2012

Regional Monitoring Program

A Report of the Regional Monitoring Program for Water Quality in the San Francisco Estuary

Update

COVER IMAGE:
Collecting a Bay sediment sample.
Photograph by Thomas Jabusch.

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Preface

The Regional Monitoring Program

The overarching goal of the Regional Monitoring Program for Water Quality in San Francisco Estuary (RMP) is to answer the highest priority scientific questions faced by managers of Bay water quality. The RMP is an innovative collaborative effort between the San Francisco Bay Regional Water Quality Control Board, the regulated discharger community, the San Francisco Estuary Institute, and many other scientists and interested parties.

Note to Pulse Readers

The RMP is shifting from annual to biennial production of the Pulse of the Estuary, along with production of the RMP Update in alternate years. In contrast to the Pulse, which focuses on Bay water quality and summarizes information from all sources, the RMP Update has a narrower and specific focus on highlights of the RMP.

Purpose of this Document

The purpose of this document is to provide a concise overview of recent RMP activities and findings, and a look ahead to significant products anticipated in the next two years.

The report includes:

- **a brief summary of some of the most noteworthy findings of this multifaceted Program;**
- **a description of the management context that guides the Program;**
- **a summary of progress and plans in addressing priority water quality topics; and**
- **the latest monitoring results and updated trend plots for key pollutants, water quality indicators, or factors that influence water quality.**

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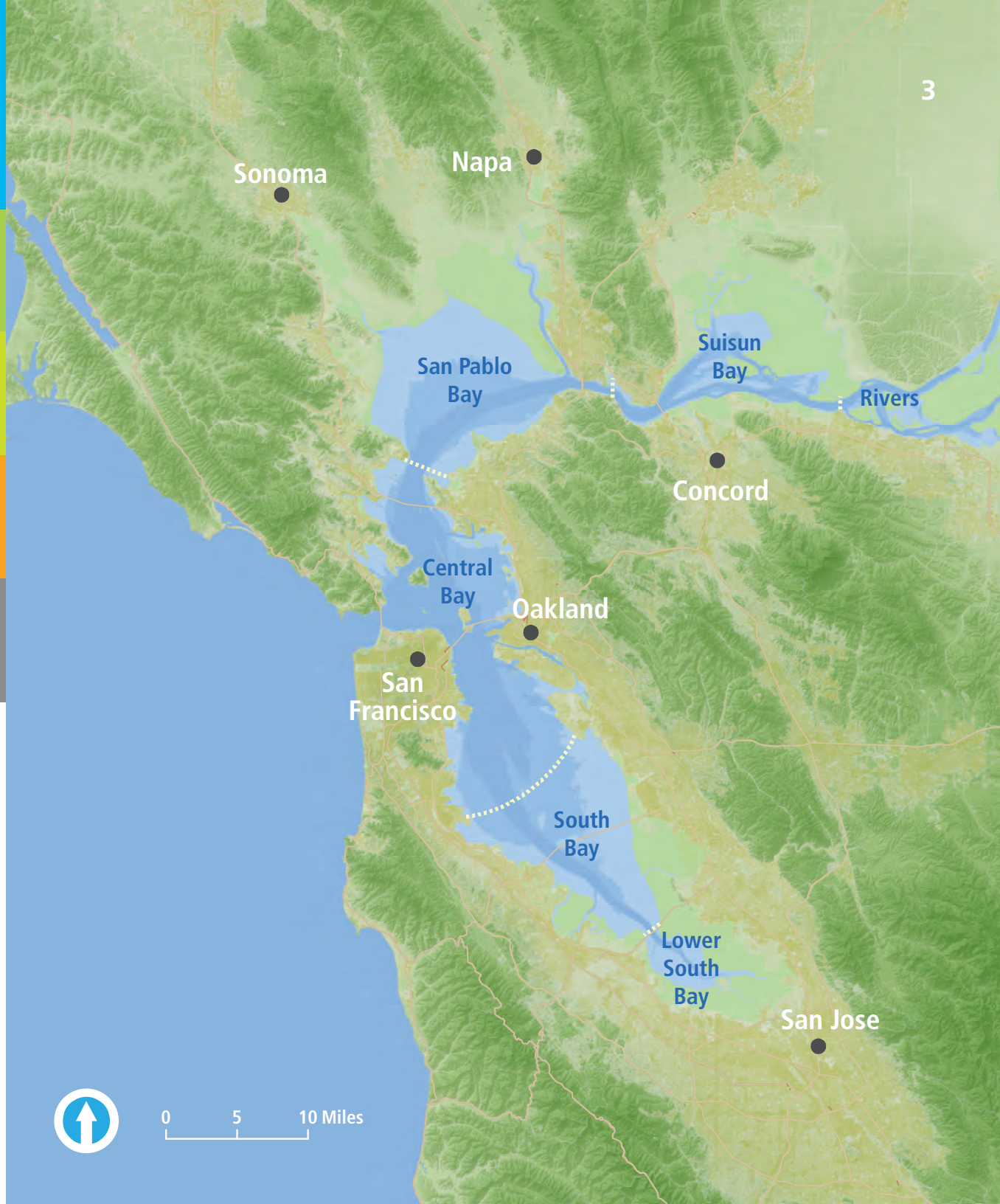
Comments or questions regarding this report or the Regional Monitoring Program can be addressed to Dr. Jay Davis, RMP Lead Scientist, (510) 746-7368, jay@sfei.org.



Sampling Bay sediment. Photograph by Thomas Jabusch.

Program Highlights

RMP Highlights: Present and Future

The Regional Monitoring Program (RMP) is by necessity a multifaceted array of studies and activities. The RMP must consider hundreds of contaminants, an assortment of types of information needed to manage all of these substances, and a myriad of policies to address potential impacts on various beneficial uses of the Bay. This section of the RMP Update provides brief summaries of some of the most noteworthy recent activities and accomplishments, followed by a look ahead to anticipated highlights in the next few years.

The RMP Top Ten: Recent Activities and Accomplishments

1) Multi-Year Planning: Improving the Linkage of Science and Policy

In 2011, the RMP Steering Committee initiated a new level of planning that represents a significant step forward in improving the connection between RMP science and management of Bay water quality. The Committee held two workshops in 2011 focused on development of a Multi-Year Plan for the Program. The Plan articulates stakeholder priorities regarding water quality information needs. The Plan includes explicit documentation of anticipated policy decisions, so the Program can provide the scientific knowledge needed to inform the decisions in a timely manner. The Technical Review Committee and other technical workgroups and teams use this guidance from the Steering Committee in formulating workplans that optimize use of RMP funds to address the most critical information needs. With this new planning process, the Steering Committee has a much more active role in steering the Program, and the focus of the RMP on addressing critical information needs is sharper than ever.

2) Status And Trends Remodel: Stretching Our Monitoring Dollars

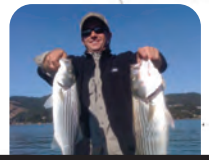
Key elements of a monitoring program must remain constant over the long-term in order to effectively track general trends in contamination. However, a purely static monitoring program would become less and less relevant over time as management priorities change, as understanding increases, and as technology advances. In 2011 the Program re-evaluated its investment in Status and Trends monitoring, which had been the largest item in the budget since the Program began in 1993. The RMP committees concluded that the information being gained from some Status and Trends components was not great enough to justify the level of investment that was being made. The frequency of water and sediment sampling was reduced from annual to biennial, with some constituents to be analyzed even less frequently. Sport fish monitoring was also changed from a three-year cycle to a five-year cycle. These changes freed up $400,000 that could be used to fund special studies or other elements of the Program. As of 2012, Special Studies replaced Status and Trends as the largest component of the RMP budget. This change epitomizes how the Program is evolving to maintain its relevance and value.

3) Bay Water Quality Report Card: Communicating RMP Information

The new State of the Bay Report published by the San Francisco Estuary Partnership in 2011 summarized progress in attaining management goals relating to habitat, water supply and quality, living resources, ecological processes, and stewardship. A water quality evaluation was a component of the Report that assessed whether the Bay is safe for aquatic life, whether Bay fish are safe to eat, and whether the Bay is safe for swimming. RMP data were featured prominently in this assessment. Many monitored pollutants are considered to pose very low risk to Bay aquatic life, but a few (especially methylmercury, exotic species, the toxicity of sediments, and trash) pose substantial threats. Several other pollutants appear to pose risks to Bay aquatic life, but definitive regulatory goals for the Bay have not yet been developed. Fish from the Bay are not entirely safe to eat, due mainly to polychlorinated biphenyls (PCBs), methylmercury, and dioxins. Most Bay beaches are safe for swimming in the summer, but bacterial contamination is a concern at a few beaches in the summer, and at most beaches in wet weather. Overall, thanks to the considerable investment that has been made in wastewater treatment infrastructure and the diligent efforts of

Safe for Aquatic Life

Methylmercury	★
Exotic Species	★★
Sediment Toxicity	★★★
Trash	★★★
Copper	★★★★
Dissolved Oxygen	★★★★★
Silver	★★★★★
Other Priority Pollutants	★★★★★
Selenium	?
PAHs	?
PBDEs	?
PFOS	?
Emerging Contaminants	?



Safe to Eat

PCBs	★
Methylmercury	★★
Dioxins	★★
Legacy Pesticides	★★★★★
Selenium	★★★★★
PBDEs	★★★★★
Other Priority Pollutants	★★★★★
Emerging Contaminants	?

Safe to Swim

Beach Bacteria (April-October)	★★★★
Beach Bacteria (Wet Weather)	★★★

poor	★
poor to fair	★★
fair	★★★
fair to good	★★★★
good	★★★★★
goals not established	?

Summary of Bay Water Quality, 2011.

**A five star rating indicates that regulatory goals have been met.
Fewer stars indicate varying degrees of distance from regulatory goals.**

water quality managers, the Bay is much safer for aquatic life and for people to fish and swim in than it was in the 1960s. Substantial control efforts that began in the 1970s as a result of the Clean Water Act solved most of the obvious problems of the 1960s and set the Bay on a course for gradual recovery for many pollutants. However, challenges, information gaps, and uncertainties remain to respond to legacy contaminants (such as mercury and PCBs), emerging contaminants, nutrients, and other threats to water quality. Complete and timely resolution of remaining and emerging water quality challenges will require significant investments of resources to replace and improve our aging water quality infrastructure.

4) Nutrient Strategy: Informing Big Decisions

Thanks to turbid water, high rates of consumption by clams, and strong tidal mixing, San Francisco Bay has had the good fortune to avoid the excessive algal growth that commonly occurs in other large urban estuaries. Since the late 1990s, however, phytoplankton biomass has increased throughout the Bay, a response to increased water clarity and oceanographic conditions that have resulted in reduced clam abundance. In addition, in the Sacramento River and northern portions of the Bay, there is evidence suggesting that high levels of one form of nitrogen, ammonium, may be inhibiting rather than stimulating phytoplankton growth. These concerns have raised the question of whether additional treatment may be needed to remove nutrients from municipal wastewater.

In response to these concerns and to inform these decisions, the RMP initiated development of a Nutrient Science Strategy in 2011. The Nutrient Science Strategy for the Bay is a collaborative effort with

major contributions from RMP, USGS, the State and Regional Boards, and BACWA. The initial steps of the Strategy include summarizing our current state of knowledge on nutrient impacts on water quality, developing plans for enhanced monitoring, and establishing a capacity to evaluate future scenarios with predictive models. Additional details on the Nutrient Strategy are provided on page 24.

5) Small Tributary Loading: Critical Information For Managing Urban Runoff

Small tributaries have become a focal point of strategies to reduce contaminant inputs to San Francisco Bay. The state of knowledge on contaminant loads from small tributaries, however, remains rudimentary. Two significant and closely related initiatives to address these information needs have recently taken shape: the Municipal Regional Stormwater Permit and the RMP Small Tributary Loading Strategy. Initial work under the Small Tributary Loading Strategy established a multi-year overarching, coordinated blueprint for monitoring under the RMP and the Municipal Regional Permit. The primary present emphasis of the Strategy, with a planned RMP investment of over $1.8 million from 2011-2015, is monitoring contaminant loads in representative small tributaries. In 2011, a significant reconnaisance survey was conducted of 16 watersheds that has changed our methods for prioritizing in-depth sampling of tributaries. Additional details on the Small Tributary Loading Strategy are provided on page 22.

6) Collaborative Sport Fish Monitoring and Updated Safe Eating Guidelines for the Bay

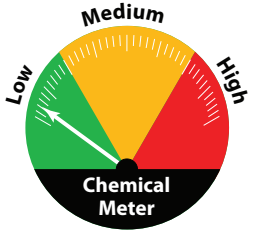
A report on the most recent round of RMP sport fish sampling was released in spring 2011. At the same time, the California Office of Environmental Health Hazard Assessment released updated safe eating guidelines for the Bay. The guidelines replace an earlier 1994 advisory, and draw on over a decade of more recent data, primarily from the RMP, showing San Francisco Bay fish contain mercury and polychlorinated biphenyls (PCBs). They also incorporate nutrition science showing that fish provide dietary protein and essential nutrients, including omega-3 fatty acids that promote heart health and support neurological development. The 2009 sampling included an unprecedented collaboration of the RMP, the state Surface Water Ambient Monitoring Program, and the Southern California Bight Regional Monitoring Program. Benefits of this collaboration for the RMP included more thorough sampling of Bay fish, elimination of reporting costs, and a valuable statewide context for interpreting Bay contamination. San Francisco Bay stood out among statewide coastal locations with relatively high concentrations of both methylmercury and PCBs. For methylmercury, this is additional evidence suggesting the influence of the mining legacy in the Bay watershed.

Fishing in San Francisco Bay.
Photograph by Jay Davis.

New safe eating guidelines for the Bay published in 2011 were largely based on RMP data

A guide to eating San Francisco Bay fish and shellfish

Women 18 - 45 and children 1 - 17



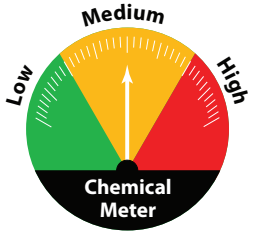
Brown rockfish

Jacksmelt

Red rock crab

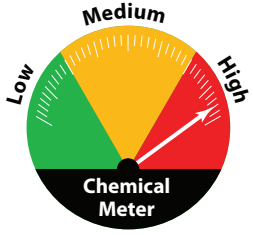
Chinook (king) salmon ♥

♥ = High in Omega-3s



California halibut

White croaker



Shiner perch or other surfperches

Sharks

Striped Bass

White sturgeon

Jacksmelt photo: Kirk Lombard, California Halibut: John Shelton

- **Eat only the skinless fillet.** PCBs are in the fat and skin of the fish.
- Cook thoroughly and allow the juices to drain away.
- For crab, eat only the meat.

What is a serving?

For Adults For Children

The recommended serving of fish is about the size and thickness of your hand. Give children smaller servings.

What is the concern?

Some fish have high levels of PCBs and mercury. PCBs might cause cancer. Mercury can negatively affect how the brain develops in unborn babies and children. It is especially important for women who are pregnant or breastfeeding to follow these guidelines.

♥ Why eat fish?

Eating fish is good for your health. Fish have Omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

Safe to eat 2 servings per week	OR	Safe to eat 1 serving per week	Do not eat AND Do not eat any fish from the Lauritzen Channel in Richmond Inner Harbor

California Office of Environmental Health Hazard Assessment • www.oehha.ca.gov/fish.html • (916) 327-7319 or (510) 622-3170 5-11

7) Mercury and PCBs in Small Fish: Searching for Sources to the Food Web

As part of the RMP Mercury Strategy, the Program conducted extensive small fish monitoring from 2008-2010 in a concerted effort to determine spatial patterns of uptake into the food web. Almost 1,000 composite samples were analyzed for mercury. In 2010, PCBs were also analyzed as a key element of the RMP PCB Strategy.

For mercury, the clearest spatial pattern was a general increase in concentration from Suisun Bay toward the southern end of the Bay (Lower South Bay). Whether this is driven by higher mercury in the Bay margin areas where these fish forage or conditions in the South Bay that favor net methylmercury production is unclear. Samples were collected to evaluate the potential influence of wetlands, industrial watersheds, watersheds with mercury mining, hotspots of sediment mercury, and municipal wastewater discharges. The results suggested increased uptake below mining sites and other sediment hotspots and decreased uptake near municipal wastewater discharges. The vast majority of these samples (e.g., 95% of the 2010 samples) exceeded the TMDL target for small fish of 0.03 ppm.

The PCB results for small fish were very enlightening. Confirming earlier pilot studies, concentrations in the small fish were unusually high. The average concentration in small fish in 2010 was 216 ppb, much higher than the average for the most contaminated sport fish species sampled in 2009 (shiner surfperch – 121 ppb). The leading hypothesis to explain these high concentrations is that the small fish are foraging in habitats on the margin of the Bay that are more contaminated than open Bay habitats where the sport fish forage. PCB concentrations in the small fish in this survey were found to correlate well with PCB concentrations in nearby sediment, supporting this hypothesis. The high PCB uptake observed in small fish is an important element of the linkage between PCB sources and accumulation in the Bay food web.

8) Mercury Isotopes

Another RMP study published in 2011 provided important evidence of the link between sources of mercury and accumulation in the food web. A key question that has been debated by scientists is whether the mercury present in mercury mining waste is recalcitrant or whether it can be subject to methylation and uptake into the food web. Dr. Joel Blum of the University of Michigan applied a novel technique of measuring mercury isotopes as tracers. Mercury is an element that occurs in several different isotopic forms. Mercury mining and other natural processes can lead to variation in the percentages of each form. Dr. Blum and his team measured mercury isotopes in small fish and in Bay sediment, and compared the results to the isotopic signatures found in mining waste, soil, sediment, and other materials. In Lower South Bay a clear association was found between the signatures found in sediment, small fish, and mercury mining waste, pointing toward the historic New Almaden Mercury Mining District as a primary source. This study provided compelling evidence that the mercury present in mining waste can indeed make its way into the food web.

9) Collaborative Monitoring of Emerging Contaminants in Mussels

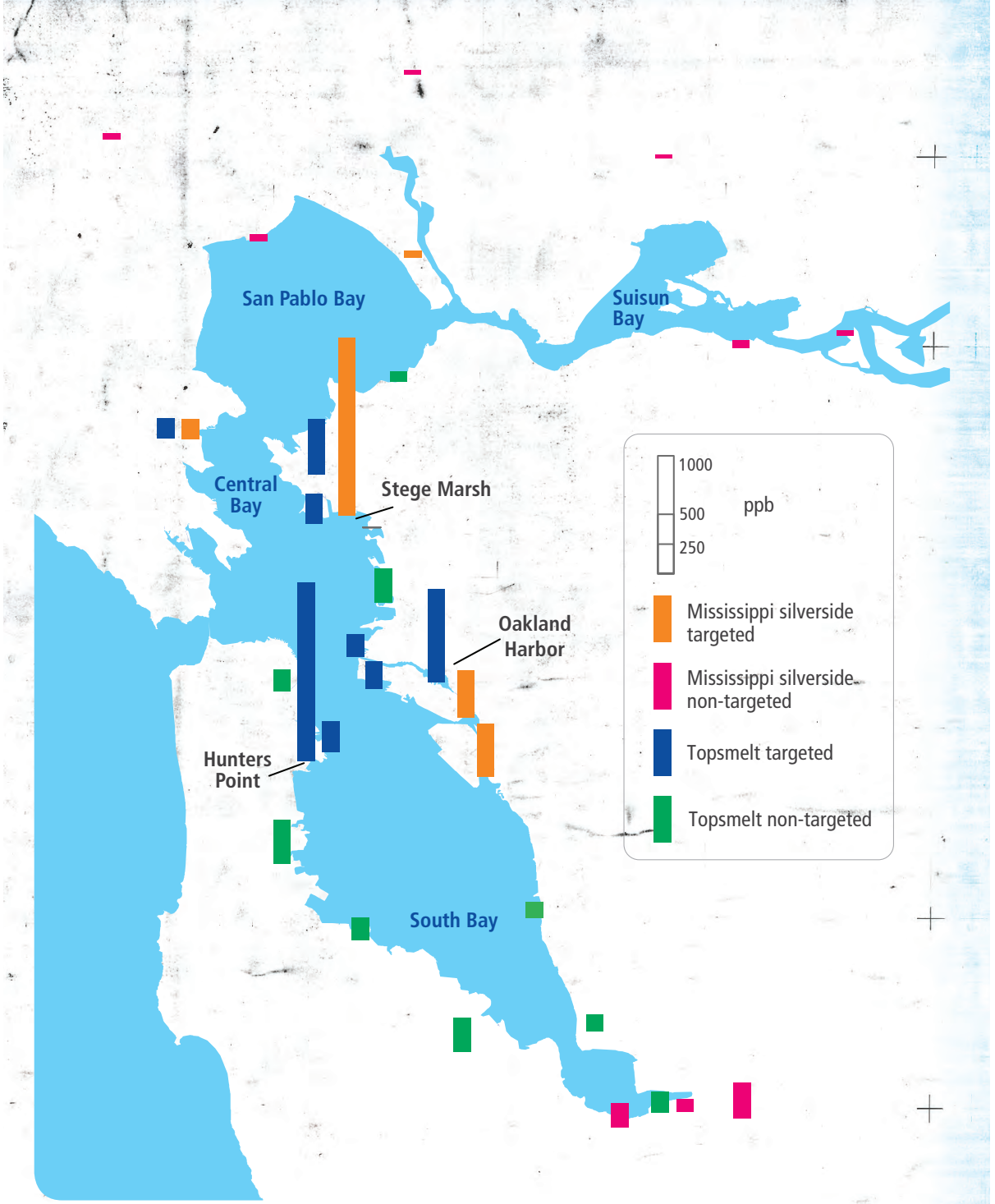
Another collaborative statewide survey was performed in 2010 to measure a wide assortment of contaminants of emerging concern (CECs) in mussels. Partners in this effort included the RMP, the State Water Board, the Southern California Coastal Water Research Project, and the National Oceanic and Atmospheric Administration (NOAA). NOAA applied its entire annual budget for the National Mussel Watch Program to this California survey. AXYS Analytical Services, a lab that analyzes organics for the RMP, also provided substantial pro bono support for a companion study examining CECs in Bay mussels, sediment, and water. Pharmaceuticals were detected in all three matrices at relatively low concentrations, generally below available acute toxicity thresholds. It is not clear whether long-term exposure to these compounds will result in adverse effects. As with the statewide sport fish survey, the benefits of this collaboration to the RMP include a richer dataset for the Bay, efficiencies in reporting the information, and a valuable statewide perspective for understanding CEC concentrations in the Bay. Reports on this work will be published in late 2012.

10)
PBDEs in Fish and Terns: Diminished Concern

PBDEs, a class of bromine-containing flame retardants that was practically unheard of in the early 1990s, increased rapidly in the Bay food web through the 1990s and became pollutants of concern. The California Legislature has banned the use of two types of PBDE mixtures ("penta" and "octa") in 2006; one mixture ("deca") is being phased out.

Prior to 2011, a lack of threshold concentrations for protection of human health or wildlife precluded a definitive assessment of PBDEs. In 2011 the California Office of Health Hazard Assessment published thresholds for assessing PBDE risks to human health. All of the Bay sport fish samples collected in 2009 were well below this threshold.

Some of the highest concentrations of PBDEs observed anywhere in the world were measured in Forster's Terns from the Bay in 2001 and 2002, and raised concern for possible impacts on terns and other Bay wildlife, but the lack of thresholds for interpreting these concentrations inhibited assessment of risks. The results of a RMP study published in 2011 suggest that tern embryos are less sensitive to PBDE exposure than the most sensitive species reported (American Kestrel), and, though the approach used to evaluate exposure in the study was not definitive in this regard, effects on tern embryos at the concentrations found in the Bay do not appear likely.



High concentrations of PCBs observed in small fish have helped explain the persistence of PCB contamination in the Bay food web.

Coming Soon! 10 Things to Look for in 2012 and 2013...

1. Updated Regional Watershed Spreadsheet Model: Refinement of a regional watershed spreadsheet model (RWSM) to generate estimates of watershed-specific and regional loads of pollutants of concern to the Bay (2013)

2. Nutrient Conceptual Model Report: Summarizing the state of the science to support management of nutrients in the Bay (2013)

3. Modeling Workplan: A workplan for development of a quantitative modeling framework that can be used to evaluate management scenarios for nutrients and other contaminants (2012)

4. Articles on Mussel CEC Pilot Study: A special edition of a journal (Marine Pollution Bulletin) will present a series of articles on the collaborative statewide survey in 2010 that measured a wide assortment of contaminants of emerging concern (CECs) in mussels (2012)

5. CEC Synthesis Report: Providing a technical foundation for surveillance and management of CECs in the Bay (2012)

6. Report on Broad Spectrum Screening of CECs in Bay Wildlife: Results of a study using an analytical technique that allows detection of a broad spectrum of contaminants, rather than just those that are on a target analyte list (2013)

7. Report on Effects of PAHs on Flatfish: A study investigating thresholds for PAH effects in juvenile flatfish (2012)

8. Mercury Synthesis Report: Summarizing the state of the science to support reducing methylmercury in the Bay food web (2012)

9. PCB Synthesis Report: Summarizing the state of the science to support management of PCBs in the Bay food web (2013)

10. Pulse of the Estuary and RMP Annual Meeting Focused on CECs: The 2013 Annual Meeting will be held in conjunction with the State of the Estuary Conference (2013)

Recent Publications

Published Manuscripts

PFC Compounds in Wildlife from an Urban Estuary. Sedlak. 2012. Journal of Environmental Monitoring. **http://www.sfei.org/documents/perfluoroalkyl-compounds-pfcs-wildlife-urban-estuary**

Estimates of Contaminant Loads from the Sacramento/ San Joaquin River Delta. David. 2012. (submitted to Water Environment Research)

PCBs in San Francisco Bay Forage Fish. Greenfield. 2012. (Chemosphere in press)

San Francisco Bay and Delta Benthos. Thompson. 2012. (accepted in Environmental Monitoring and Assessment)

Brominated and Chlorinated Flame Retardants in San Francisco Bay Sediments and Wildlife. Klosterhaus. 2012. Environmental International. **http://www.sfei.org/documents/alternative-flame-retardants-sfbay-sediments-and-wildlife**

Best Paper of 2011 in Environmental Science and Technology

Identification of flame retardants in polyurethane foam collected from baby products. Stapleton, Klosterhaus. 2011. Environmental Science and Technology. **http://www.sfei.org/news_items/est-best-paper-2011**

Mercury Isotopes Link Mercury in San Francisco Bay Forage Fish to Surface Sediments. Gehrke. 2011. Environmental Science and Technology. **http://www.sfei.org/documents/mercury-isotopes-fish-sediment**

Sources of mercury to San Francisco Bay surface sediment as revealed by mercury stable isotopes. Gehrke. 2011. Geochimica et Cosmochimica Acta. **http://www.sfei.org/documents/mercury-isotopes-sediment-gradient**

Using Best Professional Judgment to Assess Benthic Condition. Thompson. 2011. Ecological Indicators. **http://www.sfei.org/documents/best-professional-judgment-to-assess-benthic-condition**

Methylmercury Mass Budget. Yee. 2010, Environmental Toxicology and Chemistry. **http://www.sfei.org/documents/MeHg-mass-budget**

Endocrine Disruption in Wild Fish. Brar. 2010. Aquatic Toxicology. **http://www.sfei.org/documents/endocrine-disruption-wild-fish**

Integrating Toxicity Risk in Bird Eggs and Chicks. Ackerman. 2009. Environmental Science and Technology. **http://www.sfei.org/documents/Hg-eggs-chick-feathers**

RMP Technical Reports

Molecular Methods for Sediment Toxicity Stressor Identification. Bay. 2012. **http://www.sfei.org/documents/application-gene-expression-analysis-sediment-toxicity-stressor-identification**

Estimate of Atmospheric Deposition of Dioxins. Allen. 2012. **http://www.sfei.org/documents/estimated-atmospheric-deposition-fluxes-dioxins-san-francisco-estuary**

Remote Sensing of Suspended Sediment Transport. Oram. 2012. **http://www.sfei.org/documents/remote-sensing-suspended-sediment-transport**

Guadalupe River HSPF Model. Lent. 2011. **http://www.sfei.org/documents/guadalupe-hspf-model-y3**

Age Estimates and Pollutant Concentrations of Sediment Cores. Yee. 2011. **http://www.sfei.org/documents/age-estimates-and-pollutant-concentrations-sediment-cores-san-francisco-bay-and-wetlands**

Causes of Sediment Toxicity. Phillips. 2011. **http://www.sfei.org/documents/rmp-sediment-study-2009-2010-determining-causes-sediment-toxicity-san-francisco-estuary**

Triclosan and Triclocarban Profile. Klosterhaus. 2011. **http://www.sfei.org/documents/triclosan-and-triclocarban-profile**

Triclosan Factsheet. 2011. **http://www.sfei.org/sites/default/files/RMP2011_TriclosanFactsheet_Final4web.pdf**

Contaminants in Fish From the California Coast, Y2 Statewide Survey. Davis. 2012. **http://www.sfei.org/documents/contaminants-fish-california-coast-2009-2010**

Contaminants in Fish from the California Coast, Y1 Results with RMP Sportfish Survey. Davis. 2011. **http://www.sfei.org/documents/contaminants-fish-california-coast-report**

Effects of PBDEs in Terns. Rattner. 2011. **http://www.sfei.org/documents/apparent-tolerance-common-tern-sterna-hirundo-embryos-pentabrominated-diphenyl-ether-mixtu**

RMP Goal and Management Questions

RMP stakeholders have articulated an overarching goal and a tiered framework of management questions that organize and guide RMP studies. The management questions are closely linked to existing and planned regulations.

Level 1 (Core) Management Questions

1. Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
2. What are the concentrations and masses of contaminants in the Estuary and its segments?
3. What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

Level 1 (Core) Questions	**Question 1** Levels of concern and associated impacts	**Question 2** Concentrations and masses (spatial distribution)	**Question 3** Sources, pathways, loadings, and processes	**Question 4** Increased or decreased (trends)	**Question 5** Projected concentrations, masses, and impacts
Level 2 Questions	**Q1** Which chemicals have potential for impacts?	**Q1** Are there particular regions of concern?	**Q1** Which sources, pathways, etc. contribute most to impacts?	**Q1** Effects of management actions on concentrations and mass?	**Q1** Impacts forecast under various management scenarios?
	Q2 What is the potential for impacts due to contamination?		**Q2** Opportunities for management intervention for important pathways?	**Q2** Effects of management actions on potential for adverse impacts?	**Q2** Which contaminants predicted to increase?
	Q3 What are appropriate guidelines?		**Q3** Effects of management actions on loads and processes?		
	Q4 What contaminants are responsible for impacts?				

General Goal of the RMP

Collect data and communicate information about water quality in the San Francisco Estuary in support of management decisions.

Consistent with, these general goals, the RMP addresses NPDES permit provisions for special studies and routine monitoring of the Bay

The following key criteria are used to evaluate potential RMP elements (in order of priority):

1) addresses relevant NPDES permit requirements
2) supports policies and adaptive implementation
3) addresses scientific information needs

Current and Anticipated Management Decisions, Policies, and Actions by the Regulatory Agencies that Manage Bay Water Quality

Decisions, Policies, and Actions

Ongoing

Determination of Permit Limits

Long-Term Management Strategy for Placement of Dredged Material/Dredged Material Management Office
Regional Sediment Management Strategy

Dredging Permits
Bioaccumulation testing triggers
and in-Bay disposal levels

Biennial 303(d) List and 305(b) Report

Copper
Compare levels to site specific objectives triggers

Cyanide
Antidegradation policy
Ambient levels below site specific objectives

Selenium
North Bay Selenium TMDL
South Bay Selenium TMDL

Dioxins
Review/reissue permit requirements
Review 303(d) listings and establish
TMDL development plan

Mercury
Review existing TMDL and establish plan to revise
Revised mercury TMDL and/or implementation
Plan

PCBs
Review existing TMDL and establish plan to revise
Revised PCBs TMDL and/or implementation plan

New and Future

Nutrients
New estuarine numerical endpoints
Assessment of ammonia/ammonium

Legacy Pesticides (DDT, Dieldrin, Chlordane)
Delist

Pathogens
Review Bay beaches 303(d) listings
and establish TMDL development plan

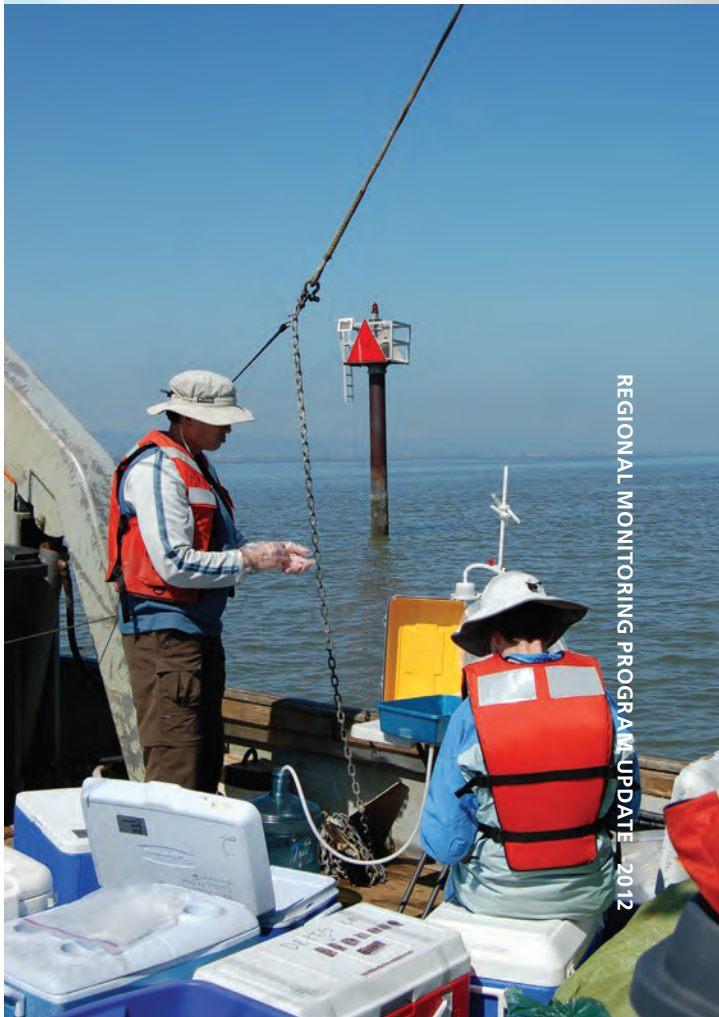
Sediment Hot Spots
Review 303(d) listings and establish
TMDL development plan

Chemicals of Emerging Concern
State Water Board Recycled Water Policy
Development of additional State
and Regional Water Board policies

Toxicity
Adoption of new state policy for toxicity
assessment and control

Sediment Quality Objectives
303(d) listings
Determination of reasonable potential
and permit requirements

The RMP contributes to effective management by providing scientific support for current policies and by anticipating and addressing information needs related to future policies and actions.



Sampling Bay water.
Photograph by Susan Klosterhaus.

The 303(d) List

Section 303(d) of the 1972 Federal Clean Water Act requires that states develop a list of water bodies that do not meet water quality standards, establish priority rankings for waters on the list, and develop action plans, called Total Maximum Daily Loads (TMDLs), to improve water quality.

The list of impaired water bodies is revised periodically (typically every two years). The RMP is one of many entities that provide data to the State Water Board to compile the 303(d) List and to develop TMDLs. The process for developing the 303(d) List for the Bay includes the following steps:

- development of a draft List by the San Francisco Bay Regional Water Board;
- adoption by the State Water Board; and
- approval by USEPA.

In August 2010, the State Water Board adopted the 2010 303(d) List. The 2010 List was approved by USEPA.

The Regional Water Board and State Water Board are now working on updating the 303(d) List. The primary pollutants/stressors for the Estuary and its major tributaries on the 2010 303(d) List include:

Trace elements

Mercury and Selenium

Pesticides

Dieldrin, Chlordane, and DDT

Other chlorinated compounds

PCBs, Dioxin and Furan Compounds

Others

Exotic Species, Trash, and Polycyclic Aromatic Hydrocarbons (PAHs)

Regulatory Status of Pollutants of Concern

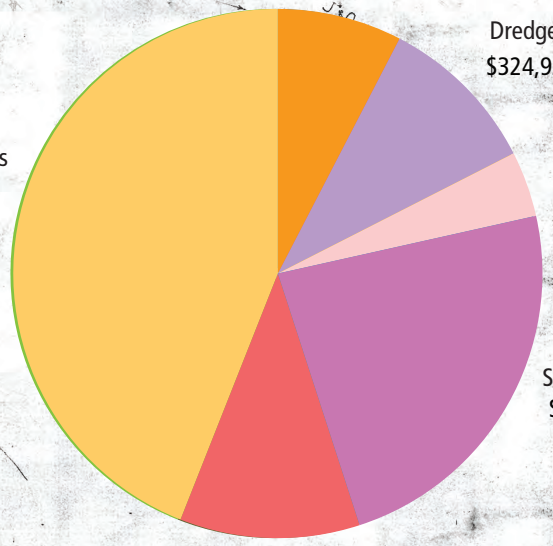
Pollutant	*Status*
Copper	Site-specific objectives approved for entire Bay San Francisco Bay removed from 303(d) List in 2002
Dioxins / Furans	TMDL in early development stage
Legacy Pesticides (Chlordane, Dieldrin,and DDT)	Under consideration for delisting
Mercury	Bay TMDL and site-specific objectives approved in 2008 Guadalupe River Watershed TMDL approved in 2010
Pathogens	Richardson Bay TMDL adopted in 2008 Bay beaches (Aquatic Park, Candlestick Point, China Camp, and Crissy Field) added to 303(d) List in 2006
PCBs	TMDL approved in 2009
Selenium	TMDL in development for North Bay – completion projected for 2014 Revised site-specific water quality criteria for protection of Bay-Delta wildlife by USEPA anticipated in 2013
Trash	Central and South Bay shorelines added to the 2010 303(d) List

Approved: State Board and USEPA approval

Sampling Bay water.
Photograph by Susan Klosterhaus.

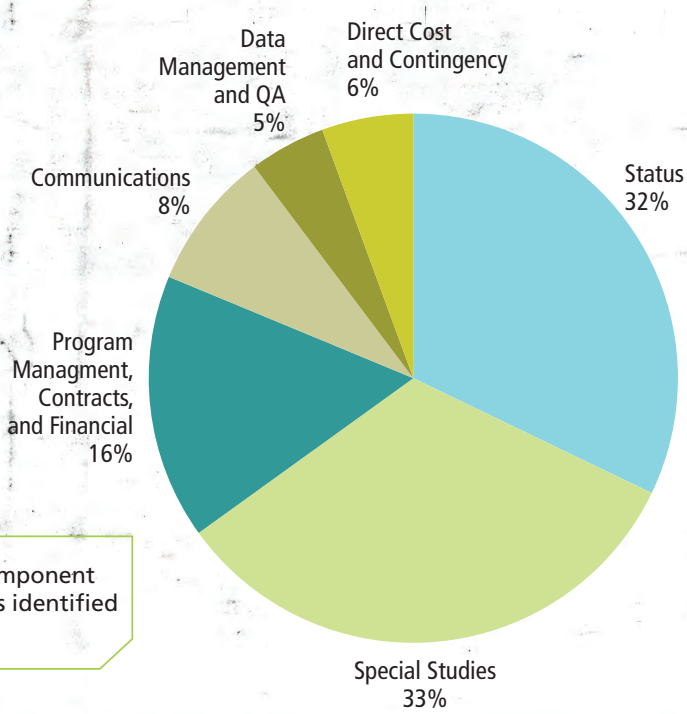
Program Management: Budget

RMP Fees by Sector: 2013



RMP revenue was $2.99 million in 2005 and 2006, increased by 2% per year in 2007-2010, and $3.24 million for 2010, 2011 and 2012. Revenue will increase by 1.5% in 2013, 2% in 2014, and 2% in 2015.

RMP Expenses: 2012

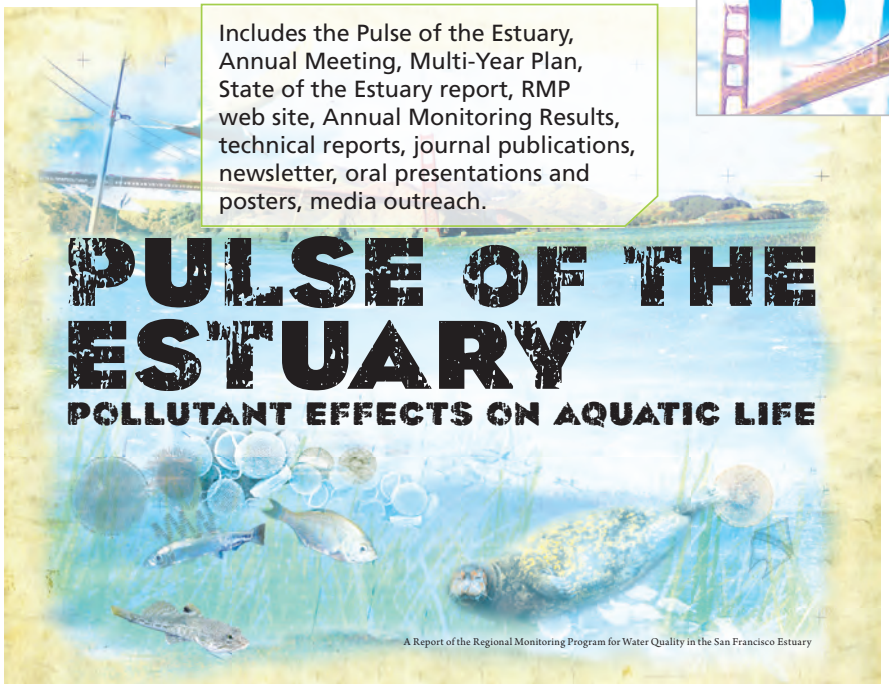


Special studies became the largest component of the RMP in 2012 due to efficiencies identified in the Status and Trends element.

Program Management: Budget

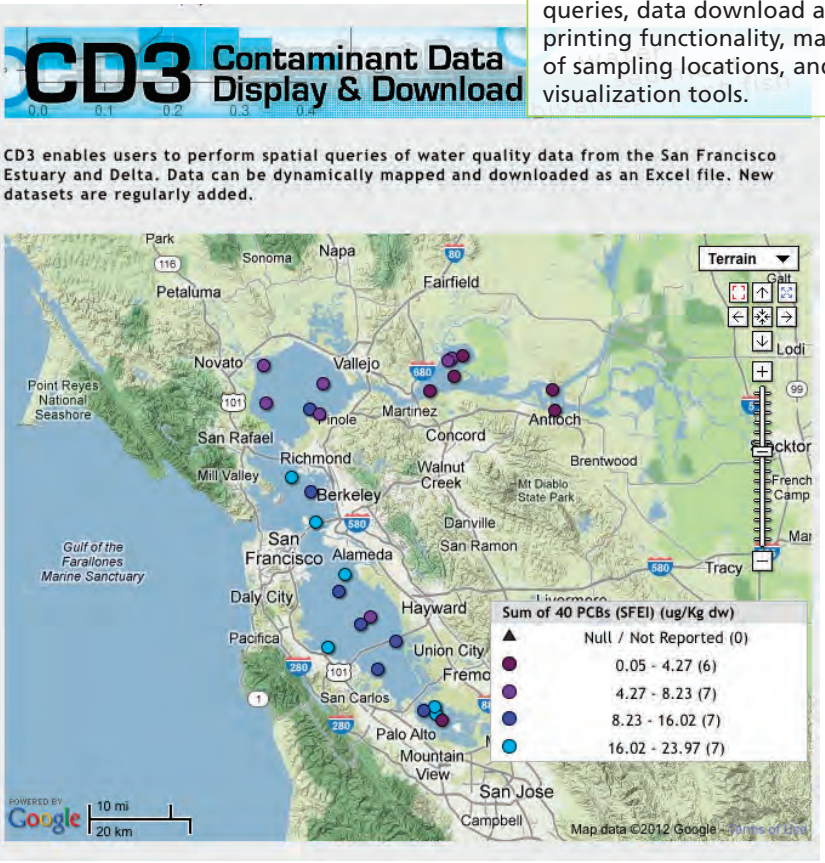
Communications

Includes the Pulse of the Estuary, Annual Meeting, Multi-Year Plan, State of the Estuary report, RMP web site, Annual Monitoring Results, technical reports, journal publications, newsletter, oral presentations and posters, media outreach.



Data Management and Quality Assurance

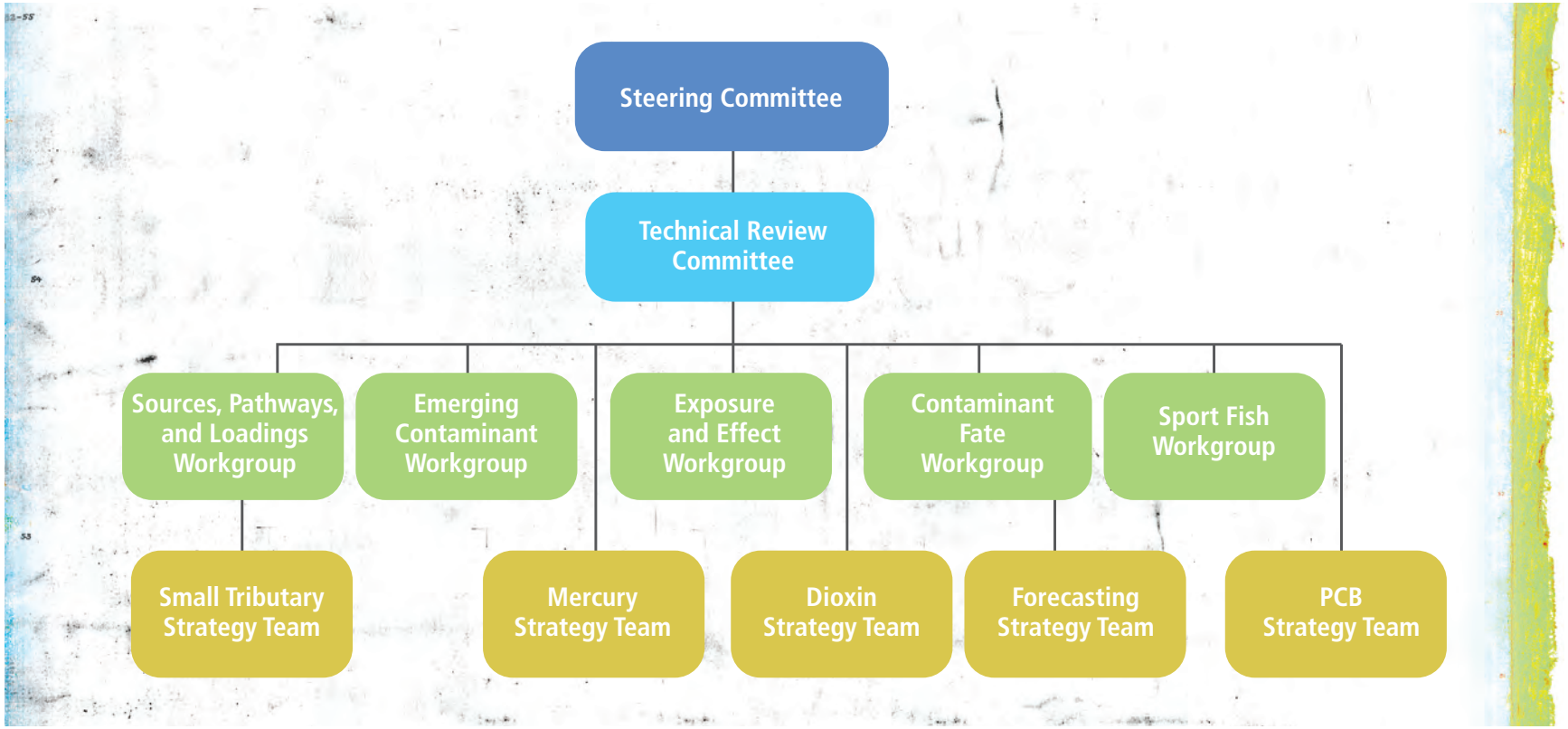
The RMP database contains approximately 900,000 records generated since the Program began in 1993. Web-based data access tools include user-defined queries, data download and printing functionality, maps of sampling locations, and visualization tools.



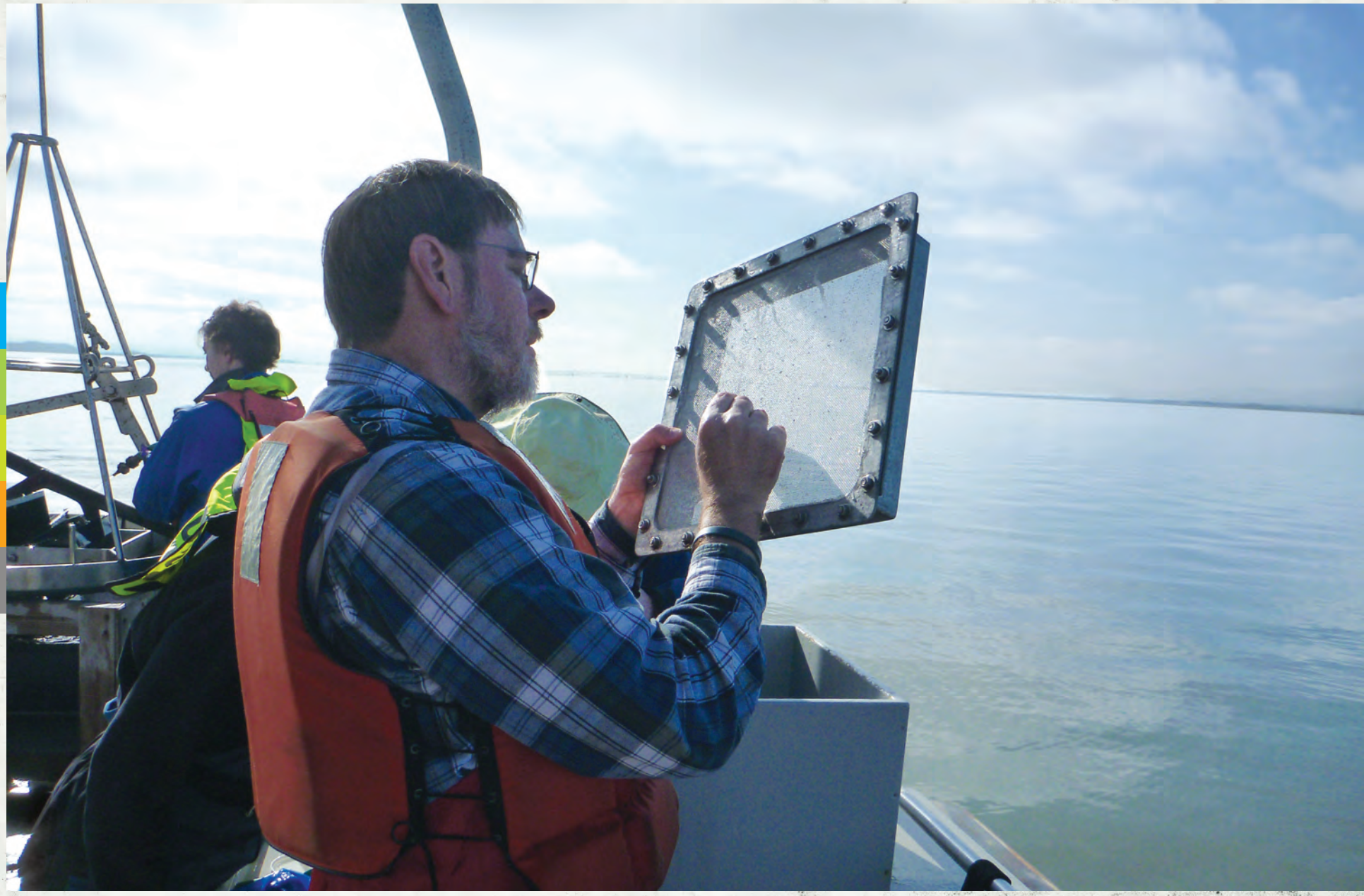
Program Management

Includes internal coordination (staff management), committee and work-group meetings, coordination with Program participants, external coordination with related groups, program planning, contract and financial management, and workgroup and peer review coordination.

Program Oversight



Collaboration and adaptation in the RMP are achieved through the engagement of stakeholders and scientists in frequent committee and workgroup meetings. The Steering Committee consists of representatives from discharger groups (wastewater, stormwater, dredging, industrial) and regulatory agencies (Regional Water Board, USEPA, and U.S. Army Corps of Engineers). The Steering Committee determines the overall budget and allocation of program funds, tracks progress, and provides direction to the Program from a manager's perspective. Oversight of the technical content and quality of the RMP is provided by the Technical Review Committee (TRC), which provides recommendations to the Steering Committee. Five workgroups report to the TRC and address the main technical subject areas covered by the RMP: sources, pathways, and loadings; contaminant fate; exposure and effects; emerging contaminants; sport fish contamination, and nutrients. The workgroups consist of regional scientists and regulators and invited scientists recognized as authorities in their field. The workgroups directly guide planning and implementation of special studies. RMP strategy teams constitute one more layer of planning activity. These stakeholder groups meet as needed to develop long-term RMP study plans for addressing high priority topics. Topics addressed to date include mercury, PCBs, dioxins, small tributary loads, forecasting, and nutrients.



Mike Kellogg screening benthos. Photograph by Don Yee.

Program Area Updates

Small Tributary Loading

Note: "Small tributary" refers to the rivers, creeks, and storm drains that enter the Bay downstream from the Region 2 Water Board boundary (Mallard Island).

Relevant Management Policies and Decisions

- Refine pollutant loading estimates for future TMDLs and management decisions, including TMDL updates.
- Provisions of the Municipal Regional Permit (MRP).
- Prioritizing small tributaries for cleanup actions.
- Identifying the best management actions for small tributaries.

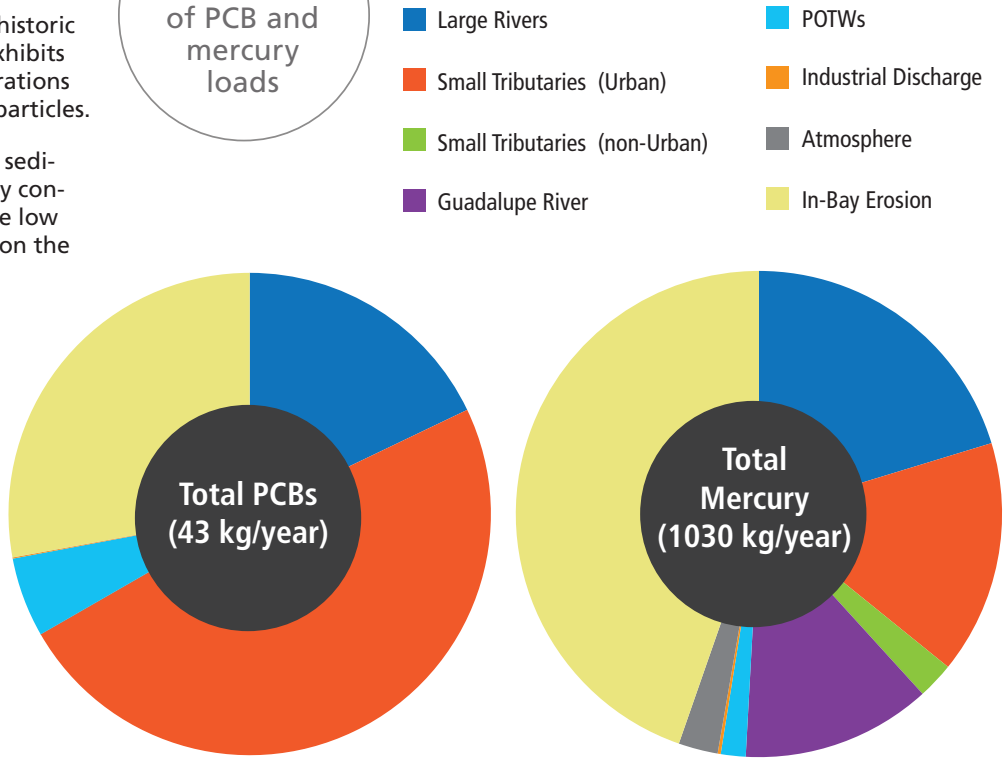
Recent Noteworthy Findings

- Small tributaries are the dominant loading pathway for suspended sediments, PCBs, and mercury.
- Mercury loads in stormwater are primarily associated with suspended sediment particles and most pollutant mass enters the Bay during the largest storms.
- Older urban systems exhibit moderate PCB concentrations in water and moderately high PCB concentrations on sediment particles.
- PCB concentrations vary more widely in stormwater and soil samples relative to mercury.
- PCBs in stormwater are commonly associated with suspended sediment particles, and in very contaminated watersheds may also occur as an emulsion.
- PCBs are associated with small areas with highly polluted soils within our watersheds – finding such areas is a challenge.
- Dioxin loads measured in two tributaries suggest a regional load estimate of 8.9 g of dioxin toxic equivalents. Concentrations appear to be highest in industrialized urban areas.
- Just six stormwater samples were used to identify Pulgas Creek and Santa Fe Channel as high leverage watersheds in relation to pollutant sources and sensitive Bay margin areas.
- The Guadalupe River with historic mercury mines upstream exhibits very high mercury concentrations in water and on sediment particles.
- Walnut Creek with its high sediment load has high mercury concentrations in water despite low concentrations of mercury on the sediment particles.

Priority Questions for the Next Five Years

1. Which are the "high-leverage" small tributaries that contribute or potentially contribute most to Bay impairment by pollutants of concern?
2. What are the loads or concentrations of pollutants of concern from small tributaries to the Bay?
3. How are loads or concentrations of pollutants of concern from small tributaries changing on a decadal scale?
4. What are the projected impacts of management actions on loads or concentrations of pollutants of concern from the high-leverage small tributaries, and where should management actions be implemented in the region to have the greatest impact?

The latest estimates of PCB and mercury loads



Small Tributary Loading

Workplan Highlights

- Monitoring of contaminant loads from representative watersheds: San Leandro Creek, Sunnyvale East Channel, Guadalupe River, and Lower Marsh Creek (Richmond and Pulgas Pump stations will be added in WY 2013)
- Stormwater load estimation using the regional watershed spreadsheet model (RWSM) with an updated user interface
- Back-calculation of PCB and Hg concentrations in stormwater for specific land uses or source areas in preparation for field studies to fill data gaps

Partners and Coordination

This work is being closely coordinated with monitoring performed by:

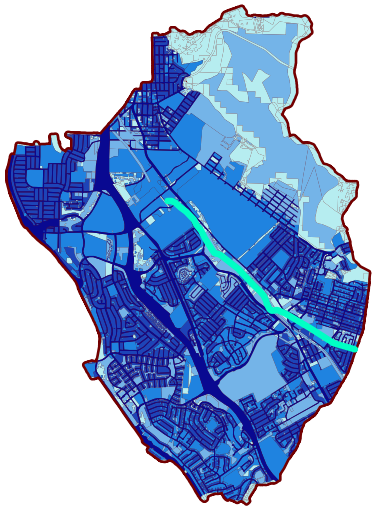
- Bay Area Stormwater Management Agencies Association (representing the 76 cities, counties, and flood management districts covered by the Municipal Regional Permit)
- Santa Clara Valley Water District

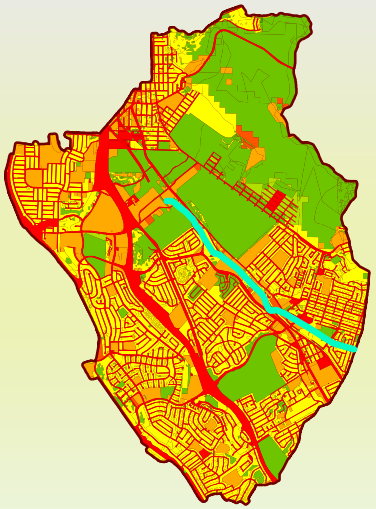
Relation to Permit Requirements

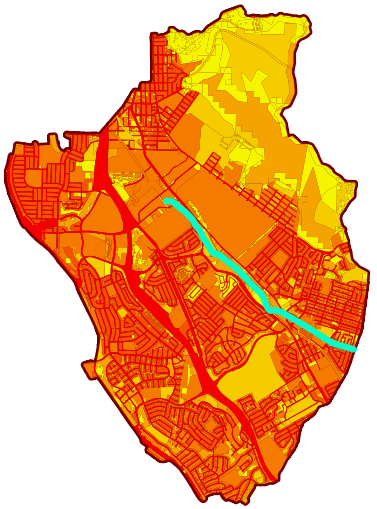
- The RMP-funded work partially satisfies monitoring requirements specified in the Municipal Regional Stormwater Permit

Approach for loading estimation in the Regional Stormwater Loading Spreadsheet Model

Annual Runoff Volume X **Concentration** = **Annual Load**







Nutrients

Relevant Management Policies and Decisions

Primary

- Nutrient numeric endpoints
- Evaluate need for revised objectives for dissolved oxygen (DO) and ammonia
- Water quality assessment – impairment status
- NPDES permits (e.g., POTW, MRP) - on-going

Secondary

- Delta Flows
- Regional Sediment Strategy
- Watershed TMDLs
- Recycled Water Policy and POTW projects

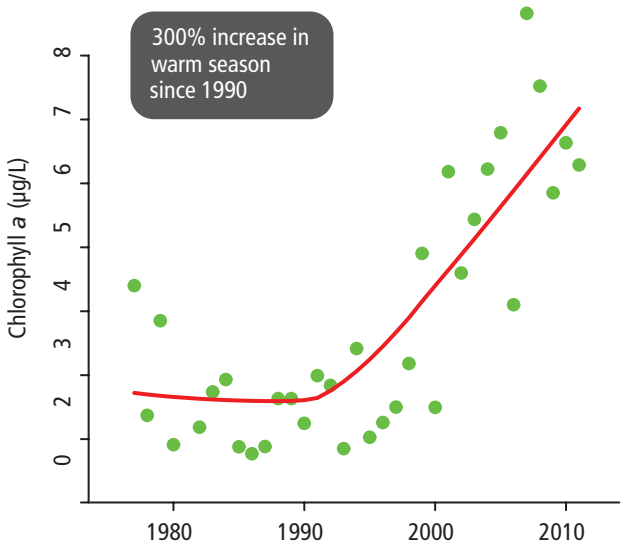
Recent Advances in Understanding and Priority Information Needs

- There is a growing body of evidence that suggests the historic resilience of San Francisco Bay to the harmful effects of nutrient enrichment is changing.
- Since the late 1990s, regions of the Bay have experienced significant increases in phytoplankton biomass (30-105% from Suisun to South Bay) and significant declines in DO concentrations (2.0 and 4.0% in Suisun Bay and South Bay, respectively).
- USGS has found declining suspended sediment in the Bay – however, no data are available for shallow subtidal regions.
- There is a need for long-term status and trends monitoring of nutrients and eutrophication.
- At present, Bay water quality objectives related to nutrients are limited to un-ionized ammonia and dissolved oxygen.
- There are outstanding questions about the role and importance of ammonium with respect to beneficial use impairment.

Priority Questions for the Next Five Years

1. Is there a problem or are there signs of a problem?
   a. Are anthropogenic nutrients currently, or trending towards, adversely affecting beneficial uses of the Bay?
   b. Are beneficial uses in segments of the Bay impaired by any form of nutrients?
   c. Are trends spatially the same or different in the segments of the Bay?
2. What are appropriate guidelines for assessing the Bay's health with respect to nutrients and eutrophication?
3. Which nutrient sources, pathways, and transformation processes contribute most to concern?
   a. What is the relative contribution of each loading pathway (POTW, Delta, urban stormwater runoff, non-point sources, etc.) to the Bay overall and the Bay's key sub-systems, and how do these loads vary seasonally?
   b. What is the contribution of nutrient regeneration (benthic fluxes) from sediments and denitrification/nitrogen fixation to Bay nutrient budgets?
4. What nutrient loads can the Bay assimilate (without impairment of beneficial uses)?
5. What future impairment is predicted for nutrients in the Bay?

Summer Chlorophyll in South Bay



Nutrients

Workplan Highlights

- Report summarizing our current state of knowledge
- Pilot studies of improved nutrient monitoring approaches
- Development of quantitative models that allow forecasting nutrient impacts under different management scenarios

Partners and Coordination

The Nutrient Science Strategy is a collaborative effort with major contributions from:

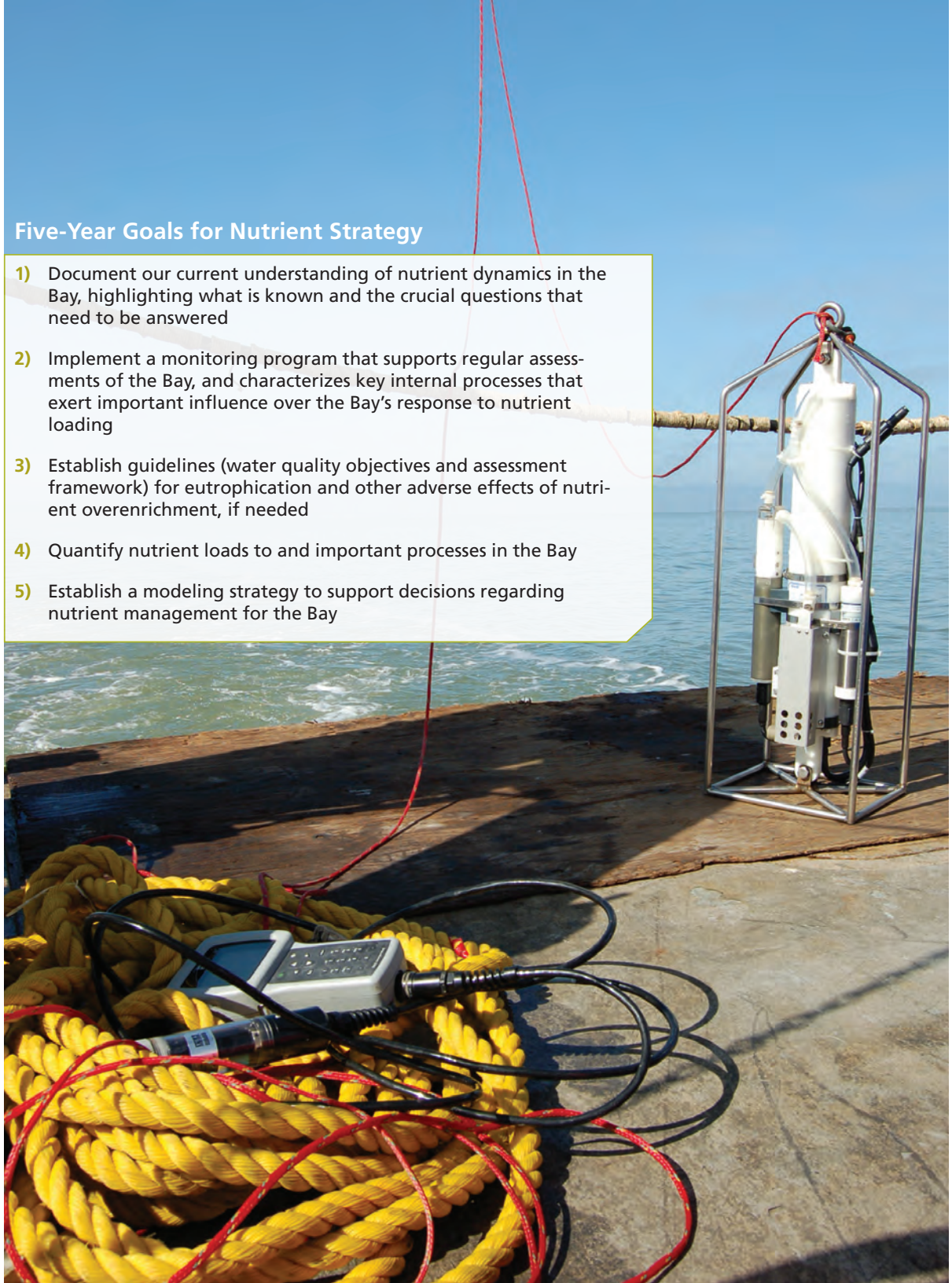
- RMP
- US Geological Survey
- State Water Board
- San Francisco Bay Regional Water Board
- Bay Area Clean Water Agencies
- Southern California Coastal Water Research Project

Relation to Permit Requirements

- Developing underlying scientific basis for future permit decisions
- Closely coordinated with permit requirements for Central Contra Costa Sanitation District to evaluate nutrient concerns in Suisun Bay

Five-Year Goals for Nutrient Strategy

1) Document our current understanding of nutrient dynamics in the Bay, highlighting what is known and the crucial questions that need to be answered
2) Implement a monitoring program that supports regular assessments of the Bay, and characterizes key internal processes that exert important influence over the Bay's response to nutrient loading
3) Establish guidelines (water quality objectives and assessment framework) for eutrophication and other adverse effects of nutrient overenrichment, if needed
4) Quantify nutrient loads to and important processes in the Bay
5) Establish a modeling strategy to support decisions regarding nutrient management for the Bay



Sampling equipment on the R/V Shana Rae.
Photograph by Susan Klosterhaus.

Forecasting (Modeling)

Relevant Management Policies and Decisions

- NPDES permits for nutrients
- The next iteration of the mercury and PCBs TMDLs
- Potential TMDLs for other contaminants
- Priorities for cleaning up local watersheds and contaminated margin sites
- Identifying best options for management actions to reduce impairment

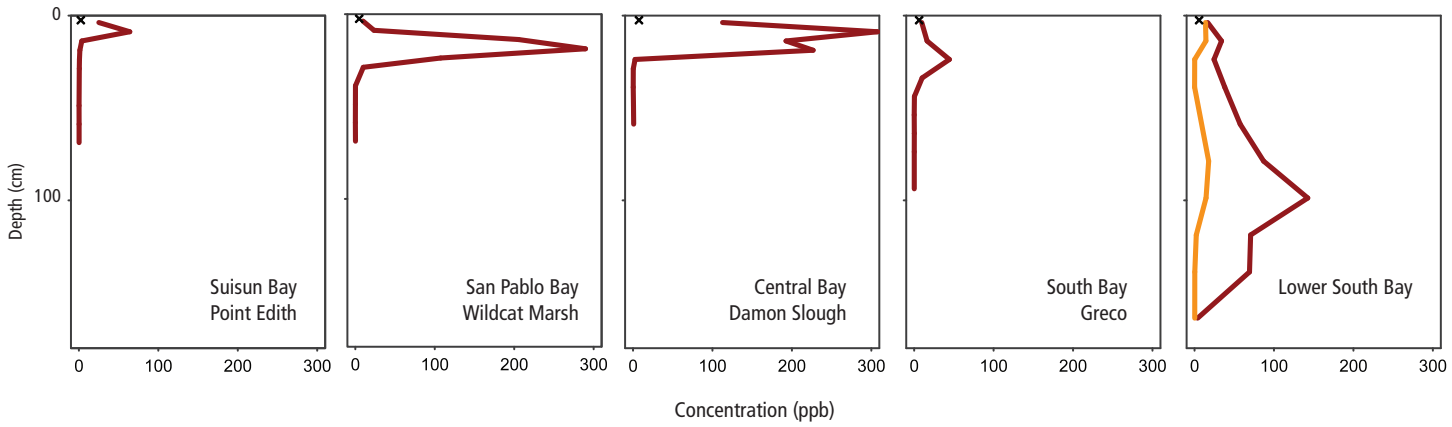
Recent Noteworthy Findings

- Sediment cores from open-water sites exhibited total mercury and PCB concentrations in deeper sediments that were generally similar to surface sediments, suggesting diminished concern for prolonged recovery due to erosion of contaminated subsurface material.
- Sediment cores from wetland sites showed wide fluctuations with peak concentrations of mercury and PCBs corresponding to approximately 1960. The wetland cores are subject to minimal mixing, and thus preserve a signal of past variation in loading and concentrations in the Bay.

Priority Questions for the Next Five Years

1. What patterns of exposure are forecast for major segments of the Bay under various management scenarios?
2. What is the contribution of contaminated Bay margins to Bay impairment?
3. What are the projected impacts of Bay margin management actions to Bay recovery?

PCBs in Wetland Cores



Sediment cores from Bay tidal marshes provide a clear picture of trends over time because of the consistent deposition and lack of vertical mixing in the marsh environment. Six wetland cores examined by RMP document drastic decreases in PCB concentrations since the 1960s. In Wildcat Marsh, for example, concentrations dropped from a maximum of 290 ppb at a depth of 19 cm to 10 ppb at a depth of 4 cm, a 97% decrease. These wetland cores document a major reduction in loads from local watersheds and in concentrations in the Bay.

Forecasting (Modeling)

The ultimate goal of the Forecasting Strategy is to predict Bay water quality under different management scenarios. Efforts in the next two years will focus on modeling nutrients.

Workplan Highlights

- A multi-year workplan for modeling is in development, in close conjunction with the Nutrient Strategy

Partners and Coordination

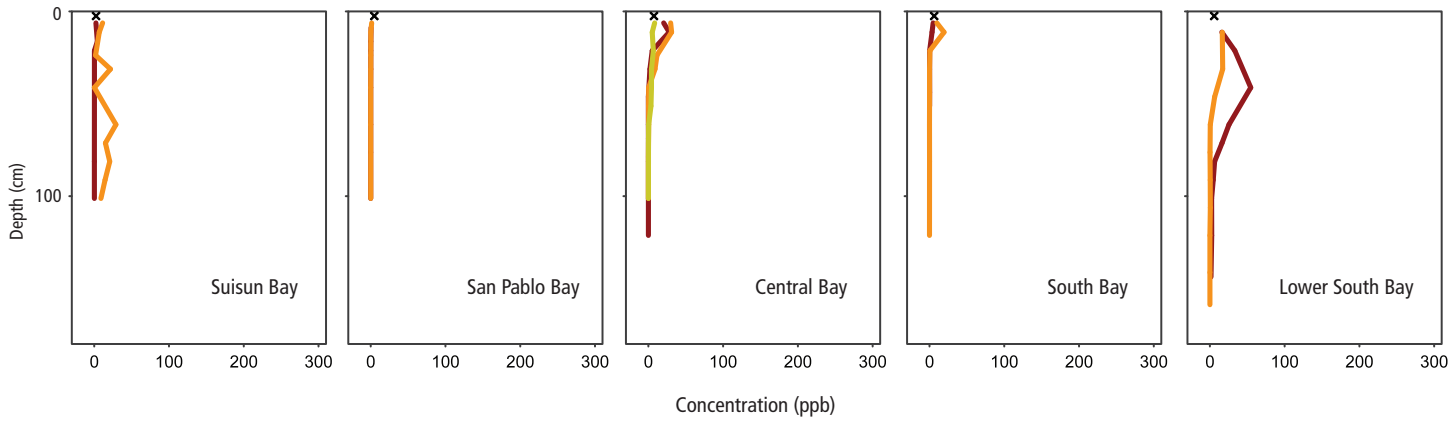
This work is being closely coordinated with monitoring performed by:

- US Geological Survey
- Bay Area Clean Water Agencies

Relation to Permit Requirements

- Addresses critical information needs identified in the PCB and mercury TMDLs to be addressed by municipal and industrial wastewater dischargers and stormwater management agencies
- Developing underlying scientific basis for future permit decisions regarding nutrients
- Closely coordinated with permit requirements for Central Contra Costa Sanitation District to evaluate nutrient concerns in Suisun Bay

PCBs in Bay Cores



Sediment cores from the open Bay are more affected by extensive erosion and mixing, so they are less valuable as a record of change over time. However, Bay cores provide information on the subsurface contaminant inventory that is susceptible to erosion, and this information is essential to forecasting the recovery of the Bay. Prior to the recent RMP study, the small amount of information available suggested that the subsurface reservoir of contaminants might be large and greatly prolong recovery. Overall, though subsurface concentrations are elevated in some areas of the open Bay, these deposits appear to be less of a concern than previously thought.

Emerging Contaminants

Relevant Management Policies and Decisions

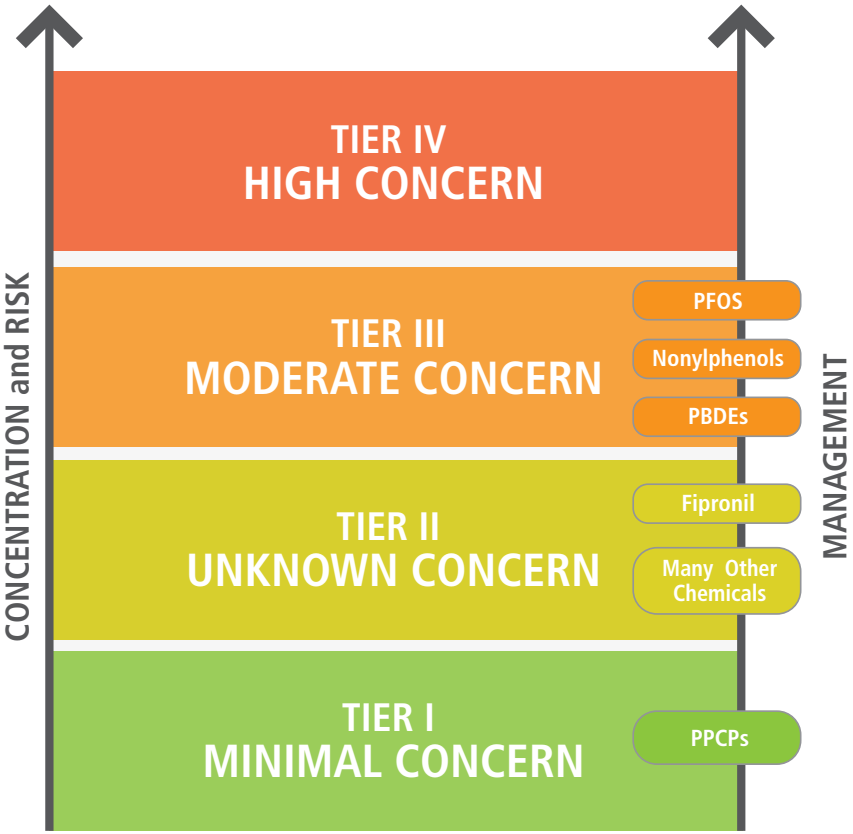
- Development of State Water Board Policy on CECs in freshwater, coastal, and marine ecosystems
- Regional Water Board policy
- State Water Board Toxicity Policy
- Narrative water quality objectives prohibiting toxicity and water quality degradation

Recent Noteworthy Findings

- Perfluorinated chemicals in bird eggs are high relative to other locations that have been studied and in South Bay exceed a published health risk threshold.
- Triclosan was detected in sediment at seven out of ten sites with concentrations ranging from 5-10 ppb in the Central and South Bay, and a maximum of 40 ppb. Sediment toxicity thresholds are not available, but these concentrations may be of some concern.
- A screening study of alternative flame retardants generally found low concentrations. Some phosphate-based chemicals are present in sediment at levels comparable to PCBs and PBDEs; work is underway to determine if they accumulate in biota.
- A screening study of pharmaceuticals and personal care products generally found concentrations well below available acute and chronic toxicity thresholds.
- Chlorinated paraffin concentrations in the Bay also are low relative to other ecosystems.
- A small screening study (6 samples from 4 locations) in 2009 found nonylphenol concentrations in small fish ranging from 50 to 420 ppb, similar to other estuaries in California.

Priority Questions for the Next Five Years

1. What emerging contaminants have the greatest potential to adversely impact beneficial uses in the Bay?



Emerging Contaminants

Emerging contaminant studies in the RMP have been augmented substantially by pro bono work and matching funds. A synthesis in 2012 will set the stage for a multi-year plan for 2013 and beyond.

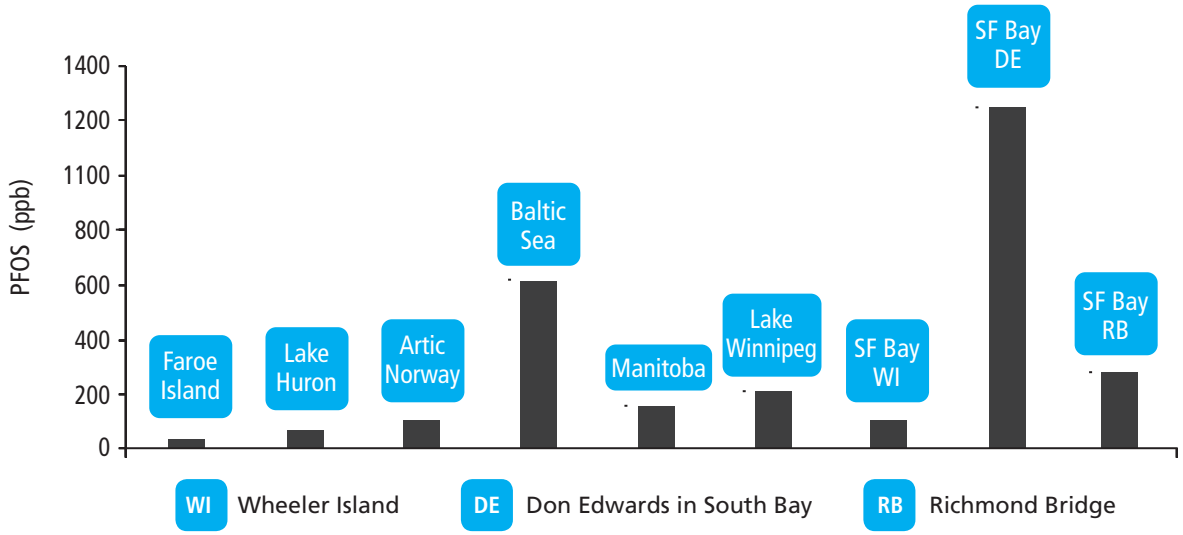
Workplan Highlights

- Summary of our current state of knowledge on CECs in the Bay
- Development of a multi-year plan for RMP CEC studies
- Reports on the statewide pilot study of CECs in mussels
- Report on a study of CECs in Bay mussels
- Collaborative study on development of bioanalytical tools for CECs
- Synthesis of information on PBDEs

Partners and Coordination

Partnerships with many organizations have substantially augmented RMP efforts on emerging contaminants:

- National Oceanic and Atmospheric Administration
- State Water Board
- Southern California Coast Water Research Project
- National Institute of Standards and Technology
- AXYS Analytical
- Canada Department of Fisheries and Oceans
- Environment Canada
- The Marine Mammal Center
- US Environmental Protection Agency
- Duke University
- Cal Poly San Luis Obispo
- San Diego State University
- University of Minnesota



PFOS concentrations in Bay bird eggs, especially those in South Bay, are high relative to concentrations measured in other parts of the world.

Sampling sediment at Cooley Landing. Photograph by Meg Sedlak.

Exposure and Effects

Relevant Management Policies and Decisions

- Implementation of sediment quality objectives
- The next iteration of the mercury TMDL
- Permitting decisions regarding dredging projects
- Continued implementation of narrative water quality objective prohibiting toxicity

Recent Noteworthy Findings

- In every year since RMP sampling began in 1993, 26% or more of sediment samples have been determined to be toxic to one or more test species. The causes of this toxicity remain unidentified.
- Studies have indicated that mercury is impairing hatchability of Forster's tern eggs in San Francisco Bay, but that the reduction of nest success at the TMDL bird egg monitoring target of 0.5 ppm is less than 10%.
- A study examining possible endocrine responses in shiner surfperch and staghorn sculpin found hormonal imbalances that appeared to be related to PCB exposure.
- Tern embryos are less sensitive to PBDE exposure than the most sensitive species studied (American Kestrel). Effects on tern embryos at the concentrations found in the Bay do not appear likely.

Priority Questions for the Next Five Years

Effects on Benthos

1. What are the spatial and temporal patterns of impacts of sediment contamination?
2. Which pollutants are responsible for observed impacts?
3. Are the toxicity tests, benthic community assessment approaches, and the overall SQO assessment framework reliable indicators of impacts?

Effects on Fish

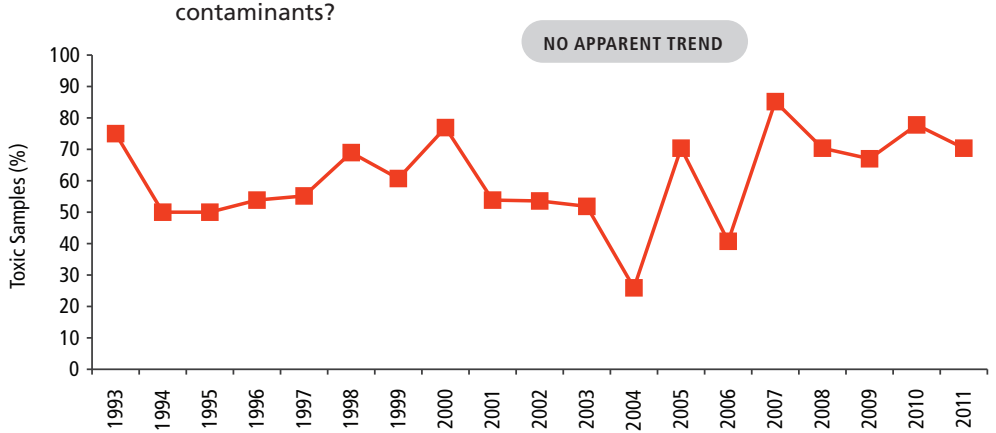
4. Are pollutants, individually or in combination, reducing the reproductive ability, growth, and health of sensitive fish populations?
5. What are appropriate thresholds of concern for contaminant concentrations for Bay species?
6. What are cost-effective indicators for monitoring effects of contaminants?

Effects on Birds

7. Is there clear evidence of pollutant effects on survival, reproduction, or growth of individual birds?
8. Are pollutants in the Bay adversely affecting bird populations?
9. What are appropriate guidelines for protecting bird populations that are at risk?
10. Do spatial patterns in accumulation indicate particular regions of concern?

Sorting benthos.
Photograph by Ellen Willis-Norton

Percent Toxic Sediment Samples



Exposure and Effects

Exposure and effects effort on benthos and fish in 2012 and 2013 focus on enhancing tools for assessing sediment quality and identifying causes of sediment toxicity, and evaluating the effects of PAHs and copper on fish.

Workplan Highlights

- Report on effects of PAHs in flatfish
- Report on effects of copper on olfaction in salmonids
- A workshop and workplan development on identification of causes of moderate sediment toxicity
- Development of a benthic index for mesohaline waters of the Bay
- Report on sediment quality at Bay hotspots
- Summary report on the Exposure and Effects Pilot Study

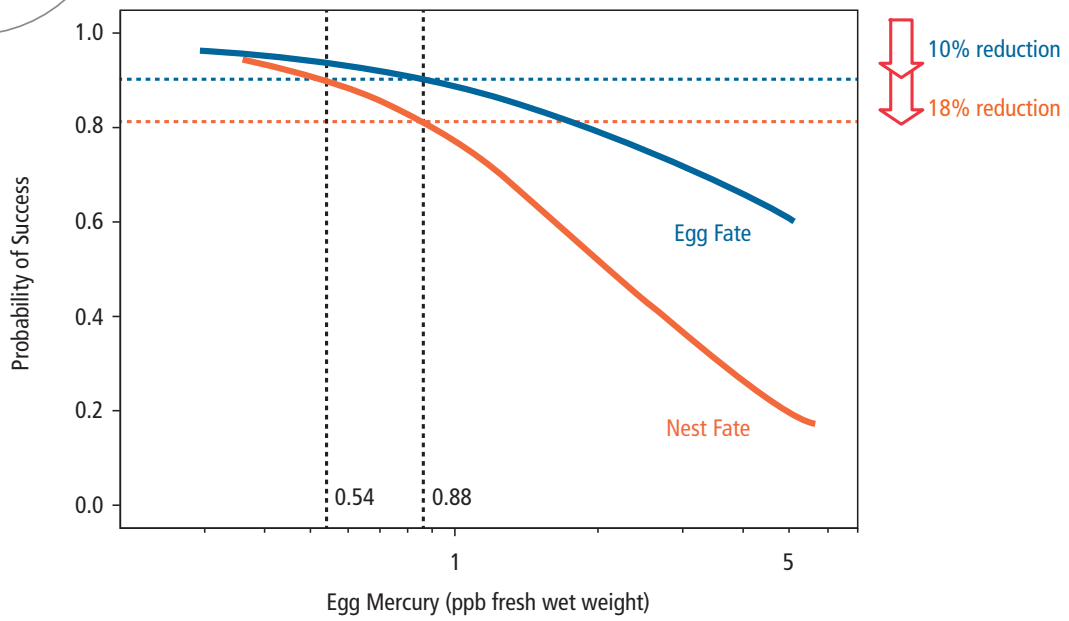
Relation to Permit Requirements

- Addresses technical uncertainties identified in the Basin Plan's implementation program for copper site-specific objectives, to be addressed by municipal and industrial wastewater dischargers and stormwater management agencies
- Thresholds for bioaccumulation testing of dredged material based on ambient sediment conditions

Partners and Coordination

- National Oceanic and Atmospheric Administration
- Copper Development Association
- Southern California Coastal Water Research Project
- UC Davis – Granite Canyon
- State Water Board
- US Geological Survey Western Ecological Research Center

The estimated reduction of Forster's tern nest success corresponding to the TMDL bird egg monitoring target of 0.5 ppm is about 10%



Mercury

Relevant Management Policies and Decisions

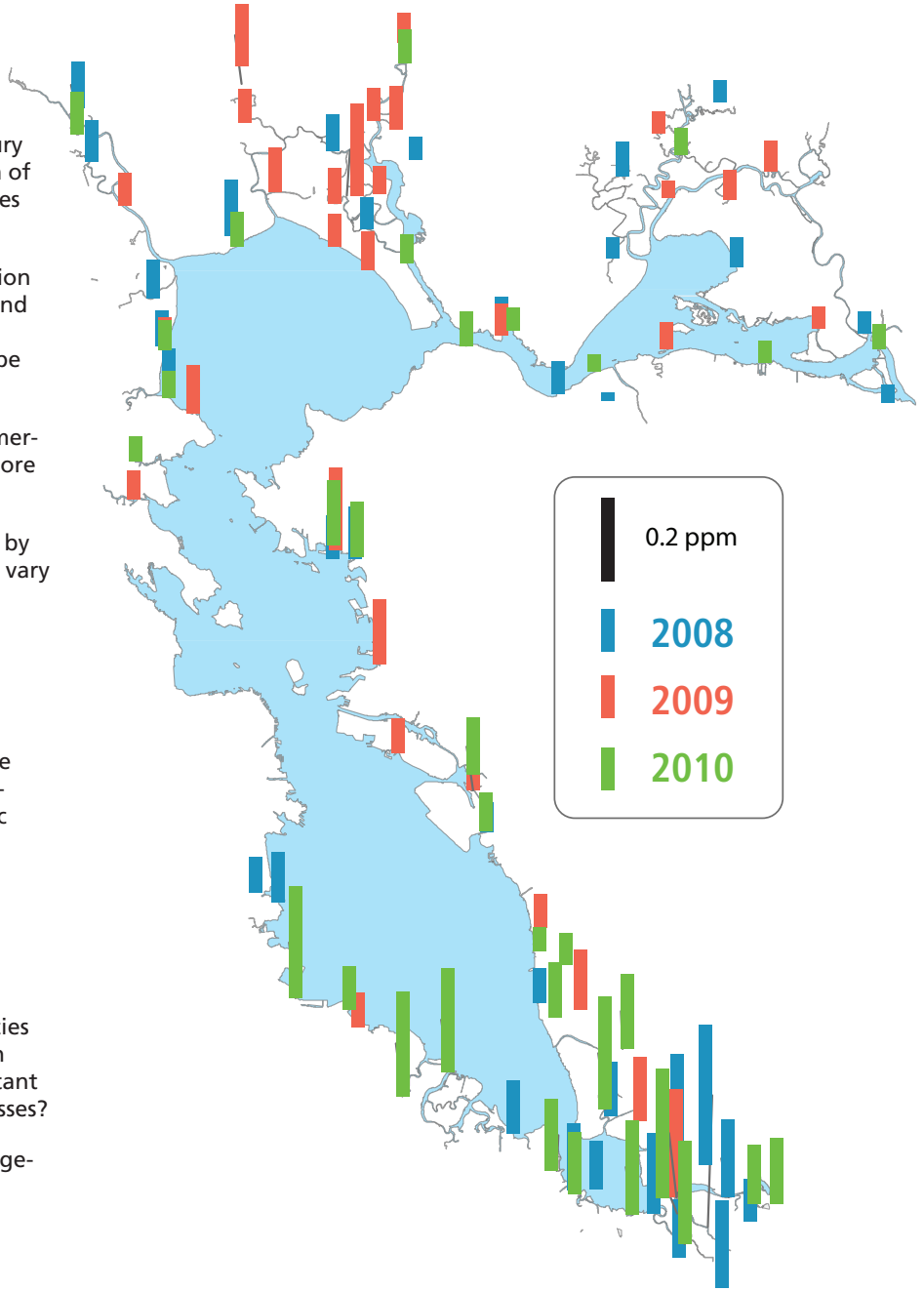
- Review new information and prepare plan to update the current mercury TMDL and implementation plan
- The next iteration of the mercury TMDL
- Identifying best options for management actions to reduce mercury impairment

Recent Noteworthy Findings

- The median mercury concentration in striped bass in 2009 was 0.44 ppm, higher than the TMDL target of 0.20 ppm. Concentrations have shown no decline since 1970.
- Monitoring of mercury in small fish indicates that a high proportion (85% in 2008-2010) of samples was above the 0.03 ppm TMDL target for wildlife prey.
- The small fish monitoring also indicates that concentrations are relatively high in the Lower South Bay region.
- Based on mercury concentrations in blood, nearly 60% of all breeding Forster's Terns sampled in the Bay are at high risk of toxic effects.
- Sediment cores suggest extensive transport and mixing of past loads and diminished concern for erosion of contaminated subsurface material.
- A mass budget for methylmercury indicates that in-Bay production of methylmercury is about 100 times greater than external loading.
- Source control (principally erosion of mining waste, stormwater, and wastewater) is being pursued but will take many decades to be effective.
- Control of internal net methylmercury production may achieve more rapid reductions.
- Opportunities for reducing risk by controlling internal production vary by habitat (open Bay, managed pond, tidal marsh).

Priority Questions for the Next Five Years

1. Where is mercury entering the food web? – we may have answered this sufficiently – topic for Strategy Team discussion.
2. Which processes, sources, and pathways contribute disproportionately to food web accumulation?
3. What are the best opportunities for management intervention for the most important pollutant sources, pathways, and processes?
4. What are the effects of management actions?
5. Will total mercury reductions result in reduced food web accumulation?



Mercury concentrations (ppm) in silverside from 2008-2010.

Mercury

The Mercury Strategy began with a multi-year suite of studies in 2008. A synthesis in 2012 will set the stage for a new multi-year plan for 2013 and beyond.

Workplan Highlights

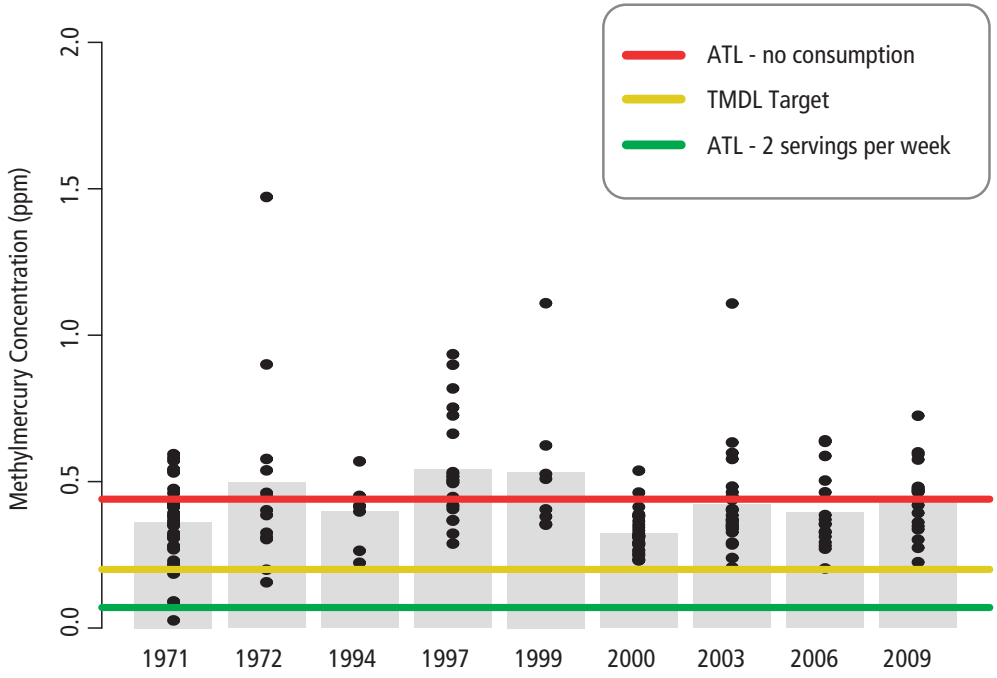
- Synthesis document summarizing our current state of knowledge related to reducing methylmercury in the Bay food web
- Development of an update multi-year plan for mercury studies

Relation to Permit Requirements

- Addresses critical information needs identified in the mercury TMDL to be addressed by municipal and industrial wastewater dischargers and stormwater management agencies

Partners and Coordination

- U.S. Geological Survey
- Dartmouth University
- UC Davis
- University of Michigan
- Trent University



Methylmercury concentrations (ppm) in striped bass from San Francisco Bay, 1971-2009. Bars indicate average concentrations. Points represent individual fish.

PCBs

Relevant Management Policies and Decisions

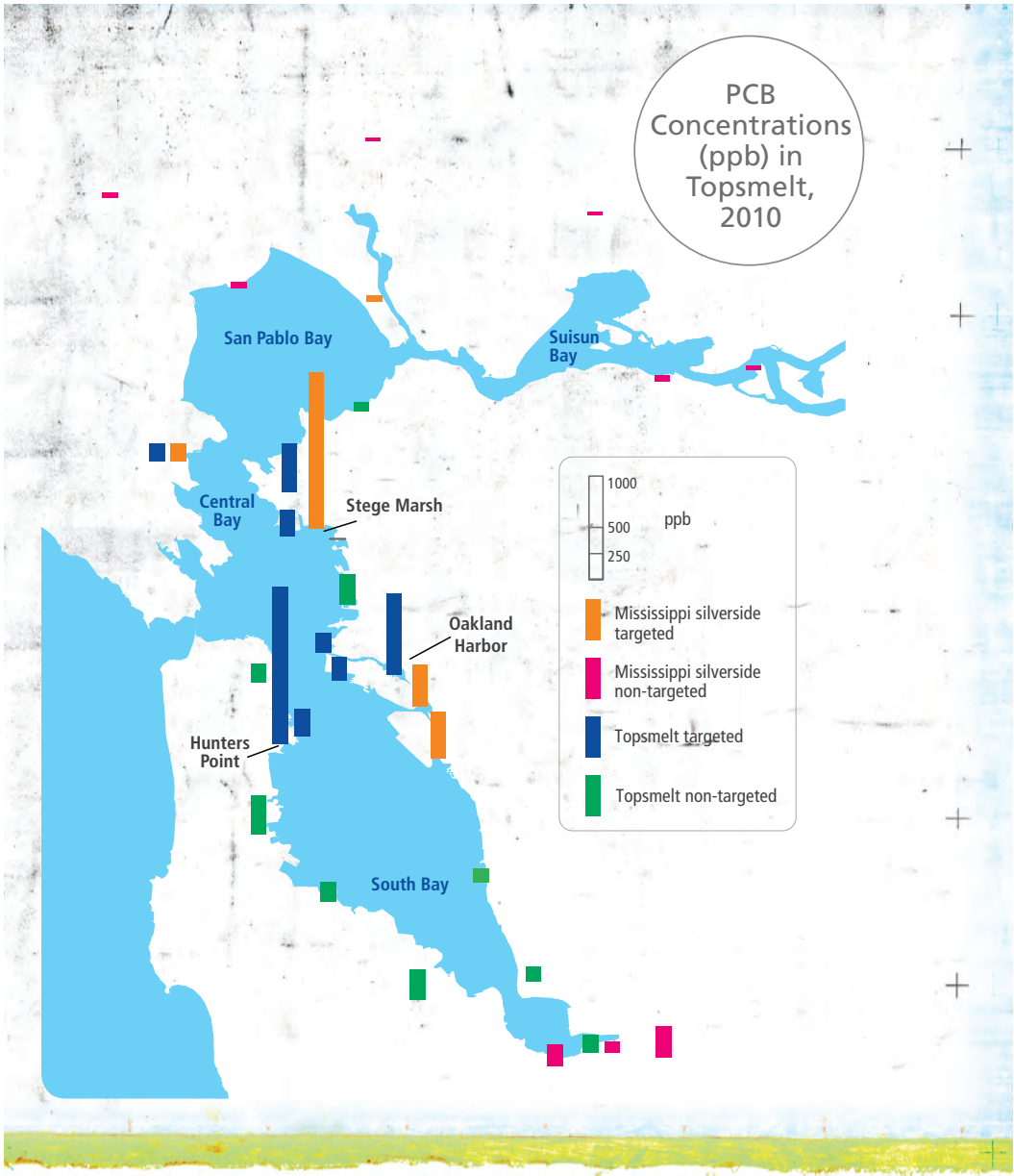
- Review new information and prepare plan to update the current TMDL
- The next iteration of the PCBs TMDL
- What management actions are the best options for reducing PCB impairment?

Recent Noteworthy Findings

- Sport fish were lower on a wet weight basis in the most recent sampling (2009), though on a lipid weight basis concentrations were comparable to past sampling rounds.
- Risks to fish-eating birds persist. In 2000-2003, 17% of 149 tern eggs were above an effects threshold.
- Small fish accumulate high concentrations of PCBs that correlate with concentrations in sediment.
- Bivalve monitoring continues to indicate declines, with half-lives ranging among stations from 7 to 14 years, and longer half-lives in the South Bay.
- Bay sediment appears to be cleaner than in the 1990s. The Bay-wide average was 7.0 ppb in 2004-2009 compared to 31 ppb in the 1990s. A different sampling design and different methods probably contribute to this apparent decrease.
- Average concentrations in Suisun Bay sediments are lower than in the other Bay segments.
- Bay cores show some areas with higher concentrations at depth, but this is less of a concern than previously thought.
- A new PCB has been identified in effluents and the environment across the U.S. PCB 11 and several other PCBs are inadvertent by-products in the manufacturing of commonly used pigments. These pigment PCBs are distinct from the Aroclor-derived PCBs that are the subject of the PCBs TMDL.

Priority Questions for the Next Five Years

1. What potential for impacts on humans and aquatic life exists due to PCBs?
2. What are appropriate guidelines for protection of beneficial uses?
3. What is the total maximum daily load of PCBs that can be discharged without impairment of beneficial uses?
4. What are the rates of recovery of the Bay, its segments, and in-Bay contaminated sites from PCB contamination?
5. What are the present loads and long-term trends in loading from each of the major pathways?
6. What role do in-Bay contaminated sites play in segment-scale recovery rates?
7. Which small tributaries and contaminated margin sites are the highest priorities for cleanup?
8. What management actions have the greatest potential for accelerating recovery or reducing exposure?
9. What is the most appropriate index for sums of PCBs?



PCBs

Studies under the PCB Strategy began in 2010. A synthesis in early 2013 will set the stage for a multi-year study plan for 2014 and beyond.

Workplan Highlights

- Synthesis document summarizing our current state of knowledge related to management of PCBs
- Development of an update multi-year plan for PCB studies

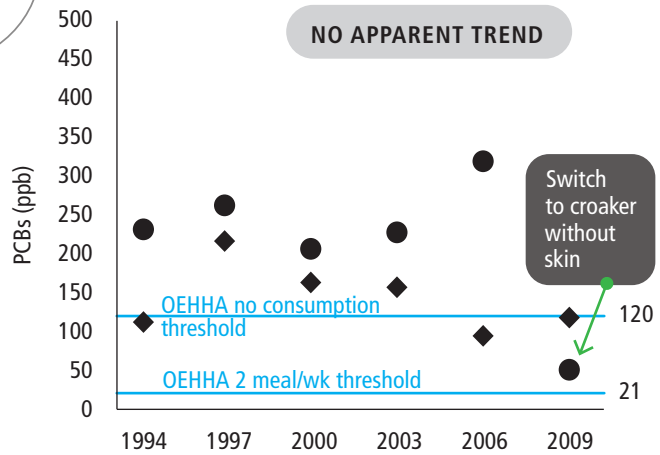
Relation to Permit Requirements

- Addresses critical information needs identified in the PCB TMDL to be addressed by municipal and industrial wastewater dischargers and stormwater management agencies

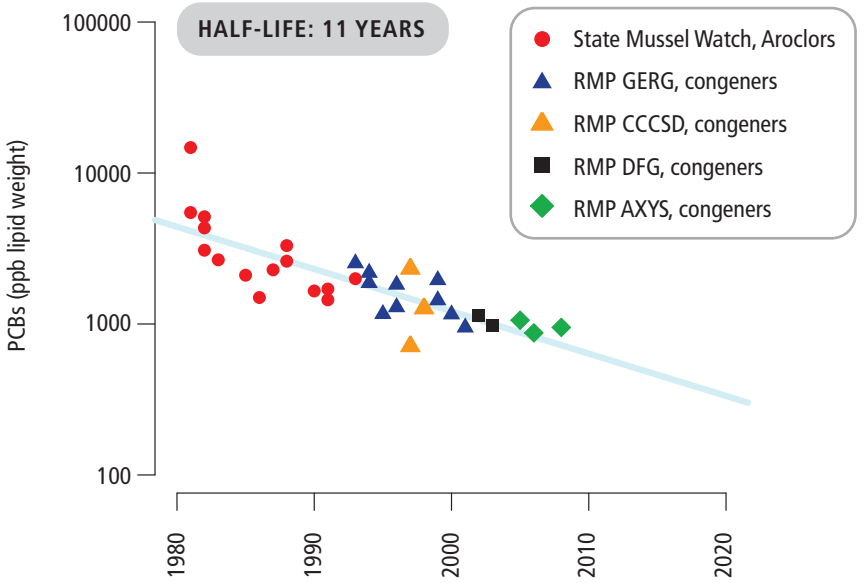
Partners and Coordination

- UC Davis (sampling)

PCBs in Sport Fish



PCBs in Mussels at Pinole Point



Dioxins

Relevant Management Policies and Decisions

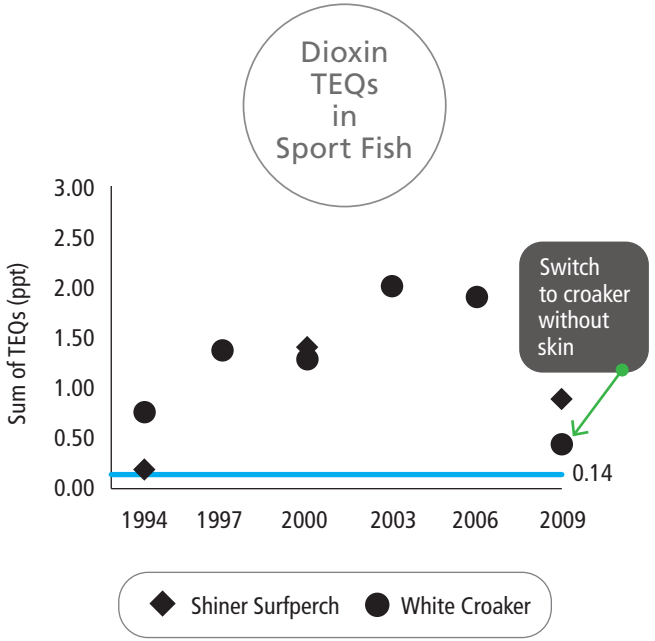
- Reissue permit requirements
- Review 303(d) listings
- Establish TMDL development plan

Recent Noteworthy Findings

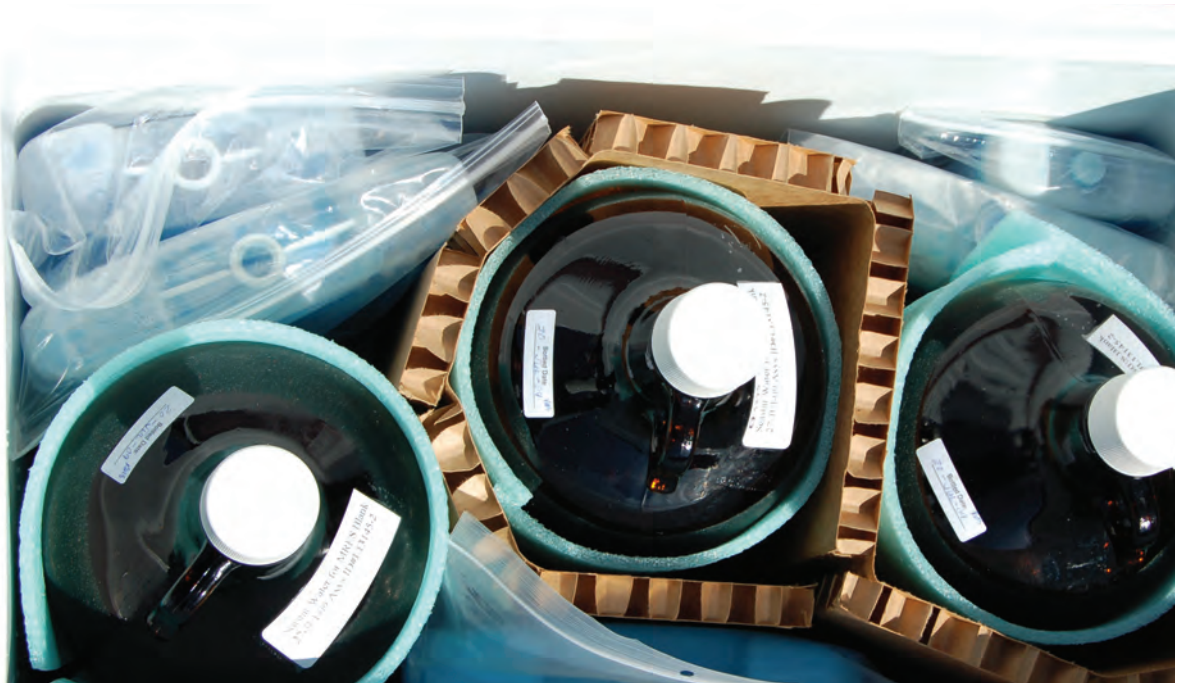
- The key sport fish indicator species (shiner surfperch and white croaker) have been higher than the Water Board screening value of 0.14 ppt and show no sign of decline, but there is a great deal of uncertainty regarding the human health risk associated with dioxins in sport fish.
- Dioxin-toxic equivalents in Least Tern, Caspian Tern, and Forster's Tern eggs are at or above estimated thresholds for adverse effects; risks especially significant in combination with dioxin-like PCBs.
- Few data on dioxins are available on other priority questions – the Dioxin Strategy was developed to address this need.
- Recent wetland cores suggest rapidly declining inputs from local watersheds during recent decades, though additional coring data are needed to support this hypothesis.

Priority Questions for the Next Five Years

1. Are the beneficial uses of San Francisco Bay impaired by dioxins?
2. What is the spatial pattern of dioxin impairment?
3. What is the dioxin reservoir in Bay sediments and water?
4. Have dioxin loadings/concentrations changed over time?
5. What is the relative contribution of each loading pathway as a source of dioxin impairment in the Bay?
6. What future impairment is predicted for dioxins in the Bay?



Baywide average dioxin and furan TEQ concentrations (ppt) in white croaker (circles) and shiner surfperch (diamonds).



Water sampling bottles. Photograph by Amy Franz.

Dioxins

Workplan Highlights

- Monitoring stormwater, sediment, and bird eggs.

Partners and Coordination

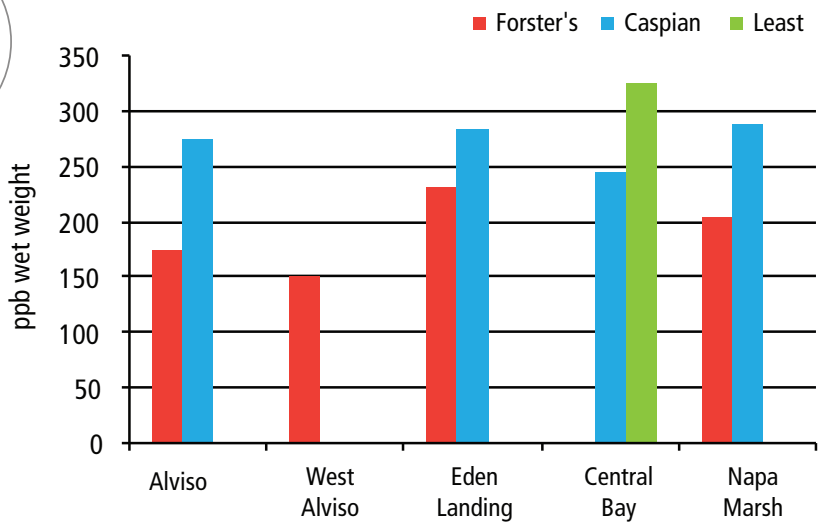
- Bay Area Clean Water Agencies

Relation to Permit Requirements

- The Dioxin Strategy is generating the information needed to support development of appropriate effluent limits for municipal and industrial discharges

Dioxin Strategy studies began in 2008, with a multi-year plan extending through 2012. Synthesis activities are planned for 2013 and 2014 after the data from the earlier studies are available.

Dioxin TEQs in Terns



Mean concentrations of dioxin and furan TEQs in three tern species, 2000-2003. Mean concentrations for the California Least Tern fall within the effects threshold range. Concentrations within the effects threshold range were observed in some eggs of all species. From Adelsbach and Maurer (2007).

Sampling water at Mallard Island. Photograph by Nicole David.

Selenium

Workplan Highlights

- Continued monitoring of selenium in sport fish, water, and sediment

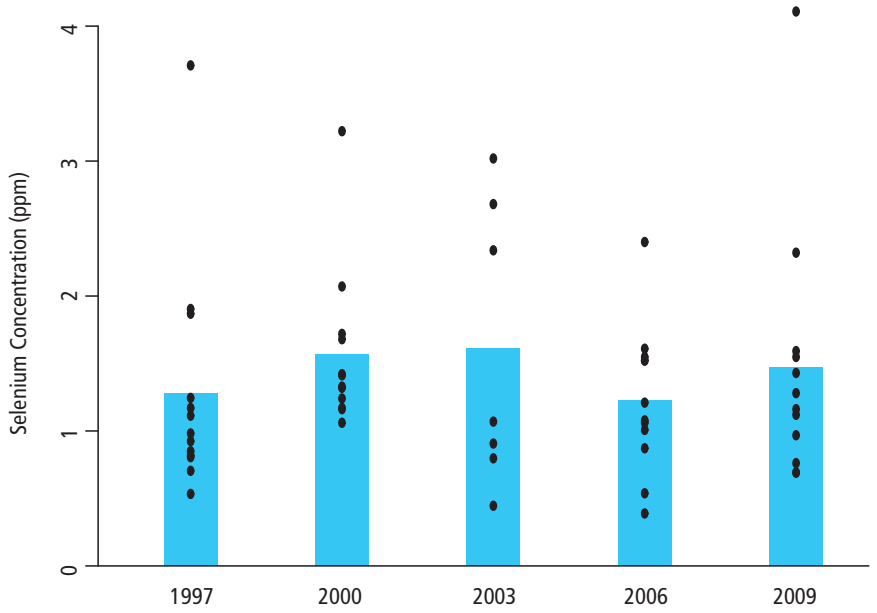
Relevant Management Policies and Decisions

- Selenium TMDL for North Bay
- Selenium TMDL for South Bay

Recent Noteworthy Findings

- Selenium concentrations in multiple sport fish species in 2009 were well below OEHHA's lowest threshold for human health.
- The vast majority of selenium concentrations in white sturgeon in 2009 were below the target for fish proposed in the Preliminary Project Report for the North Bay TMDL.

Selenium in White Sturgeon



Selenium concentrations (ppm wet weight) in white sturgeon in San Francisco Bay, 1997-2009. Bars indicate average concentrations. Points represent individual samples (either composites or individual fish).

Sampling Bay water. Photograph by Susan Klosterhaus.

Status and Trends

Relevant Management Decisions

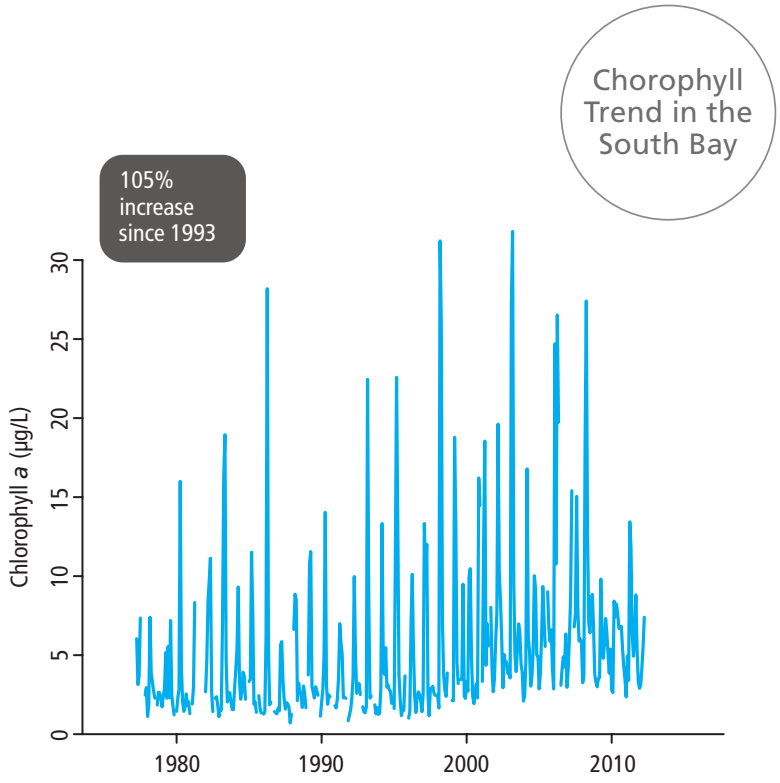
- Revision of Mercury and PCB TMDLs
- Development of Se TMDLS for North Bay and South Bay
- Potential de-listing of legacy pesticides
- Evaluation of sediment and water quality objectives
  - Copper site-specific objective and cyanide anti-degradation policy
  - 303 (d) listings
  - Reasonable potential analysis
- Dredged material management
  - Defining ambient conditions in Bay (PCBs, Hg, PAHs, etc.)
- Development of and assessment with nutrient numeric endpoints; management of ammonium

Recent Advances in Understanding

- Annual sampling of water and sediment chemistry has documented a general lack of trend in persistent pollutants and spatial patterns that vary by pollutant but are consistent from year to year.
- A sudden decrease in suspended sediment concentrations (SSC) occurred in 1999.
- Increasing chlorophyll concentrations have been observed in the Bay and are attributed to a variety of possible drivers (e.g., decrease in SSC concentrations and an increase in bivalve predators).
- PBDEs appear to be leveling off (BDE 47) or declining (BDE 209).
- Concentrations of mercury in sediment correlate poorly with methylmercury in sediment (MeHg represents 1% of total Hg).

Priority Questions for the Next Five Years

1. Are chemicals at levels of concern?
2. What are the concentrations and masses of priority contaminants?
3. Have concentrations and masses increased or decreased?



Status and Trends

Workplan Highlights

- Monitoring bivalve, sediment and water in alternating years.
- Triennial monitoring of bird eggs and analysis of sport fish every five years.

Partners and Coordination

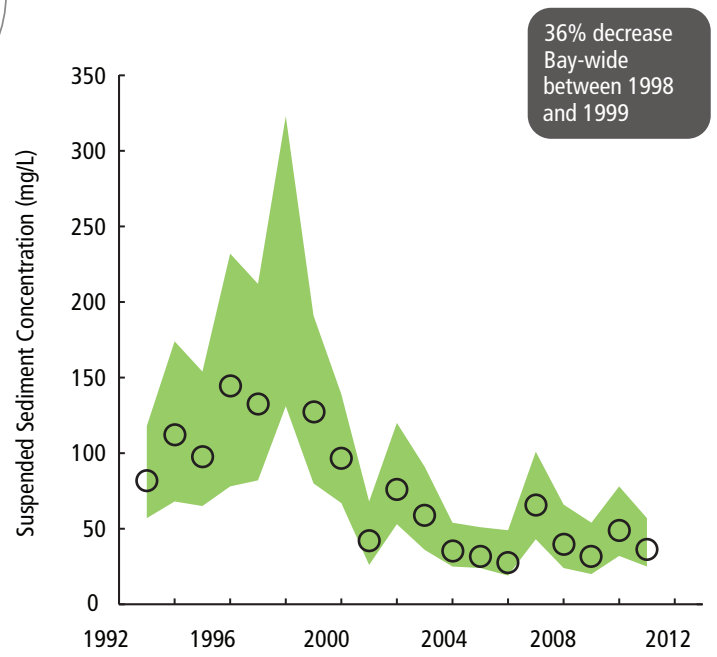
- Applied Marine Sciences
- AXYS Analytical
- EBMUD
- City and County of San Francisco
- USGS
- Marine Pollution Studies Laboratory
- California Department of Fish and Game
- City of San Jose
- Brooks Rand Analytical
- Columbia Analytical Services
- Moss Landing Marine Laboratory

Relation to Permit Requirements

- Satisfies requirement for receiving water compliance monitoring for NPDES discharge permit holders

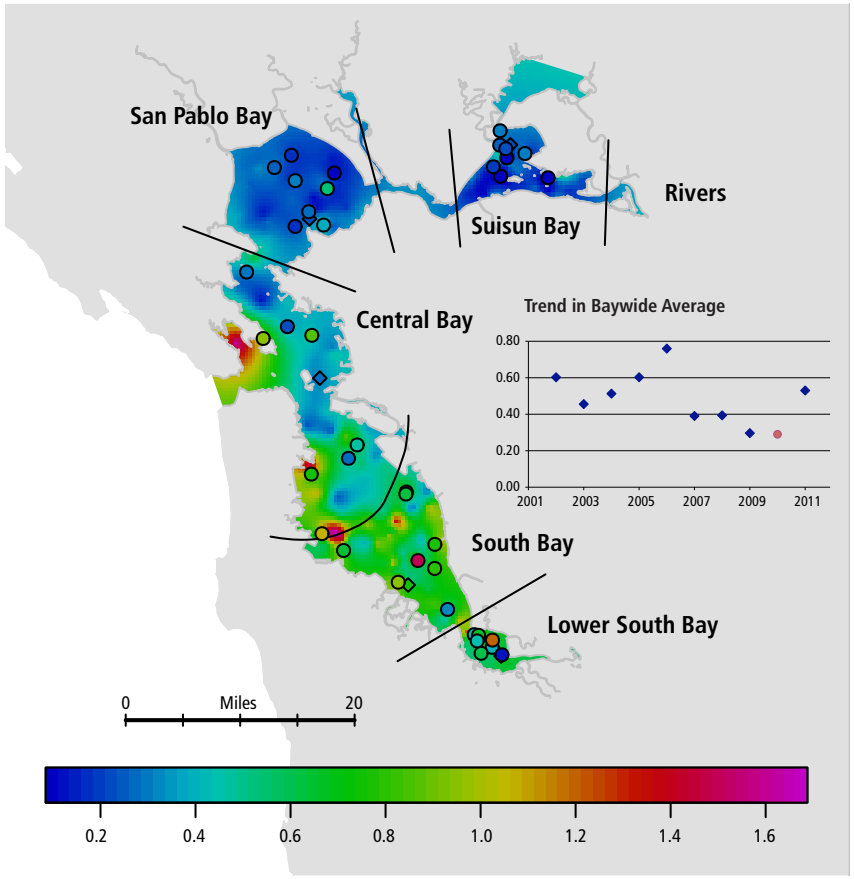
Status and Trends sampling was scaled back significantly in 2012, freeing up $400,000 per year for special studies and other topics.

Suspended Sediment Trend at a Representative Station



Status and Trends

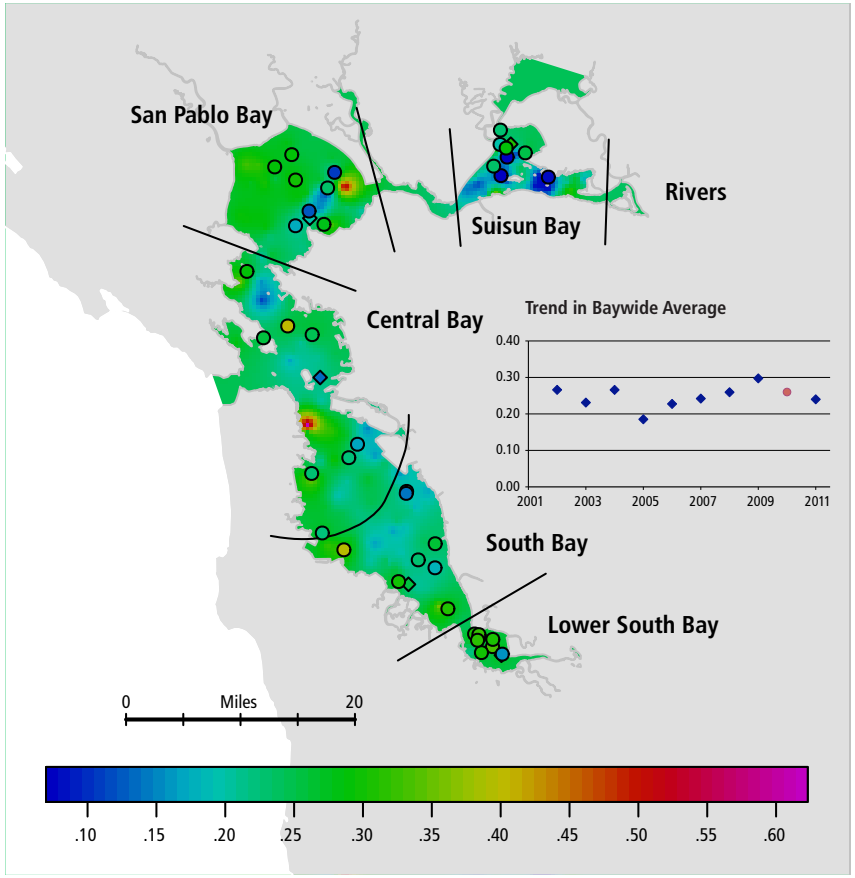
Methylmercury in Sediment (ppb)



Concentrations of methylmercury in sediment south of the Bay Bridge have been consistently higher than those in the northern Estuary. Methylmercury production can vary tremendously over small distances and over short time periods, so the colored contours shown should be viewed as the result of several "snapshots" of Bay conditions at the time of the surveys in the summers of 2002-2011 (except for 2010, when sampling occurred during the wet season - these data are excluded from the map and the statistics that follow). Long-term (2002-2011) average concentrations have been highest in South Bay and Lower South Bay (0.72 and 0.68 ppb, respectively), and lowest in Suisun Bay (0.20 ppb) and San Pablo Bay (0.27 ppb). The Bay-wide average concentration in 2011 (0.53 ppb) was similar to the long-term average (0.50 ppb). No regulatory guideline exists for methylmercury in sediment.

Footnote: Contour plot based on 425 RMP data points over nine rounds of dry season sampling from 2002-2011 (data from a wet season sampling in 2010 are excluded). The maximum concentration was 6.1 ppb at a site in Central Bay in 2009. Colored symbols on map show results for samples collected in 2011. Circles represent random sites. Diamonds represent historic fixed stations. Trend plot shows annual Bay-wide averages. Red circle on trend plot indicates a wet season sample; other samples were dry season. Concentrations presented on a dry weight basis.

Mercury in Sediment (ppm)

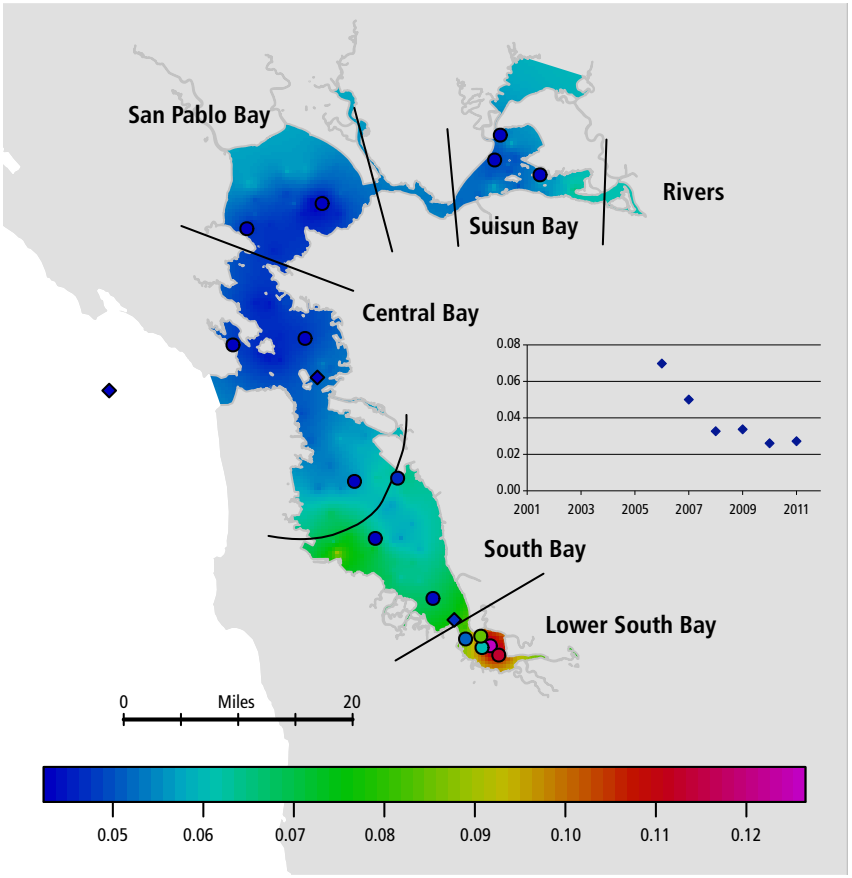


In contrast to methylmercury, long-term average total mercury concentrations in sediment during the dry season have been highest in San Pablo Bay (0.27 ppm). Average concentrations have been slightly lower in Lower South Bay and Central Bay (both 0.26 ppm) and South Bay (0.22 ppm), and lowest in Suisun Bay (0.17 ppm). The Bay-wide average for the eight-year period was 0.25 ppm. Also in contrast to methylmercury, Bay-wide average concentrations of total mercury in sediment have shown relatively little variability over this period, ranging from a low of 0.19 ppm in 2005 to a high of 0.30 ppm in 2009. Highlighting the lack of correlation between total mercury and methylmercury, the lowest Bay-wide average methylmercury concentration for the ten-year period was observed in 2009, coinciding with the highest average total mercury concentration. No regulatory guideline exists for total mercury in sediment.

Footnote: Contour plot based on 425 RMP data points over nine rounds of dry season sampling from 2002-2011 (data from a wet season sampling in 2010 are excluded). The maximum dry season concentration was 0.94 ppm in Central Bay in 2009. Colored symbols on map show results for samples collected in 2011. Circles represent random sites. Diamonds represent historic fixed stations. Trend plot shows annual Bay-wide averages. Red circle on trend plot indicates a wet season sample; other samples were dry season. Concentrations presented on a dry weight basis.

Status and Trends

Methylmercury in Water (ng/L)



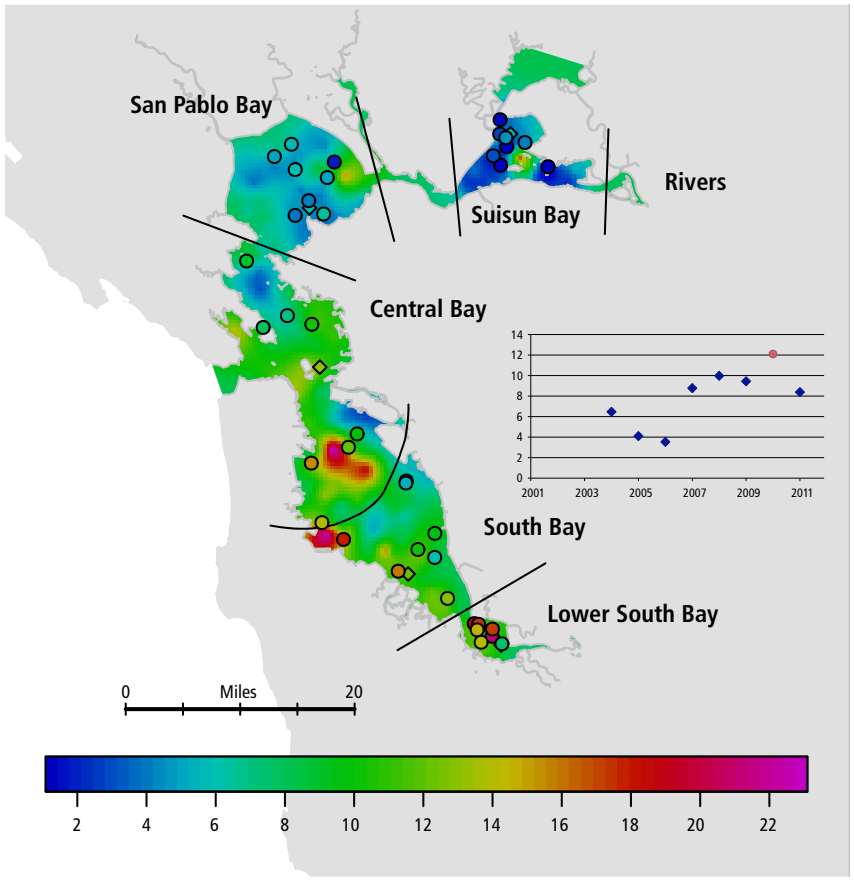
Water from Lower South Bay had the highest average concentration of methylmercury by far (0.11 ng/L) of any segment from 2006 to 2011. South Bay had the next highest average (0.06 ng/L). Methylmercury typically represents only about 1% of the total of all forms of mercury in water or sediment, but it is the form that is readily accumulated in the food web and poses a toxicological threat to highly exposed species. Methylmercury has a complex cycle, influenced by many processes that vary in space and time. No regulatory guideline exists for methylmercury in water. The Bay-wide average in 2011 was 0.03 ng/L. The Bay-wide average for the six-year period was 0.04 ng/L. The Bay-wide averages for 2008-2011 were lower than those observed in 2006 and 2007.

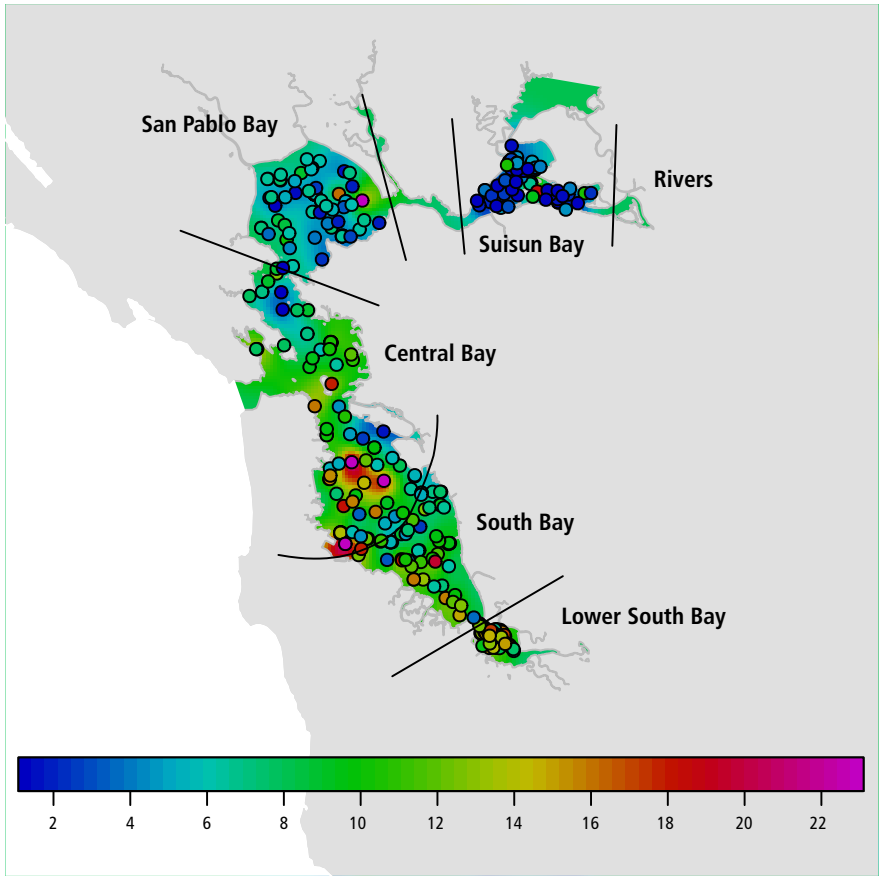
Footnote: Map plot based on 141 RMP data points from 2006-2011. Earlier years not included because a less sensitive method was employed. The maximum concentration was 0.28 ng/L at a site in Lower South Bay in 2011. Trend plot shows annual Bay-wide averages. Data are for total methylmercury. Colored symbols on map show results for samples collected in 2010. Circles represent random sites. Diamonds represent historic fixed stations.

Collecting a Bay sediment sample. Photograph by Thomas Jabusch.

Status and Trends

Sum of PCBs in Sediment (ppb)





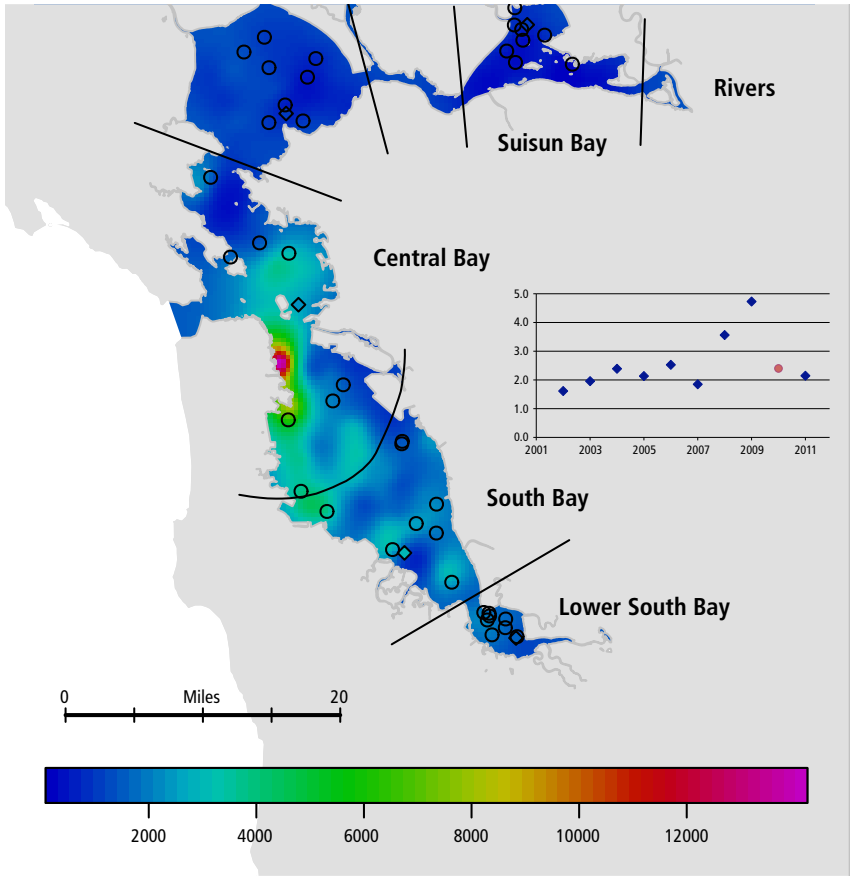
Average PCB concentrations in Bay sediment have been highest in the southern reach of the Estuary: Lower South Bay (10.7 ppb), South Bay (8.6 ppb), and Central Bay (9.0 ppb). Average concentrations have been lower in San Pablo Bay (4.7 ppb) and Suisun Bay (2.4 ppb). The Bay-wide average for 2011 was 8.4 ppb, higher than the overall long-term average of 7.2 ppb. Models suggest that sediment PCB concentrations must decline to about 1 ppb for concentrations in sport fish to fall below the threshold of concern for human health. Suisun Bay dipped below this value in 2006 (0.8 ppb), but averaged 2.0 ppb in 2011.

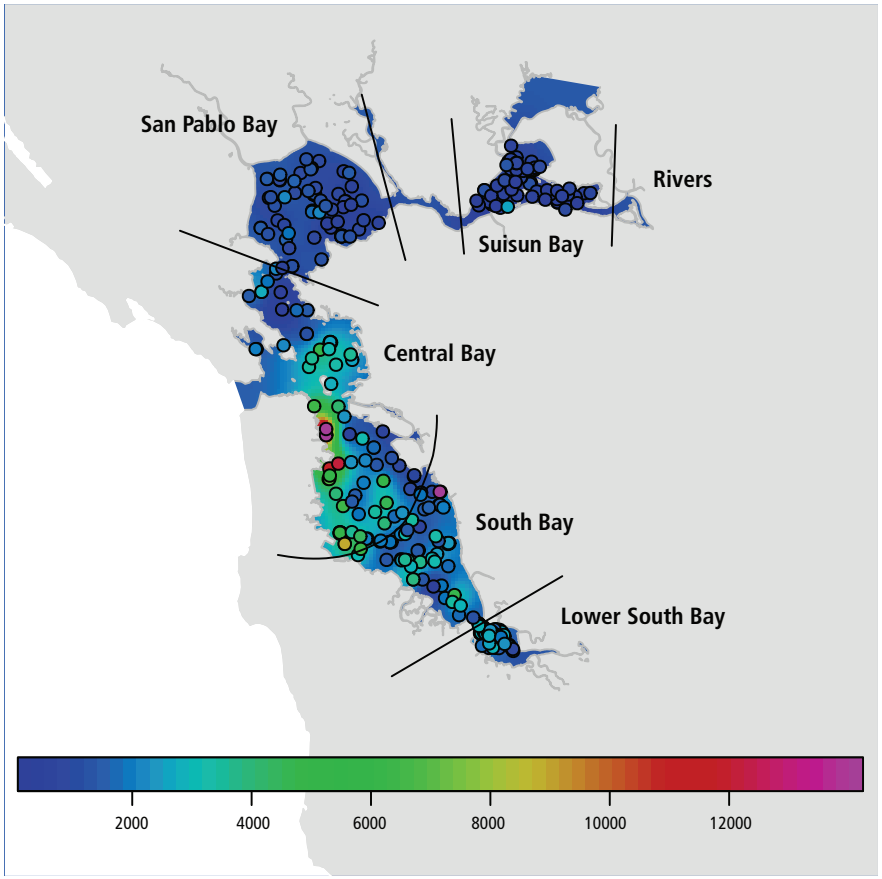
Footnote: Contour plot based on 329 RMP data points over nine rounds of dry season sampling from 2002-2011 (data from a wet season sampling in 2010 are excluded). The maximum concentration was 30 ppb in South Bay in 2008. Colored symbols on map show results for samples collected in 2011. Circles represent random sites. Diamonds represent historic fixed stations. Trend plot shows annual Bay-wide averages. Red circle on trend plot indicates a wet season sample; other samples were dry season. Concentrations presented on a dry weight basis.

PCB concentration map, showing all of the individual data points

Status and Trends

Sum of PAHs in Sediment (ppm)





Average PAH concentrations in sediment have been highest along the southwestern shoreline of Central Bay. Central Bay has had the highest average concentration (4.0 ppm) of any Bay segment. South Bay had the next highest average concentration (2.4 ppm), followed by Lower South Bay (1.9 ppm), San Pablo Bay (1.0 ppm), and Suisun Bay (0.5 ppm). The Bay-wide average in 2011 was 2.1 ppm, slightly below the long-term average of 2.6 ppm. The high annual average dry season concentrations observed in 2008 and 2009 were largely driven by a few unusually contaminated sites sampled in those years. The maximum concentration was 43 ppm at a site on the southwestern Central Bay shoreline in 2009. Eight of the ten highest samples in the ten-year period were from Central Bay.

PAH concentration map, showing all of the individual data points

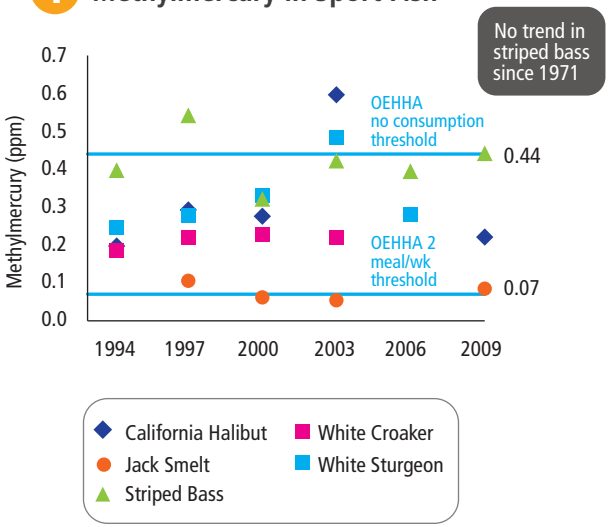
Footnote: Contour plot based on 424 RMP data points collected over nine rounds of dry season sampling from 2002-2011 (data from a wet season sampling in 2010 are excluded). Colored symbols on map show results for 2011. Circles represent random sites. Diamonds represent historic fixed stations. Trend plot shows annual Bay-wide averages. Red circle on trend plot indicates a wet season sample; other samples were dry season. Concentrations presented on a dry weight basis.

Screening a sediment sample for benthic invertebrates. Photograph by Thomas Jabusch.

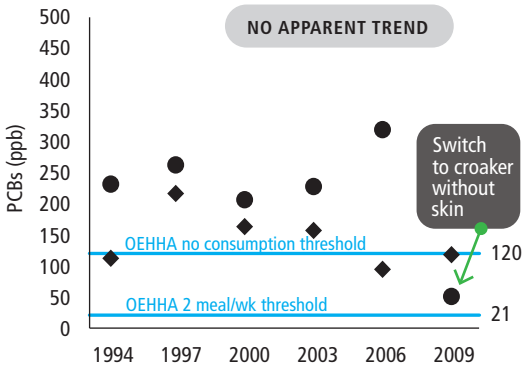
Trends at a Glance

Toxics and Bacteria

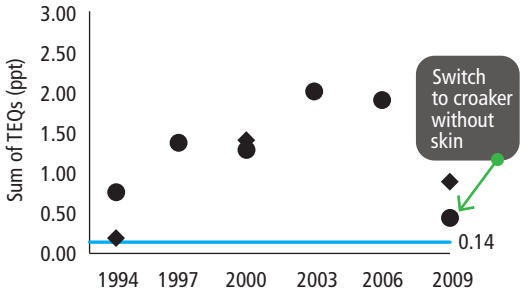
1 Methylmercury in Sport Fish



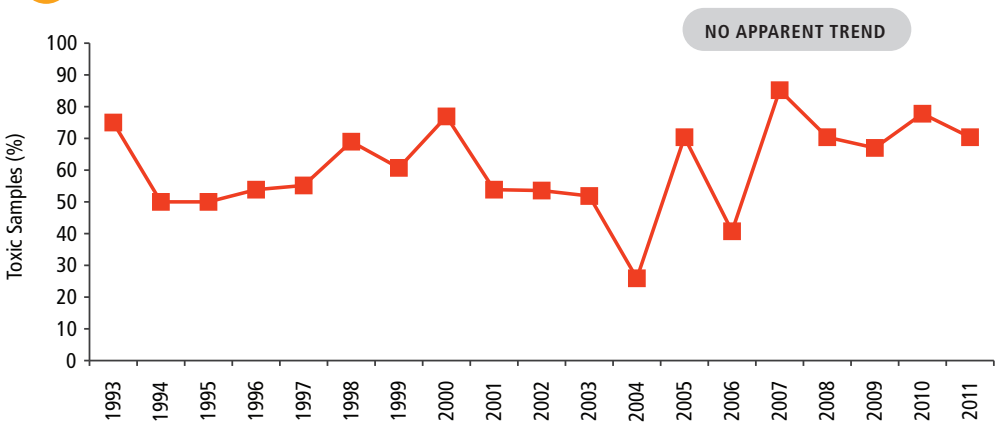
2 PCBs in Sport Fish



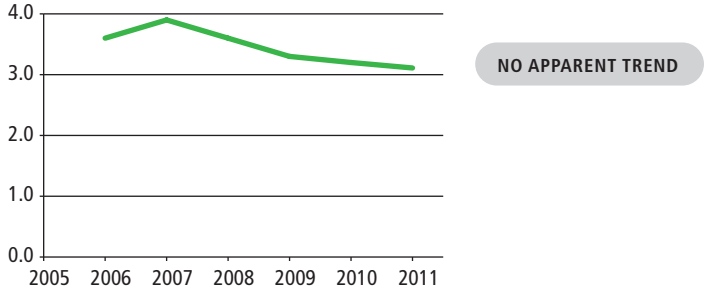
3 Dioxins in Sport Fish



4 Percent Toxic Sediment Samples



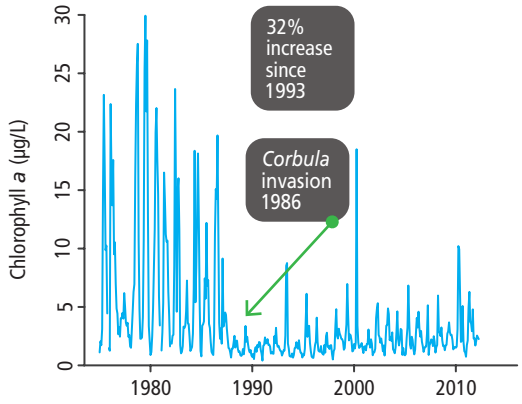
5 Beach Report Card Grades



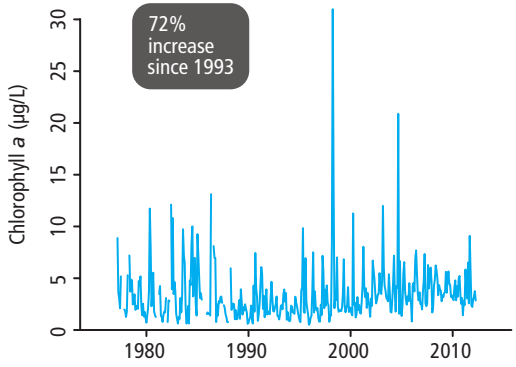
See page 55 for Graph Details

Chlorophyll and Dissolved Oxygen

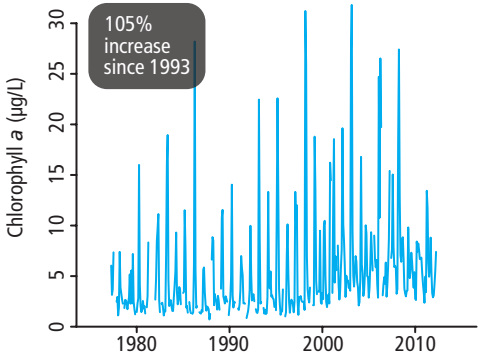
1 Chlorophyll in Suisun Bay



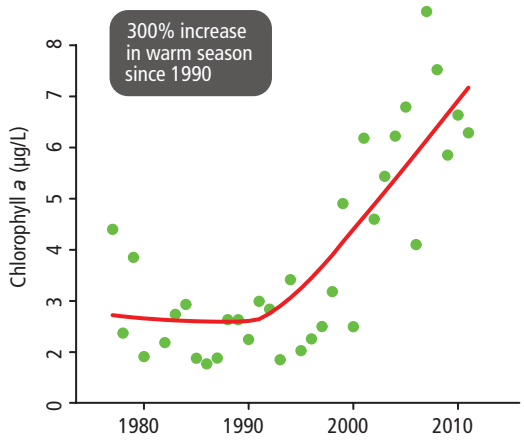
2 Chlorophyll in San Pablo Bay



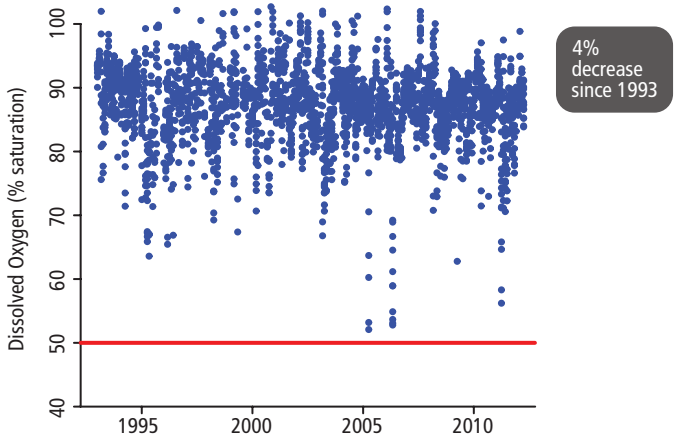
3 Chlorophyll in South Bay



4 Summer Chlorophyll in South Bay



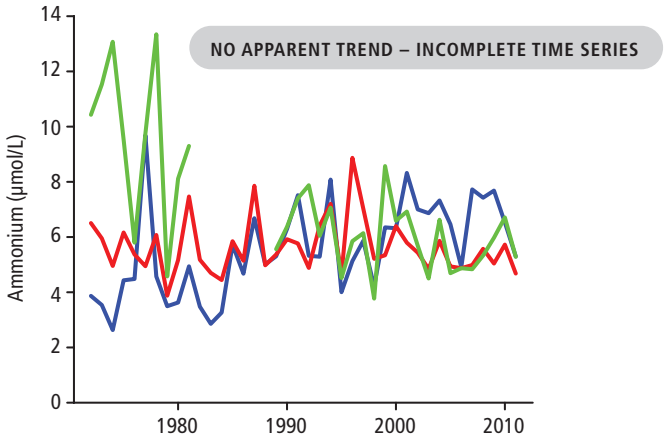
5 Bottom Dissolved Oxygen in South Bay

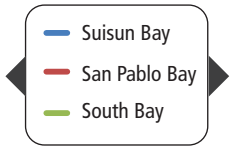


See page 55 for Graph Details

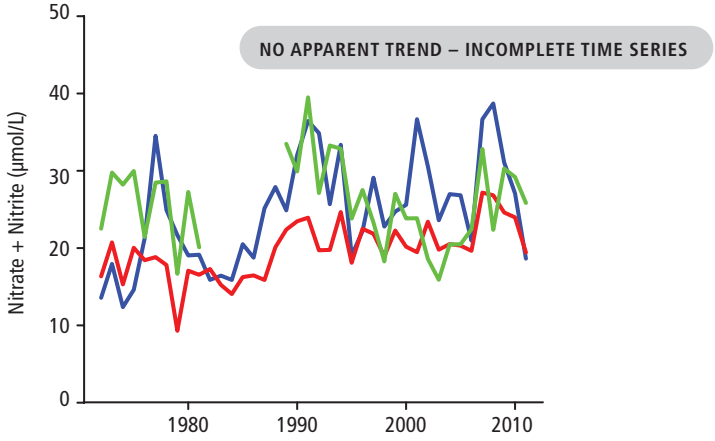
Nutrients and Sediments

1 Ammonium

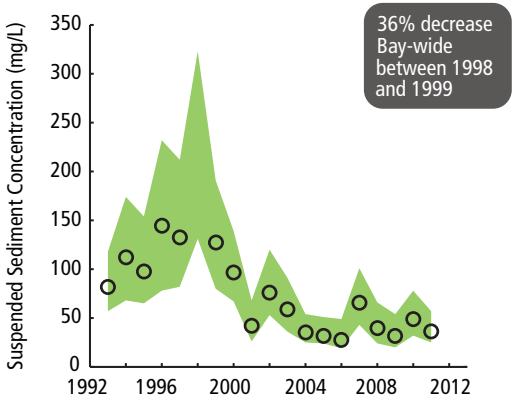




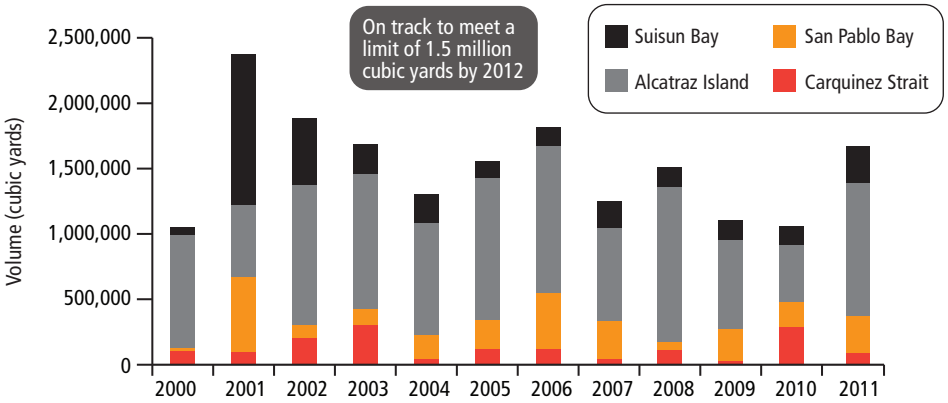
2 Nitrate and Nitrite



3 Suspended Sediment



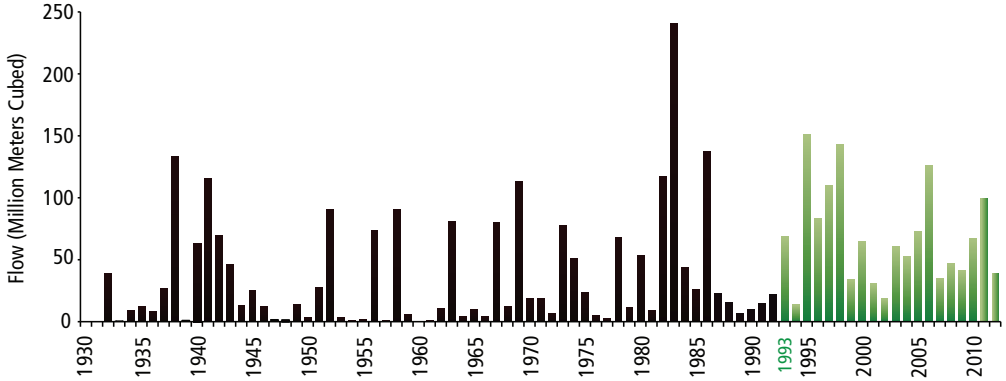
4 In-Bay Disposal of Dredged Material



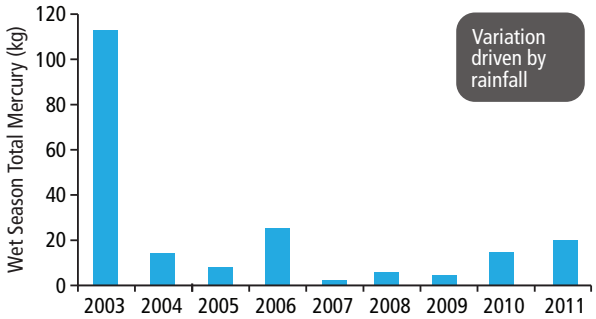
See page 55 for Graph Details

Flows and Loads

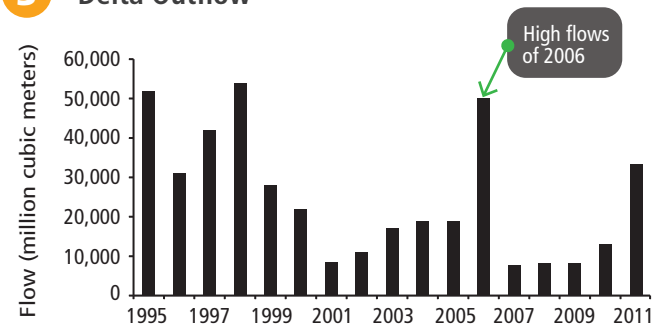
1 Guadalupe River Flow



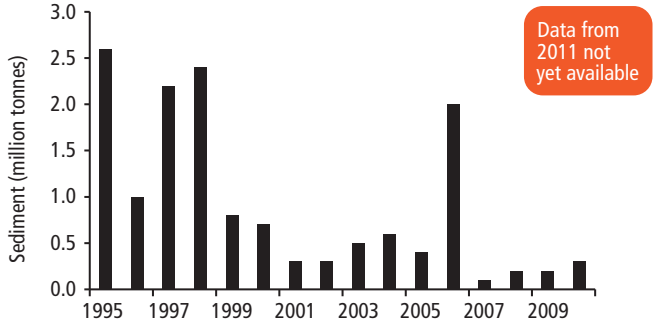
2 Guadalupe River Mercury Load



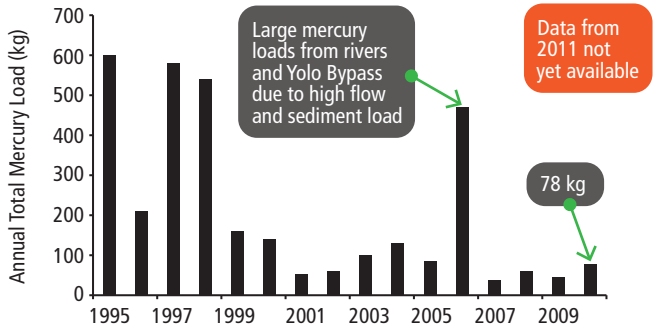
3 Delta Outflow



4 Delta Sediment Load



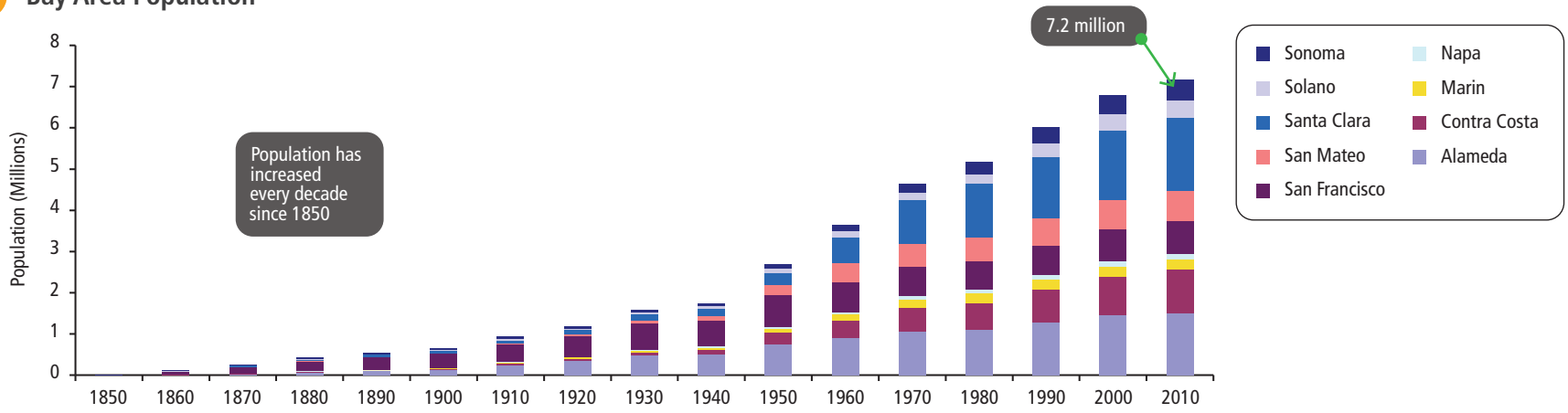
5 Delta Mercury Load



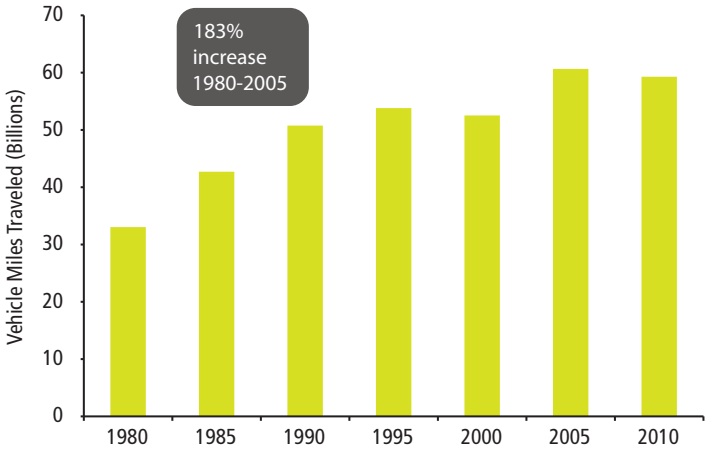
See page 55 for Graph Details

Human Presence

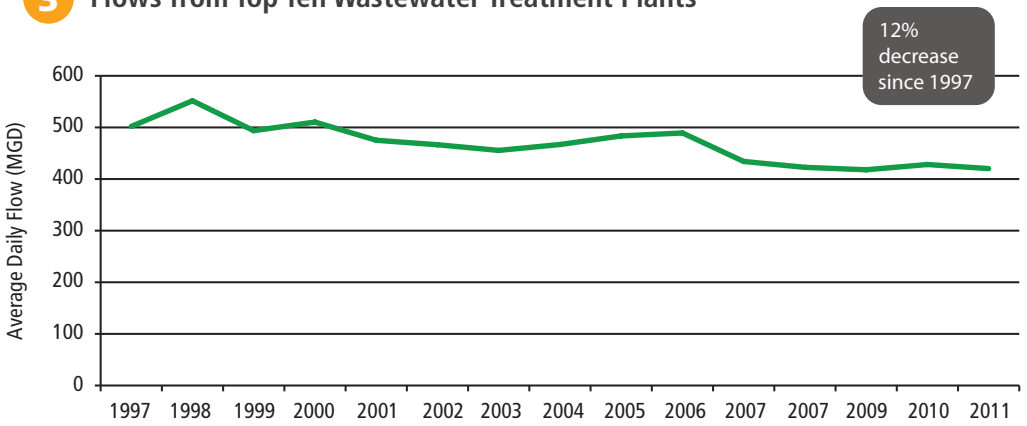
1 Bay Area Population



2 Bay Area Vehicles Miles Traveled



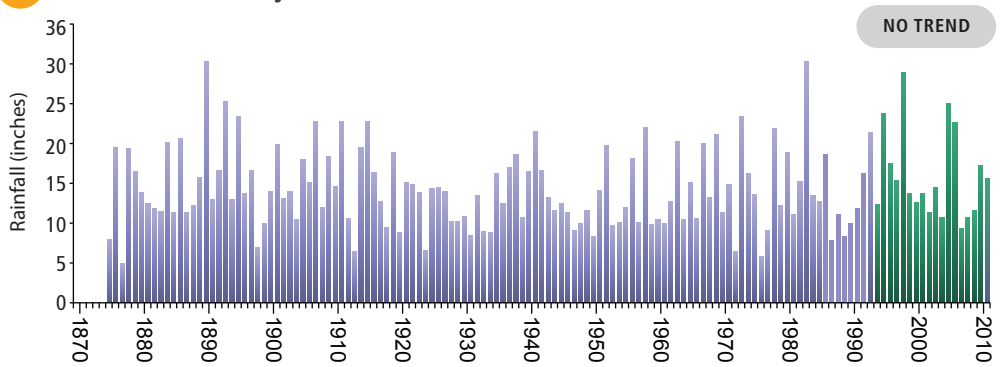
3 Flows from Top Ten Wastewater Treatment Plants



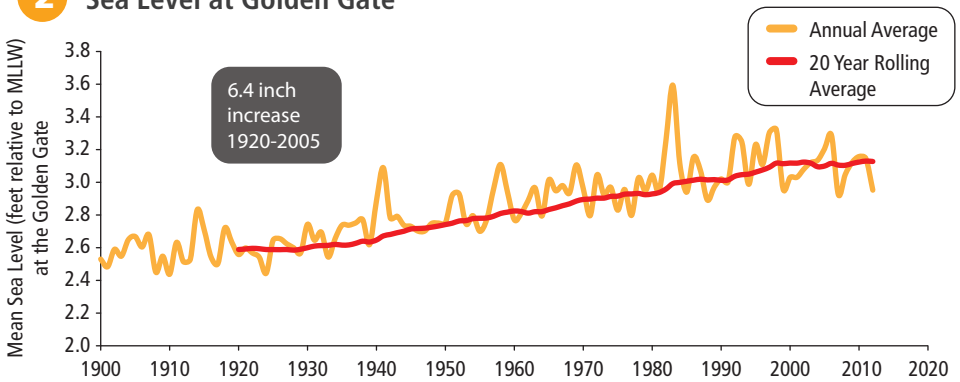
See page 55 for Graph Details

Climate and Habitat

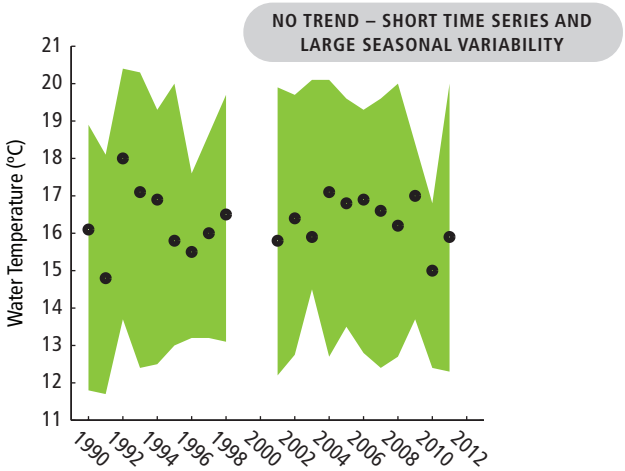
1 Rainfall in the Bay Area



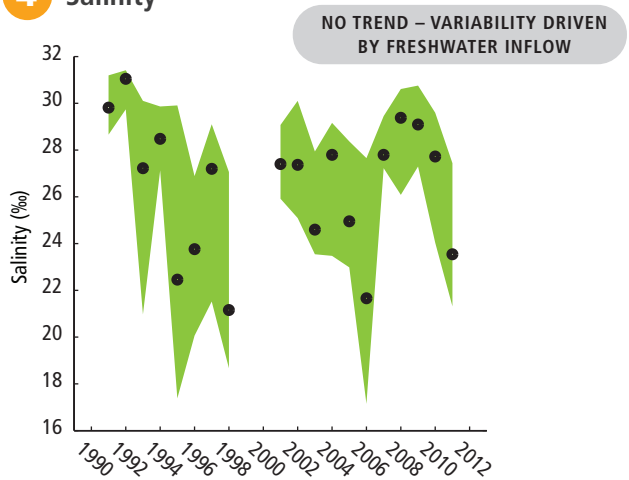
2 Sea Level at Golden Gate



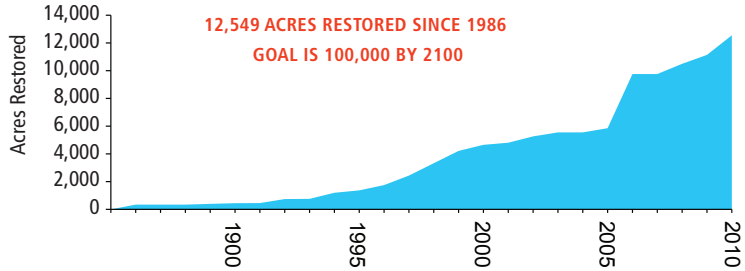
3 Water Temperature



4 Salinity



5 Restored Wetland Opened to Tidal Action

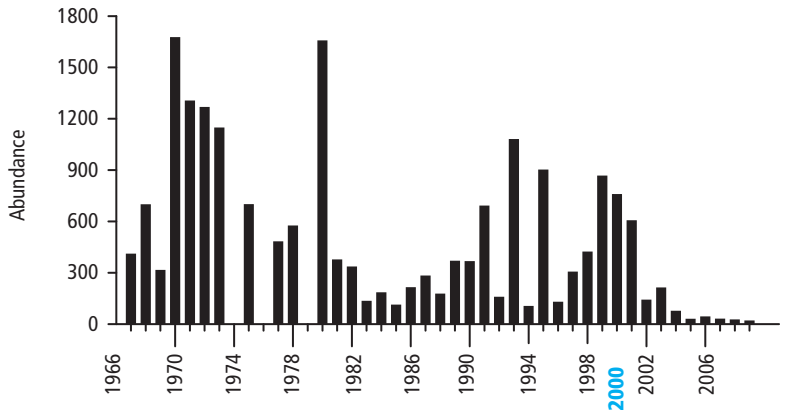


See page 55 for Graph Details

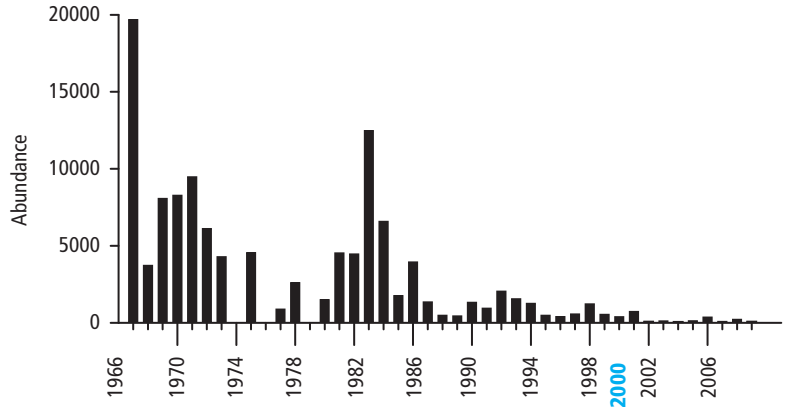
Populations

Pelagic Organism Decline

Delta Smelt

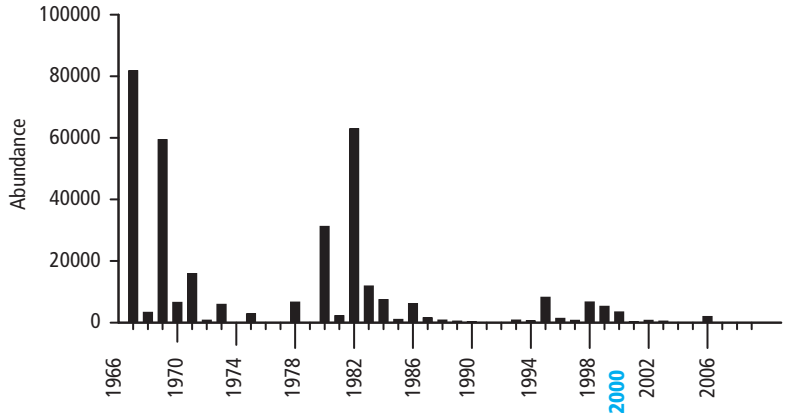


Striped Bass

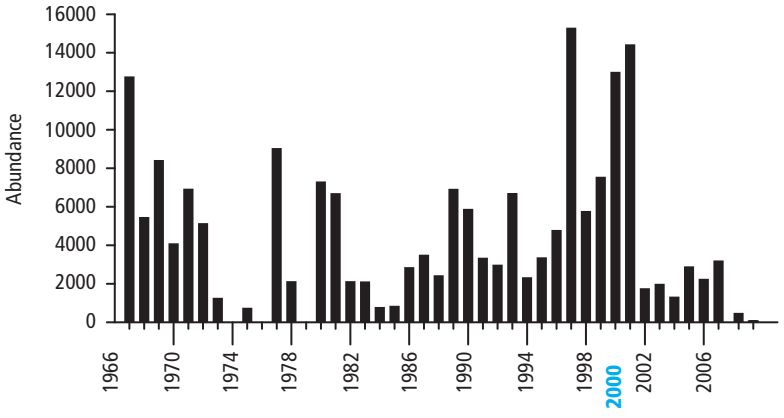


All species have been near record lows since 2002

Longfin Smelt



Threadfin Shad



See page 55 for Graph Details

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1) Bay-wide average methylmercury concentrations. Averages for striped bass based on concentrations for individual fish normalized to 60 cm. The no consumption advisory tissue level for mercury is 440 ppb, and the two serving advisory tissue level is 70 ppb.

2) Bay-wide average PCB concentrations. The no consumption advisory tissue level for PCBs is 120 ppb, and the two serving advisory tissue level is 21 ppb. White croaker were analyzed without skin in 2009, and with skin in previous years.

3) Bay-wide average dioxin TEQ concentrations. The San Francisco Bay Water Quality Control Board has developed a screening value for dioxin TEQs of 0.14 parts per trillion (ppt). White croaker were analyzed with skin from 1994-2006, and without skin in 2009.

4) Sediment samples are tested using amphipods and mussel larvae.

5) Average of Bay Area summer beach season (April-October) grades from Heal the Bay's annual beach report card.

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Data from USGS: sfbay.wr.usgs.gov/access/wqdata. Data from prior to 1969 from USGS. Data collected monthly at fixed stations along the spine of the Bay. Data for stations D10, D8, D7, D6, and D41 from IEP: http://www.water.ca.gov/bdma/meta/Discrete/data.cfm

1) Chlorophyll a, averaged over top 3 meters and all stations, in Suisun Bay (stations D10, D8, D7, D6, s4, s5, s6, and s7).

2) Chlorophyll a, averaged over top 3 meters and all stations, in San Pablo Bay (stations D41, s11, s12, s13, s14, and s15).

3) Chlorophyll a, averaged over top 3 meters and all stations, in South Bay (stations s21, s22, s23, s24, s25, s26, s27, s28, s29, s30, s31, s32, and s33).

4) Chlorophyll a in South Bay, averaged over top 3 meters, all stations, and June-October season for each year. Trend line is a smoothed fit.

5) Minimum dissolved oxygen percent saturation from each South Bay station, averaged over all stations. Minimum dissolved oxygen values typically occur at or near the bottom. Horizontal line indicates 50% saturation.

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1 and 2) Data from USGS: sfbay.wr.usgs.gov/access/wqdata

3) Suspended-sediment concentration, Dumbarton Bridge, 20 feet below mean lower low water. Based on 15-minute data collected by the U.S. Geological Survey (Buchanan and Morgan 2010).

4) Data from the U.S. Army Corps of Engineers.

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1) Data from the U.S. Geological Survey. Data for all graphs are for water years (Oct 1 to Sep 30).

2) Total loads for each water year. Additional matching funds for this study provided by the CEP, USACE, SCVWD, and SCVURPPP.

3) Daily average Delta outflow from DAYFLOW. DAYFLOW data are available from the California Department of Water Resources (www.water.ca.gov/dayflow/).

4) Total sediment loads for each water year. Loads based on continuous measurements taken at Mallard Island by USGS (http://sfbay.wr.usgs.gov/sediment/cont_monitoring/).

5) Total loads for each water year. Loads from 2002–2006 are based on field data. Loads for earlier and later years are estimated from relationships observed between suspended sediment and mercury in 2002–2006.

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1) Data from the Association of Bay Area Governments and U.S. Census Bureau. http://census.abag.ca.gov/counties/counties.htm

2) Data from Caltrans: http://traffic-counts.dot.ca.gov/

3) Data provided by the ten largest municipal wastewater dischargers to the Bay: San Jose, East Bay Dischargers, East Bay Municipal Utility District, San Francisco, Central Contra Costa, Palo Alto, Fairfield-Suisun, South Bayside System Authority, San Mateo, Vallejo.

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1) Annual rainfall measured at San Jose shown as index for Bay Area rainfall. These data are for climatic years (July 1 to June 30 with the year corresponding to the end date). Source: Jan Null, Golden Gate Weather Services

2) Data from National Oceanic and Atmospheric Administration: http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=19000520&edate=20110521&wl_sensor_hist=W5&relative=&datum=6&unit=1&shift=g&stn=9414290+San+Francisco%2C+CA&type=Historic+Tide+Data&format=View+Data

3) Water year median water temperature and interquartile range, San Mateo Bridge, 4 feet below mean lower low water. From 15-minute data collected by the U.S. Geological Survey (Buchanan 2009). 1999-2000 not shown because data were temporarily not collected during bridge construction. Some variation is caused by different periods of missing data.

4) Same information as #3. Salinity reflects freshwater inflow to the Bay with lower values for higher inflows. Ocean water has a salinity of 35.

5) Data from the California Wetlands Portal (www.californiawetlands.net/tracker/).

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All data from: Baxter, R. et al. 2010. Interagency Ecological Program 2010 Pelagic Organism Decline Work Plan and Synthesis of Results. http://www.water.ca.gov/iep/docs/FinalPOD2010Workplan12610.pdf

Labelling a sample vial.
Photograph by Linda Wanczyk.

GLOSSARY

ATL	Advisory tissue level
BACWA	Bay Area Clean Water Agencies
CECs	Contaminants of emerging concern
CEP	Clean Estuary Partnership
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved oxygen
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
RMP	Regional Monitoring Program
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PBDEs	Polybrominated diphenyl ethers
PFOS	Perfluorooctane sulfonate
POTW	Publicly-owned treatment works
ppb	Parts per billion
ppm	Parts per million
PPCPs	Pharmaceuticals and personal care products
SCVURPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SCVWD	Santa Clara Valley Water District
SQOs	Sediment quality objectives
SSC	Suspended sediment concentration
TEQs	Toxic equivalents
TMDL	Total maximum daily load
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WWTP	Wastewater treatment plant

America's Cup. Photograph by Burt Sedlak.

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View of the Mothball Fleet from the R/V Turning Tide.
Photograph by Thomas Jabusch.

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