

## RMP

CONTAMINANT MONITORING IN SAN FRANCISCO BAY:  
SEEKING ANSWERS TO DIFFICULT ENVIRONMENTAL QUESTIONS

Why is the Bay considered "impaired" by mercury, PCBs, and other contaminants?

Are there other contaminants that are also causing impairment?

Where do Bay contaminants come from?

How long will it take for contaminant concentrations in the Bay to fall below levels of concern?

Are contaminants causing adverse effects on Bay organisms?

Are efforts to reduce contamination in the Bay having an effect?

The Regional Monitoring Program was initiated in 1993 to answer these and other questions about contaminants in the Bay. The RMP is a collaboration among regulators, dischargers, and an independent scientific organization, that through a combined effort, are building a world-class database on contamination in the Estuary.

A key to the success of the RMP is its adaptive management approach that allows the Program to evolve over time to meet environmental management needs.

This supplement describes for ESTUARY readers the evolution of the RMP, highlighting several new field efforts launched in 2002.

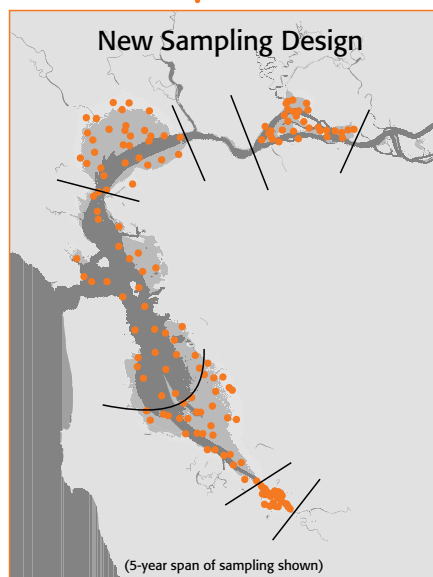
The RMP is comprised of three components: status and trends monitoring, pilot studies, and special studies. Status and trends monitoring of contaminants in water, sediment, and bivalve tissue is conducted annually. This annual monitoring is supplemented with: 1) short-term pilot studies designed to evaluate new monitoring tools, which if proven to be effective may be incorporated into the status and trends component, and 2) special studies to address specific questions that help interpret contaminant data.

The RMP responds to feedback from members of the regulatory, scientific, and environmental communities to maximize the Program's relevance to local environmental management issues. Quarterly Technical Review and Steering Committee meetings provide a regular forum to discuss the latest findings and regulatory needs. Specialized workgroups of local and national experts are organized to discuss key topics (contaminant inputs, fate, and effects) and help build state-of-the-art study designs to address specific RMP objectives or management questions, and provide technical oversight and guidance.

Additionally, an external review is conducted on a five-year cycle to evaluate the Program's organization and performance. After the first five years of RMP sampling, a Program review was conducted in 1997 and refined the RMP objectives to address specific scientific and management questions important to regulatory agencies. The 1997 Review Panel recommended that the

### FOR MORE INFORMATION

- about the RMP, or to
- receive the RMP
- newsletter, contact the
- San Francisco Estuary
- Institute (SFEI) at
- 510-746-7334 or visit
- the RMP Web site at
- <<http://www.sfei.org/rmp>>.



*The new monitoring design incorporates both fixed sites from the previous design and new random sampling locations. This map illustrates the new segmentation scheme and the better spatial coverage provided by the new design effort.*



Regional Monitoring Program  
San Francisco Estuary Institute  
7770 Pardee Lane, 2nd floor  
Oakland, CA 94621  
510-746-7334  
<http://www.sfei.org>

*Continued on next page*

Continued from previous page

RMP sampling design be changed to answer questions, such as "What proportion of the Estuary has contaminant levels above regulatory guidelines?"

## RANDOM SAMPLING IMPROVES STATUS AND TRENDS MONITORING

When the RMP was first established, the primary objectives of the Program were to collect background data on trace contaminants in the Estuary and to determine seasonal and long-term trends in contaminant concentrations. Samples were mainly collected at fixed locations in the deeper shipping channels of the Estuary, and site selection was based on being outside the immediate influence of point sources or preserving continuity with historical State Mussel Watch sampling sites. With this fixed station design, comparing monitoring results relevant to water quality guidelines could only be discussed for the fixed sampling locations in the Estuary, and patterns and trends in contaminant concentration could only be described on a limited scale. While this information has been used to identify key contaminants of concern in the Estuary and to inform the TMDL process, the fixed station design left large portions of the Estuary unexamined and did not provide a basis for representing smaller segments of the Bay, or the Bay as a whole.

The new sampling design, implemented in July 2002, provides better coverage of the Estuary by randomly collecting water and sediment samples throughout its entire geographic extent. This will characterize each of the Estuary's five main segments (see figure on previous page). The new design offers other benefits, such as enabling calculation of the proportion of the Estuary exceeding a guideline and allowing comparisons of the shallows and the deeper channels.

The new design limits status and trends monitoring to annual sampling in the dry season, when contaminant levels fluctuate less compared to the wet season. Long-term trends will be evaluated at a subset of sediment sites. Some of the historical RMP water and sediment sampling sites will be maintained to provide a link between the two sampling designs.

The design of the bivalve monitoring element was also re-evaluated. A nonrandomized design will occur, (anchoring of the bivalve bags makes random sampling logistically infeasible), and analysis of trace metals has been reduced to a five-year cycle.

The list of analytes included in status and trends monitoring has also been adjusted. Based on findings from a special study (see *Previously Unidentified Organic Contaminants* on pg. 4), the RMP target analyte list has been expanded to include brominated flame retardants, musk ketones, and other synthetic compounds that persist in the environment and are suspected of disrupting endocrine system functions.

In a proactive approach, the RMP will maintain a level of surveillance by tracking the presence of new synthetic substances. Also, a two-year special study is looking at several compounds that are included in the California Toxics Rule (which established water quality objectives for the state) but are not currently monitored by the RMP, to determine if any of these compounds are at levels of concern.

## SOURCES, PATHWAYS, AND LOADINGS OF CONTAMINANTS

To describe general sources and loading of contaminants to the Estuary, the Sources, Pathways, and Loadings Workgroup (SPLWG) produces recommendations for data collection, interpretation, and synthesis, and guides the sampling design and evaluation of results. The SPLWG has identified several potential pathways by which priority contaminants can enter the Estuary: atmospheric deposition, small tributaries, the Sacramento and San Joaquin Rivers, effluent discharges, and historic sediment deposits.

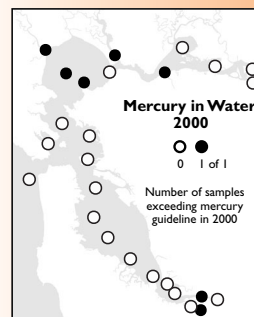
# Meeting the Program

## Objective 1

*Compare monitoring results to relevant water quality objectives and other guidelines*

### Monitoring results are compared to

- Water quality objectives
- Sport fish screening values
- Sediment effects thresholds

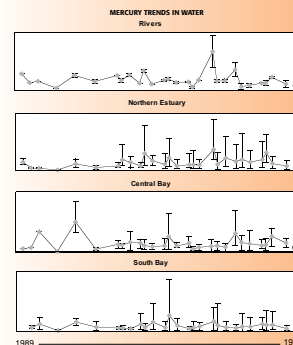


## Objective 2

*Describe patterns and trends in contaminant concentration*

### Patterns and trends are described for

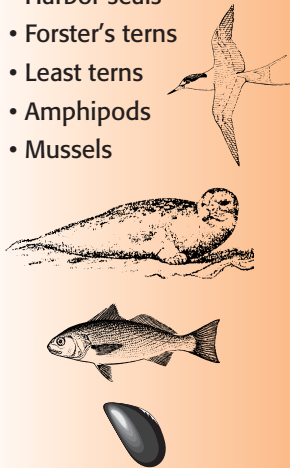
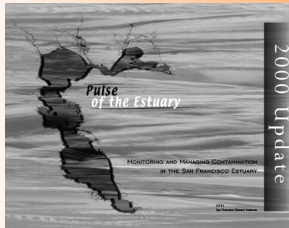
- Water
- Sediment
- Bivalves
- Sport fish
- Diving ducks
- Cormorants



Special studies have begun to fill data gaps on contaminant loads from these pathways. For example, the Mercury Deposition Network Pilot Study evaluates concentrations of mercury in rainwater as part of a national air deposition study, and the Estuary Interface Pilot Study (see *Results of the Estuary Interface Pilot Study* on pg. 4) characterized the contaminant contributions from small tributaries in the South Bay in an effort to better understand the influence of urbanized watersheds on receiving waters in the Estuary.

Other studies focus on loadings to the Estuary from small and large tributaries. One effort is building upon a long-term USGS study and estimating the contaminant loads associated with suspended sediments from the Sacramento and San Joaquin Rivers. A second effort is collaborating with the Clean Estuary Partnership on a four-year study measuring transport of contaminants associated

# Objectives

Objective 3	Objective 4	Objective 5
Describe general sources and loadings of contamination to the Estuary	Measure contaminant effects on selected parts of the Estuary ecosystem	Synthesize and distribute information from a range of sources to present a more complete picture of contaminants in the Estuary
<p>Contaminant sources and loadings are identified in</p> <ul style="list-style-type: none"> <li>• Atmospheric deposition</li> <li>• Sacramento and San Joaquin Rivers</li> <li>• Small tributaries (collaboration with Clean Estuary Partnership—CEP)</li> <li>• Historic sediment deposits (collaboration with CEP)</li> </ul>	<p>Contaminant effects are measured in</p> <ul style="list-style-type: none"> <li>• Benthic communities</li> <li>• White croaker</li> <li>• Harbor seals</li> <li>• Forster's terns</li> <li>• Least terns</li> <li>• Amphipods</li> <li>• Mussels</li> </ul> 	<p>Information is synthesized through</p> <ul style="list-style-type: none"> <li>• Literature reviews</li> <li>• Contaminant mass budgets</li> <li>• <i>Pulse of the Estuary</i> annual report</li> <li>• Upcoming status and trends report on contaminants</li> </ul> 

with suspended sediments from the Guadalupe River.

## EFFECTS OF CONTAMINANTS

The RMP has always included measurement of aquatic and sediment toxicity, however, in order to better address regulatory measures that prohibit toxic effects on Bay organisms, an Exposure and Effects Pilot Study began in 2002. This five-year study is developing a “toolbox” of indicators to monitor biological effects including toxicity tests, benthic community assessments, reproductive success, bioaccumulation of contaminants, and general health evaluations in fish, birds, and seals. The rationale is to develop a suite of contaminant exposure and effects indicators that respond to general and specific contamination at the biochemical, cellular, individual, population, and community levels. The RMP now measures chemical concentrations and potential effects in diving ducks, cormorants, least terns, Forster's

terns, and harbor seals. These studies are being performed in collaboration with California Department of Fish and Game, U.S. Fish and Wildlife Service, Point Reyes National Seashore, U.C. Davis, Moss Landing Marine Laboratory, and San Francisco State University.

## SYNTHESIS OF INFORMATION

The RMP has conducted several reviews of available information over the past few years to provide a foundation for the design changes described above. The need to synthesize information has also led to the development of contaminant budgets for the Bay. Contaminant budgets are being developed to better understand the long-term fate of contaminants in the Estuary. A Contaminant Fate Workgroup guides these efforts. A simple budget for PCBs was developed first, (see *Long Term Fate of PCBs in SF Bay* on pg. 4) and estimates the flows of PCBs among the air, water, sediment and land. This

simple model has provided valuable insights into the long-term fate of contaminants in the Bay. For example, the model suggests that even with no PCB inputs to the Bay, it will take several dozen years before all fish are below screening values. An improved, more detailed model for PCBs is currently being developed in collaboration with USGS. Similar mass budget models are also currently being developed for PAHs and organochlorine pesticides.

The Contaminant Fate Workgroup is also guiding an effort to address contaminant transfer from the sediments to the biota in the Estuary ecosystem. This is being accomplished through review of existing data and providing recommendations for investigating the complex processes that affect contaminant transport. Contaminant movement through the food web is also being modeled. This Workgroup bridges the efforts of the SPLWG, whose interest is in quantifying inputs of contaminants to the Estuary, and the Exposure and Effects Workgroup, whose focus is the potential impact of these contaminants on ecosystem and health.

A major project over the next two years will be a thorough analysis of contaminant data from the RMP and other Bay contaminant studies from 1993–2001. The fixed station design employed during this period was particularly valuable for temporal trend analysis. A major effort will also be made to incorporate information from non-RMP sources to provide a comprehensive update of the status and trends of Bay contamination over the past decade. Over the next two years the theme of synthesis of information from 1993–2001 will also be addressed in RMP newsletters, annual meetings, technical reports, and the annual *Pulse of the Estuary* reports.

— Sarah Lowe, Cristina Grosso, Jay Davis

## ADDITIONAL INFORMATION

*Deterministic to Probabilistic: Changing the RMP's Sampling Design*, Winter 2001/2002 issue of RMP News at <[http://www.sfei.org/rmp/rmp\\_news/rmpnews\\_vol6\\_issue2.pdf](http://www.sfei.org/rmp/rmp_news/rmpnews_vol6_issue2.pdf)>.

**RMP Reports and Publications** are available at <<http://www.sfei.org/rmp/reports.htm>>.





# NEW RMP REPORTS



## EPISODIC WATER TOXICITY DURING STORM EVENTS

The RMP has been collecting and performing toxicity tests on ambient water samples in selected tributaries in San Francisco Bay following significant rainstorm events for the past four winter seasons. The results of these tests indicate that ambient water toxicity is present in some tributaries primarily following runoff events.

Analyses suggest that some of the toxicity observed at Mallard Island (at the confluence of the Sacramento and San Joaquin Rivers) may be due to organophosphate (OP) pesticides, while the possible causes of toxicity in other water samples still remains unknown. Apparent reductions in the magnitude and frequency of ambient water toxicity over the past several years mirror reductions in the application of OP pesticides in the Estuary's watersheds.

However, the application of other pesticides, such as pyrethroids, has increased over this same period, suggesting that changes in the types of ambient toxicity in the Estuary (increased sediment toxicity, potential fish toxicity) may be occurring, and that corresponding changes in the monitoring approach—the use of tests and test species that are more sensitive to these emerging pesticides, and their fate and transport characteristics—may be necessary.

Report authored by Applied Marine Sciences and Pacific EcoRisk. Reprints available from SFEI at [pchambers@sfei.org](mailto:pchambers@sfei.org).

## RESULTS OF THE ESTUARY INTERFACE PILOT STUDY, 1996-1999

The Estuary Interface Pilot Study was initiated in 1996 with the goal of characterizing contaminant contributions from the watersheds of the Guadalupe River and Coyote Creek to the Lower South San Francisco Bay. This report summarizes results from four years of contaminant monitoring in water and sediment at two stations located near the Estuary-watershed interface: Guadalupe River in the Alviso Slough and Standish Dam in Coyote Creek. The study identified contaminants with potential watershed sources, provided rough esti-

mates of contaminant loads from the tributaries, and discussed the limitations of the current RMP monitoring design to characterize sources and loadings of contaminants to San Francisco Bay. The report recommended next steps for improving sampling methodology for future tributary monitoring intended to assist TMDL-related activities in San Francisco Bay.

Reprints available from Jon Leatherbarrow at [jon@sfei.org](mailto:jon@sfei.org).

## PREVIOUSLY UNIDENTIFIED ORGANIC CONTAMINANTS IN SF ESTUARY

The purpose of this investigation was to conduct the first comprehensive assessment of the identities, concentrations, and distributions of previously unidentified organic contaminants present in water (1993, 1994) and sediment (1993) collected from the San Francisco Estuary, water collected from the Sacramento and San Joaquin Rivers, and wastewater effluent (1997, 1998) collected from a publicly owned treatment works (POTW) in the South Bay. This was accomplished by analyzing archived gas chromatographic-mass spectrometric (GC-MS) electronic data collected by the RMP.

The study included the quantification of unknown organic compounds present in environmental samples and wastewater effluent. This was accomplished by assembling and archiving data submitted by the contract laboratories; searching the data for previously unidentified compounds and other candidate compounds that might be found based on a literature search; and searching the literature for adverse ecological or human health effects of the compounds found.

The information gathered in the report can be used to make preliminary assessments of the need to regulate newly identified organic contaminants in the Estuary.

Reprints available from Daniel Oros at [daniel@sfei.org](mailto:daniel@sfei.org).

## SF BAY ATMOSPHERIC DEPOSITION PILOT STUDY, PART III

Transport of pollutants between the atmosphere and surface water can occur by several processes, including

rain- or snow-scavenging of gases and particles, dry deposition of dust particles, deposition through cloud and fog-water, and air-water exchange processes. The primary objectives of this Pilot Study included estimating annual atmospheric loading of selected pollutants to the San Francisco Estuary and comparing atmospheric loading with loading from other sources and pathways. The first two parts of this study, concerning mercury and other trace metals, were reported in 2001.

Part Three of the Pilot Study presents study methodology, ambient air concentrations, and estimated deposition loads of PAHs and PCBs for the San Francisco Estuary. Ambient air was sampled in Concord from June through November 2000. PCB concentrations remained approximately constant, with calculated transport fluxes showing varying net losses from the water to the air. In contrast, PAHs differed up to four-fold between June and November, and flux varied from net loss from the Estuary in the summer months to deposition in the fall. Atmospheric flux may thus either supply or remove organic contaminants in water, depending upon specific conditions.

Reprints available from Don Yee at [don@sfei.org](mailto:don@sfei.org).

## THE LONG TERM FATE OF PCBs IN SF BAY

This report presents a simple mass budget model as a first step toward understanding the long-term fate of PCBs in San Francisco Bay. The model treats the whole Bay as one box with two compartments: water and sediment. Rates of major processes that remove PCBs from the Bay or transfer PCBs between water and sediment were estimated. The model was used to predict the PCB level in the Bay over time under different management scenarios. If external loading could be eliminated entirely, the mass of PCBs in the Bay is predicted to drop to half of the present value in 20 years. The model suggests that sustained loading of 10 kg per year would prevent the total PCB mass in the Bay from ever dropping below one tenth of the present mass, potentially leaving some sport fish species with PCB concentrations of human health concern.

Reprints available from Jay Davis at [jay@sfei.org](mailto:jay@sfei.org).