthalenes	.	.	.
C3-Naphthalenes	.	.	.
C4-Naphthalenes	.	.	.
C1-Phenanthrenes/Anthracenes	.	.	.
C2-Phenanthrenes/Anthracenes	.	.	.
C3-Phenanthrenes/Anthracenes	.	.	.
C4-Phenanthrenes/Anthracenes	.	.	.

Synthetic Biocides

	Water	Sediment	Bivalve Tissue
Cyclopentadienes			
Aldrin	.	.	.
Dieldrin	.	.	.
Endrin	.	.	.
Chlordanes			
alpha-Chlordane	.	.	.
cis-Nonachlor	.	.	.
gamma-Chlordane	.	.	.
Heptachlor	.	.	.
Heptachlor Epoxide	.	.	.
Oxychlordane	.	.	.
trans-Nonachlor	.	.	.
DDTs			
o,p'-DDD	.	.	.
o,p'-DDE	.	.	.
o,p'-DDT	.	.	.
p,p'-DDD	.	.	.
p,p'-DDE	.	.	.
p,p'-DDT	.	.	.
HCHs			
alpha-HCH	.	.	.
beta-HCH	.	.	.
delta-HCH	.	.	.
gamma-HCH	.	.	.
Other			
Chlorpyrifos	.		
Dacthal	.		
Diazinon	.		
Mirex	.	.	.
Oxidiazon	.		
Hexachlorobenzene	.	.	.

Table 1.2. (continued). Parameters analyzed in water, sediment, and bivalve tissue in 2001.

Polychlorinated Biphenyls (PCBs)	Water	Sediment	Bivalve Tissue
PCB 008	.	.	.
PCB 018	.	.	.
PCB 028	.	.	.
PCB 031	.	.	.
PCB 033	.	.	.
PCB 044	.	.	.
PCB 049	.	.	.
PCB 052	.	.	.
PCB 056	.	.	.
PCB 060	.	.	.
PCB 066	.	.	.
PCB 070	.	.	.
PCB 074	.	.	.
PCB 087	.	.	.
PCB 095	.	.	.
PCB 097	.	.	.
PCB 099	.	.	.
PCB 101	.	.	.
PCB 105	.	.	.
PCB 110	.	.	.
PCB 118	.	.	.
PCB 128	.	.	.
PCB 132	.	.	.
PCB 138	.	.	.
PCB 141	.	.	.
PCB 149	.	.	.
PCB 151	.	.	.
PCB 153	.	.	.
PCB 156	.	.	.
PCB 158	.	.	.
PCB 170	.	.	.
PCB 174	.	.	.
PCB 177	.	.	.
PCB 180	.	.	.
PCB 183	.	.	.
PCB 187	.	.	.
PCB 194	.	.	.
PCB 195	.	.	.
PCB 201	.	.	.
PCB 203	.	.	.

Table 1.3. Summary of RMP 2001 sampling stations and activities.
Latitude and longitude coordinates are reported in degrees (deg) and decimal minutes (dm).

Segment Name	Station Name	Station Code	Type of Sample	Measurements Made	Sampling Dates		Target Coordinates			
					Wet Season	Dry Season	Latitude deg	Latitude dm	Longitude deg	Longitude dm
South Bay	Coyote Creek	BA10	water	Q,M,O	2/7	7/31	37	28.20	122	3.80
		BA10	sediment	Q,M,O,T	-	8/14	37	28.20	122	3.80
		BA10	bioaccumulation	M,O,C	-	9/26	37	28.20	122	3.80
	South Bay	BA20	water	Q,M	2/7	7/31	37	29.69	122	5.34
		BA21	sediment	Q,M,O,T	-	8/14	37	29.69	122	5.34
	Dumbarton Bridge	BA30	water	Q,M,O,T	2/7	8/1	37	30.90	122	8.11
		BA30	sediment	Q,M,O	-	8/14	37	30.90	122	8.11
		BA30	bioaccumulation	M,O,C	-	9/26	37	30.90	122	8.11
	Redwood Creek	BA40	water	Q,M,O	2/6	7/31	37	33.67	122	12.57
		BA40	bioaccumulation	M,O,C	-	9/26	37	33.67	122	12.57
		BA41	sediment	Q,M,O,T	-	8/14	37	33.67	122	12.57
	San Bruno Shoal	BB15	water	Q,M	2/6	7/31	37	37.0	122	17.0
		BB15	sediment	Q,M,O,T	-	8/14	37	37.0	122	17.0
	Oyster Point	BB30	water	Q,M	2/6	7/31	37	40.20	122	19.75
		BB30	sediment	Q,M,O	-	8/14	37	40.20	122	19.75
	Alameda	BB70	water	Q,M,O	2/8	8/3	37	44.66	122	19.30
		BB70	sediment	Q,M,O,T	-	8/14	37	44.66	122	19.30
		BB71	bioaccumulation	M,O,C	-	9/26	37	44.66	122	19.30
Central Bay	Yerba Buena Island	BC10	water	Q,M,O	2/8	8/3	37	49.36	122	20.96
		BC10	bioaccumulation	M,O,C	-	9/25	37	49.36	122	20.96
		BC11	sediment	Q,M,O,T	-	8/13	37	49.36	122	20.96
	Golden Gate	BC20	* water	Q,M,O	NS	8/2	37	51.81	122	32.20
	Horseshoe Bay	BC21	sediment	Q,M,O,T	-	8/13	37	49.98	122	28.43
		BC21	bioaccumulation	M,O,C	-	9/25	37	49.98	122	28.43
	Richardson Bay	BC30	water	Q,M	2/8	8/2	37	51.81	122	28.66
		BC32	sediment	Q,M,O	-	8/13	37	51.81	122	28.66
	Point Isabel	BC41	water	Q,M	2/8	8/2	37	53.30	122	20.55
		BC41	sediment	Q,M,O	-	8/13	37	53.30	122	20.55
	Red Rock	BC60	water	Q,M,O	2/8	8/2	37	55.0	122	26.0
		BC60	sediment	Q,M,O,T	-	8/13	37	55.0	122	26.0
		BC61	bioaccumulation	M,O,C	-	9/25	37	55.0	122	26.0
Northern Estuary	Petaluma River	BD15	water	Q,M,O	2/12	8/6	38	6.66	122	29.0
		BD15	sediment	Q,M,O	2/15	8/10	38	6.66	122	29.0
		BD15	bioaccumulation	M,O,C	-	9/27	38	6.66	122	29.0
	San Pablo Bay	BD20	water	Q,M,O	2/12	8/6	38	2.92	122	25.19
		BD20	bioaccumulation	M,O,C	-	9/27	38	2.92	122	25.19
		BD22	sediment	Q,M,O	2/15	8/10	38	2.92	122	25.19
	Pinole Point	BD30	water	Q,M,O,T	2/12	8/6	38	1.48	122	21.65
		BD30	bioaccumulation	M,O,C	-	9/27	38	1.48	122	21.65
		BD31	sediment	Q,M,O	-	8/10	38	1.48	122	21.65
	Davis Point	BD40	water	Q,M,O	2/12	8/6	38	3.12	122	16.62
		BD40	bioaccumulation	M,O,C	-	9/28	38	3.12	122	16.62
		BD41	sediment	Q,M,O,T	2/15	8/10	38	3.12	122	16.62
	Napa River	BD50	water	Q,M,O	2/12	8/7	38	5.79	122	15.61
		BD50	sediment	Q,M,O,T	2/15	8/10	38	5.79	122	15.61
		BD50	bioaccumulation	M,O,C	-	9/28	38	5.79	122	15.61
	Pacheco Creek	BF10	water	Q,M	2/13	8/8	38	3.9	122	5.80
		BF10	sediment	Q,M,O	-	8/9	38	3.9	122	5.80
	Grizzly Bay	BF20	water	Q,M,O,T	2/13	8/8	38	6.96	122	2.31
		BF21	sediment	Q,M,O,T	2/15	8/9	38	6.96	122	2.31
	Honker Bay	BF40	water	Q,M	2/13	8/8	38	4.0	121	56.0
		BF40	sediment	Q,M,O	-	8/9	38	4.0	121	56.0
Rivers	Sacramento River	BG20	water	Q,M,O	2/14	8/7	38	3.56	121	48.59
		BG20	sediment	Q,M,O,T	-	8/9	38	3.56	121	48.59
		BG20	** bioaccumulation	M,O,C	-	9/30	38	3.56	121	48.59
	San Joaquin River	BG30	water	Q,M,O,T	2/14	8/7	38	1.40	121	48.45
		BG30	sediment	Q,M,O,T	-	8/9	38	1.40	121	48.45
		BG30	** bioaccumulation	M,O,C	-	9/30	38	1.40	121	48.45
Southern Sloughs	San Jose	C-3-0	water	Q,M,O,T	2/7	8/1	37	27.85	122	1.60
		C-3-0	sediment	Q,M,O,T	-	8/14	37	27.85	122	1.60
	Sunnyvale	C-1-3	water	Q,M,T	2/7	8/1	37	26.8	122	0.64
		C-1-3	sediment	Q,M,O	-	8/14	37	26.8	122	0.64
Estuary Interface	Standish Dam	BW10	water	Q,M,O	2/5	7/10	37	27.10	121	55.29
		BW10	sediment	Q,M,O	-	8/21	37	27.10	121	55.29
	Guadalupe River	BW15	water	Q,M,O	2/5	7/10	37	25.34	121	58.45
		BW15	sediment	Q,M,O	-	8/21	37	25.34	121	58.45

Legend:
C = bivalve condition index; O = trace organics; - sampling not conducted during wet season
M = trace elements; Q = water and/or sediment quality; * location dependent on salinity
NS = not sampled; T = toxicity (aquatic and/or sediment); ** bivalves not deployed; resident *C. fluminea* collected

Table 1.4. Contractors and principal investigators in 2001.

Principal Contractor	Dr. Robert Spies and Dr. Andrew Gunther Applied Marine Sciences, Livermore, CA
BACWA Coordination	Mr. William Ellgas and Ms. Diane Griffin East Bay Municipal Utility District, Oakland, CA
Water Trace Element Chemistry	Dr. Colin Davies, Brooks-Rand, Seattle, WA Dr. Russ Flegal, UC Santa Cruz, CA Dr. Robert Mason, University of Maryland, MD
Water Trace Organic Chemistry	Dr. Walter Jarman University of Utah, Energy/Geoscience Institute, UT
Water Hardness	Mr. Jim Chen and Ms. Kathleen Irby, Union Sanitary District, Fremont, CA
Water Toxicity Testing	Dr. Scott Ogle Pacific Eco-Risk Laboratories, Martinez, CA
Sediment Trace Element Chemistry	Dr. Colin Davies, Brooks-Rand, Seattle, WA Dr. Russ Flegal, UC Santa Cruz, CA Mr. Anthony Rattonetti, City and County of San Francisco, CA
Sediment Trace Organics Chemistry	Mr. François Rodigari East Bay Municipal Utility District, Oakland, CA
Sediment Toxicity Testing	Mr. John Hunt and Mr. Brian Anderson Marine Pollution Studies Lab, Granite Canyon, CA
Bivalve Trace Element Chemistry	Mr. Lonnie Butler, City and County of San Francisco, CA Dr. Colin Davies, Brooks-Rand, Seattle, WA
Bivalve Trace Organics and Butyltins Chemistry	Dr. Terry Wade and Dr. Jose Sericano, Texas A&M University, TX
Bivalve Condition and Survival	Mr. Paul Salop Applied Marine Sciences, Livermore, CA
USGS Water Quality	Dr. James Cloern, USGS, Menlo Park, CA
USGS Sediment Transport	Dr. David Schoellhamer, USGS, Sacramento, CA