2012

Annual Monitoring Results

A REPORT OF THE REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN THE SAN FRANCISCO BAY

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1. Introduction

Program Structure and Objectives

The Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) is the primary source for long-term contaminant monitoring information for the Bay. The RMP is an innovative and collaborative effort among the scientific community, the San Francisco Bay Regional Water Quality Control Board (Water Board), and the regulated discharger/dredging community. The Program was initiated by the Water Board as a pilot study in 1989 and has been collecting water, sediment, and bivalve tissue data since 1993. The RMP's annual budget is currently approximately $3.4 million, primarily funded through wastewater discharge and dredging permits issued by the Water Board (refer to *Appendix 1* for a current list of Program participants). The Status and Trends portion of the Program includes long-term monitoring of the Bay, while Special Studies change annually in response to changing management priorities and stakeholder needs.

The RMP is overseen by the Steering Committee (SC), the Technical Review Committee (TRC), and five workgroups, which consist of technical representatives from the Regional Board and discharger groups, scientists who are currently studying the Bay, invited scientists who are internationally recognized experts in their field, and federal and state regulators. The TRC oversees the activities of the workgroups and the technical content of the RMP as a whole. The SC determines the overall budget, allocation of Program funds, tracks progress, and provides direction to the Program from a manager's perspective. The five workgroups, the Sources, Pathways and Loadings Workgroup, the Exposure and Effects Workgroup, the Contaminant Fate Workgroup, the Emerging Contaminants Workgroup, and the Sport Fish Workgroup directly guide planning and implementation of Special Studies and provide input on relevant aspects of the annual RMP Status and Trends monitoring. These workgroups meet typically one to two times per year to review progress and make recommendations. In 2009, strategy documents and long-term work plans were developed that articulated the priority questions to be answered and longer-term information needs. Strategy documents have been developed for a number of topics including: small tributaries, modeling, mercury, polychlorinated biphenyls (PCBs), dioxins and nutrients. RMP workgroups have also developed long-term plans for studies of emerging contaminants and contaminant exposure and effects. These strategy documents and work plans lay the foundation for future monitoring. These information needs and priorities have been summarized in the RMP Multi-Year Plan (RMP 2014).

The RMP management questions were revised in 2007 as part of the RMP's Five-year Program review process and refined and approved by the SC and TRC in 2008. The current Program uses the following management questions to guide changes in the Status and Trends monitoring elements and to prioritize which Special Studies to fund:

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?

    a. Which chemicals have the potential to impact humans and aquatic life and should be monitored?

    b. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?

    c. What are appropriate guidelines for protection of beneficial uses?

    d. What contaminants are responsible for observed toxic responses?

2. What are the concentrations and masses of contaminants in the Estuary and its segments?

    a. Do spatial patterns and long-term trends indicate particular regions of concern?

3. What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?

    a. Which sources, pathways, and processes contribute most to impacts?

    b. What are the best opportunities for management intervention for the most important contaminant sources, pathways, and processes?

    c. What are the effects of management actions on loads from the most important sources, pathways, and processes?

4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?

    a. What are the effects of management actions on the concentrations and mass of contaminants in the Bay?

    b. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?

5. What are the projected concentrations, masses, and associated impacts of contaminants in the Bay?

    a. What patterns of exposure are forecast for major segments of the Bay under various management scenarios?

    b. Which contaminants are predicted to increase and potentially cause impacts in the Bay?

Status and Trends monitoring characterizes water and sediment quality and contaminants in water, sediment, and tissue in the Bay. The Water Board uses Status and Trends data for regulatory purposes, such as evaluating the Estuary for 303(d) listing, calculating National Pollutant Discharge Elimination System (NPDES) permit conditions, estimating Total Maximum Daily Loads (TMDL), and evaluating whether management actions are successful in reducing contaminant loads to the Bay through modeling. For questions regarding the RMP Status and Trends contact Meg Sedlak, meg@sfei.org.

Status and Trends monitoring includes water, sediment, bivalves, sport fish, and bird eggs. In 2011 the Program evaluated the data collected to date under Status and Trends, the questions that this element of the Program were attempting to answer and the frequency of monitoring that was needed. Based on this review, the SC and TRC recommended that the frequency of Status and Trends monitoring for sediment be reduced to biennial and water sampling be reduced to biennial for inorganics and every four years for organics. The monitoring will be staggered so for any given year the RMP will be on the water collecting some matrix. In 2012, sediment monitoring occurred in April during the wet season and collection of bivalve samples occurred in September; water monitoring was last conducted in 2011 and will occur next in 2013. A more detailed description of the latest Status and Trends monitoring design is presented below.

- Water monitoring occurs biennially during the dry season, typically in August or September, for analysis of water quality, trace metals and ancillary parameters. Organic parameters are sampled every four years and were last collected in 2011. Water toxicity is monitored on a five-year cycle and was last conducted in 2011. For details on the 2011 water sampling event see the Water Chapter in the 2011 AMR or visit the Status and Trends web page.

- Sediment monitoring occurs biennially in alternating wet (winter) and dry (late summer) seasons for the analysis of trace metals, trace organics, ancillary parameters, and sediment toxicity. A reduced number of stations (27) are sampled in the wet season; 47 stations are sampled in the dry season. For details on the 2012 wet season sediment sampling event see the Sediment Chapter or visit the Status and Trends web page.

- The RMP's bivalve bioaccumulation monitoring effort augments the long-term monitoring effort started in the early 1980s by the State Mussel Watch Program. The current monitoring design includes analysis of trace organics biennially and trace elements every 6 years. Bivalves were last analyzed for both trace element and trace organic parameters in 2008. Trace organics concentrations were measured in bivalves in 2012. Refer to the Bivalve Chapter or visit the Status and Trends web page.

- Benthic community assessments were added to the RMP Status and Trends program in 2008 as part of the State's Sediment Quality Objectives (SQO) methodology. The SQO methodology evaluates sediment quality using a triad approach with three lines of evidence (i.e., benthos, sediment chemistry and sediment toxicity) to conduct sediment assessments. In 2012, benthos samples were collected at all 27 RMP sediment sampling sites which consisted of 20 random sites and 7 historic sites.

- The Sport Fish Contamination Study screens fish tissue for contaminants of concern to human health. Sport fish sampling is conducted on a five-year cycle. Sport fish sampling includes evaluation of key fish species for long-term trend assessment, combined with follow-up sampling of additional species. The 2009 RMP sport fish sampling was part of a two-year statewide evaluation of bioaccumulation in sport fish along the entire coast of California by the State Water Board's Surface Water Ambient Monitoring Program (SWAMP). Year 1 of the Program focused on the Southern California Bight and the northern California coast near San Francisco Bay; Year 2 focused on the central coast and remaining locations along the northern California coast. A similar sampling design to that used by the RMP for sampling the San Francisco Bay was used for the entire State, allowing comparison of RMP data to results for similar species across California. The results from sampling popular sport fish species for mercury, PCBs, organochlorine pesticides, and Polybrominated Diphenyl Ethers (PBDEs) in 1994, 1997, 2000, 2003, 2006, and 2009 at several fishing locations are available via the Contaminant Data Display and Download tool (CD3) on the RMP web site and in summary reports. For more information visit the Sport Fish Monitoring Report page.

- The United States Geological Survey (USGS) has collaborated with the RMP since the beginning of the Program. As in prior years, the USGS continued ongoing studies that address basic hydrographic and sediment transport processes.

  The Hydrography and Phytoplankton study collects monthly water quality measurements in the Estuary's deep channels from the Lower South Bay to the confluence of the Sacramento and San Joaquin Rivers. Details on this study can be found on our web site. For more information refer to the *2009 Pulse of the Estuary* article Recent Trends of Phytoplankton Increases in San Francisco Bay and the *2011 Pulse of the Estuary* article A growing concern: Potential Effects of Nutrients on Bay Phytoplankton, as well as presentations from the 2011 Nutrient Workshop.

  The Sediment Dynamics in San Francisco Bay study examines the role of several physical factors controlling suspended sediment concentrations in the Estuary for a variety of hydrologic, tidal, and wind conditions and generates time series measurements for calibration and validation of sediment transport models. Time series measurements of suspended sediment concentrations are collected at six sites using optical backscatter sensors deployed at mid-depth and near the bottom. Details on this study can be found on our web site. For more information refer to the *2003 Pulse of the Estuary* article Sediment Dynamics Drive Contaminant Dynamics and the *2009 Pulse of the Estuary* article Suspended Sediment in the Bay: Past a Tipping Point.

- Triennial bird egg monitoring (cormorant and tern) was most recently conducted in 2012. This element of the Status and Trends Program documents spatial patterns of contaminant uptake into the food web and trends in biota over time. Cormorant and tern bird egg monitoring was included as part of the Status and Trends Program in 2008, with triennial sampling beginning in 2009. Cormorant eggs are analyzed for mercury, selenium, PBDEs, perfluorinated compounds, PCBs, dioxins, and pesticides. Tern eggs are analyzed for mercury, selenium and PBDEs.

In addition to these elements, various Special Studies are conducted annually. Special Studies are designed to assess new techniques for monitoring contaminants, provide information to address priority management needs or assess contaminant effects on biota in the Estuary. Special Studies also address specific scientific issues that the SC, TRC, or Water Board identify for further study. Special Studies conducted by the RMP in 2012 are discussed later in this chapter. A summary of previous studies conducted by the RMP can be found by reading previous publications of the Annual Monitoring Results report. Details on the study development and selection processes can be accessed via the Selection Process web page.

The RMP synthesizes and distributes the results of our monitoring and studies through conferences, workgroups, literature reviews, technical reports, newsletters, and the *Pulse of the Bay*. This *Annual Monitoring Results* report focuses on the Status and Trends Program. The RMP publishes separate technical reports, which are available on the web at RMP Documents and Reports. For more information on the RMP, refer to the RMP home page.

Changes to the Status and Trends Program

There have been numerous changes over the years to the RMP in order to better address management questions and adapt to changing regulatory and scientific information needs. Table 1.1 lists changes to the Program during 2012, including changes to the sampling design, sampling target parameters, availability of data, sampling stations, laboratories conducting analyses, and laboratory methods. A table of changes to the RMP since 1993 can be found in Appendix 8. Tables of reported analytes by matrix for the long-term Status and Trends monitoring of water, sediment, and bivalve tissue beginning in 1993 can be found in Appendices 5-7.

Table 1.1. Summary of Changes for the RMP Status and Trends Program, 2012

Action Codes: A= Analyte added or removed from sampling design; D= Data rejected or not available/data comparability issues; L= Change in laboratory conducting analysis or in laboratory methods; P= Change in Program/sampling design; S= Station added or removed; T= Trends analysis performed.

Action Code	Year	Action	Detail/Rationale
A	2012	Updated the parameter name for 'Phosphate as P' to 'Orthophosphate as P'.	Orthophosphate as P specifically indicates the type of phosphate being measured, removing all ambiguity as to what was measured.
P	2012	In 2012 the sampling design was modified to alternate water and sediment to biennial sampling, e.g., 2012=sed, 2013 = water, 2014 = sed. Alternating between seasons (wet and dry sampling) will continue to occur for sediment (2012 Sed = wet, 2014 sed = dry).	The purpose for alternating seasons is to assess the potential for increased toxicity in the winter months.
L	2012	Beginning in 2012, EBMUD will increase the batch size to reduce the number of QA samples they need to analyze.	Change in laboratory methodology.
P	2012	Whole bivalves will no longer be stored in short term archive storage	Whole bivalves were subject to prevalent degradation. Homogonized bivalves will be stored in long term archive storage at NIST and if enough sample material remains, aliquots will be kept in short term storage
L	2012	AXYS analytical samples that have been qualified in the LABQA Code field with 'G' - lock mass interference present, are given a QA code 'LRJA' - Data rejected - Analyte positively identified but quantitation is an estimate, flagged by laboratory.	This flag alerts data users to an increased uncertainty in the value where the severity of the impact cannot be categorized. This change was applied beginning with WY2012 POC data and 2012 RMP data.
D	2012	1993-03 sediment Mn results have been updated to have a QACode of "VRVQ", a CompCode of "Rej", and a DisplayCode of "-40".	An external user noticed that the numbers looked unusually high for two stations, suspecting a subscription error. Since we do not have the raw results to verify that unit conversion calculations were done correctly and because the numbers are so much different than other years (about 10X higher than all other sediment Mn numbers reported by the same lab) the QA officer decided to flag and censor these results.

Summary of Changes to the Sampling Design for Water and Sediment

2012 was the tenth year of the probabilistic sampling design for long-term water and sediment monitoring, which employs the EPA's Generalized Random Tessellation Stratified (GRTS) sample design (Stevens, 1997; Stevens and Olsen, 1999; Stevens and Olsen, 2000). This type of design is appropriate for addressing the RMP's overarching goals to collect data and communicate information about water quality in San Francisco Bay in support of management decisions. An important advantage of random station selection is that estimates of regional condition derived from a probabilistic survey will have a known level of uncertainty associated with them. Prior to 2003, a targeted sampling design was used. The targeted stations were purposefully located along the central axis of the Bay as far from anthropogenic sources as possible to monitor 'background' concentrations of pollutants of concern. A subset of those historic water and sediment stations from the original RMP monitoring design have been retained to provide continuity in the long-term monitoring Program.

The RMP water and sediment monitoring stations are located in six hydrographic regions of the Estuary. Random design stations are located in five of those regions: Suisun Bay, San Pablo Bay, Central Bay, South Bay, and Lower South Bay. Historic stations are also located in each of those five regions, and additionally at the confluence of the Sacramento and San Joaquin Rivers in the freshwater rivers region of the Estuary. The sampling frames for water and sediment monitoring (the area within which stations were allocated), are the three-foot and one-foot contours of the Estuary at mean lower low water, respectively (based on the National Oceanic and Atmospheric Administration's (NOAA) NAD-83 bathymetry coverage). About seventy-two random water and sediment stations were allocated into the hydrographic regions. Each year, a subset of the water stations are sampled in sequential order, increasing the spatial density of monitoring over time. For sediment, a station re-visit schedule was incorporated into the design to better evaluate trends over time (Lowe et al. 2004).

The number of random design sites sampled in each region can change based on management decisions. The initial number of sites sampled in 2002 was based on a power analysis using existing, targeted site data and Water Board management priorities. A power analysis is generally used to evaluate the number of samples needed to detect a change in contaminant concentrations over time with a known level of statistical confidence. The initial random design recommended that 26 water and 40 sediment sites be monitored while maintaining a subset of 5 historic water sites and 7 historic sediment sites (a total of 31 water and 47 sediment sites). A second power analysis was conducted in 2006 using the random design data (Melwani et al. 2008). Based on those results for key contaminants of current concern and discussions with the RMP oversight committees the number of water sites was reduced from 31 sites to 22 sites per year beginning in 2007, while the number of sediment sites was maintained at 47 sites per year.

In 2007/2008, a new design review was undertaken by the TRC. After a statistical review and consultation with the RMP participants, the RMP decided to add wet season sediment sampling back into the Status and Trends Program and recommended that wet season sediment sampling alternate with dry season sediment sampling. The addition of wet season sampling (typically done in February) provides monitoring of contaminants that have higher ambient concentrations during the winter when runoff increases. Dry season sampling continues to include eight random sites per region (n = 40). Wet season sampling includes four random sites per region (n = 20). Sampling of the historic stations did not change, and samples from these sites continue to be collected during each sampling event (maintaining one station per region plus the two Rivers stations (n = 7)). This change was first implemented in August/September 2009 (a dry season sampling year). The change in design necessitated an update from a five-year repeat sampling cycle to a six-year repeat sampling cycle to allow for balanced alternating

season sampling. See the Memorandum on our web page for more details. Sites sampled in 2012 are listed in Appendix 3 for sediment and bivalve sampling.

For more information on the Status and Trends monitoring design, refer to the following articles and technical reports: Power Analysis and Optimization of the RMP Status and Trends Program (Melwani et al., 2008), Re-design Process of the San Francisco Regional Monitoring Program for Trace Substances (RMP) Status and Trends Monitoring Component for Water and Sediment (Lowe et al., 2005), and the 2000 Pulse of the Estuary.

Summary of Changes to the Sampling Design for Bivalve Bioaccumulation Monitoring

The RMP's bivalve bioaccumulation monitoring effort augments the long-term monitoring effort started by the State Mussel Watch Program in the early 1980s. The current monitoring design includes the analysis of trace organics in bivalves biennially, and the analysis of trace metals every 6 years. In 2008 bivalves were analyzed for both trace metals and trace organic contaminants. In 2012, bivalves were only analyzed for trace organic contaminants; bivalve sampling for both trace organics and inorganics will occur again in 2014.

The bivalve bioaccumulation sample design remains a fixed sample design because deployment of caged bivalves requires secure moorings. Based on the findings from a series of Special Studies between 2000 – 2005, intended to improve technical aspects of the deployed bivalve bioaccumulation monitoring component of the RMP, several changes were made in 2003. These included:

1. Dropping three sites in the northern Estuary: Napa River (BD50), Petaluma River (BD15), and Horseshoe Bay (BC21) because only two to three sites were required per region to track long-term changes in contaminant concentrations.

2. Deploying only one bivalve species (*Mytilus californianus*). Because of the reduced salinity range of the study area due to the dropped sites, the Program was able to deploy one, fairly salinity tolerant bivalve species, which makes comparing bioaccumulation results between regions possible.

3. Deploying bivalves in cages, rather than mesh bags, reduces the loss of organisms through predation.

4. Discontinuing the bivalve maintenance cruise. This was discontinued in 2006 after a study conducted from 2002-2005 showed no significant difference in survival of bivalves in maintained and non-maintained cages.

Changes in Parameter Reporting

During 2010, the RMP began reporting results for all 209 PCB congeners. SFEI-generated Sums for 40, 208, and 209 PCBs are available through the RMP web tool, Contaminant Data Display and Download (CD3). The Sum of 40 PCBs includes the 40 historic target PCBs for the RMP. The Sum of 208 PCBs provides an index of the PCBs present in Aroclor mixtures. PCB 11 is excluded; it is abundant in some matrices but is derived from pigments and not Aroclors. PCB 11 does not have dioxin-like potency and has different sources than Aroclors. The Sum of 209 PCBs is provided solely for comparison to other studies that include all 209 congeners. SFEI does not recommend using this sum for comparison to any Aroclor-based thresholds (the TMDL target, OEHHA thresholds, etc.) - the Sum of 208 PCBs is better for that purpose.

RMP Workgroups

Five workgroups address the major technical subject areas covered by the RMP. Workgroups consist of local scientists, regulators, and stakeholders, with nationally recognized experts performing an advisory role. The workgroups directly guide planning and implementation of Pilot and Special Studies and provide input on relevant aspects of the annual RMP Status and Trends monitoring.

Sources Pathways and Loadings Workgroup

The Sources Pathways and Loadings Workgroup (SPLWG) was formed in 1999 to address the objective developed during the 1997 five-year Program review to "describe general sources and loadings of contamination to the Estuary" (Bernstein and O'Connor, 1997). The SPLWG makes recommendations for collection, interpretation, and synthesis of data on general sources and loadings of trace contaminants to the Bay. Their goal is to create a functional connection between the RMP and efforts to identify, eliminate, and prevent sources of pollution to the Bay. The SPLWG ensures that RMP projects and products are relevant and help to answer developing management questions in the context of Total Maximum Daily Loads (TMDLs) and attainment of water quality standards. For further information, see the SPLWG web page.

Contaminant Fate Workgroup

The Contaminant Fate Workgroup's (CFWG) objective is to improve our understanding of physical, chemical, and biological processes that redistribute and transform contaminants in the Bay, ultimately leading to exposure of biota. Through improved information on Bay processes, they aim to assist managers in directing limited resources and prioritizing actions for reducing negative impacts, both for new contaminants entering the system, as well as for legacy pollutants already in the Bay. See the CFWG web page for further information.

Exposure and Effects Workgroup

The Exposure and Effects Workgroup (EEWG) developed a five-year biological effects pilot study (the Exposure and Effects Pilot Study (EEPS)) that would help address beneficial use management questions developed by the Regional Board. At the end of the study, EEWG was incorporated into the RMP as a permanent workgroup. The EEWG continues to address the biological effects portions of the Status and Trends Program and Pilot and Special Studies. See the EEWG web page for more information.

Emerging Contaminants Workgroup

The Emerging Contaminants Workgroup (ECWG) evaluates the presence of emerging contaminants in the Bay, defined as chemicals that are not currently regulated, but believed to potentially pose significant ecological or human health risks (e.g., pharmaceuticals, flame retardants, and perfluorinated compounds). For additional information see the ECWG web page.

Sport Fish Workgroup

The Sport Fish Workgroup (SFWG) guides the effort to collect and analyze select species of sport fish for target parameters of concern (e.g., mercury, PCBs and dioxins) in the San Francisco Bay. The Sport Fish Study is a human health study and various thresholds are used to evaluate sport fish contaminant concentrations. For additional information visit the SFWG web page.

Strategy Development

In addition to the workgroups, teams from the workgroups and RMP stakeholders have been developing strategies for select issues that are of high priority to our stakeholders including dioxins, forecasting, mercury, PCBs, small tributary loading, and nutrients. A brief summary of strategies that have been completed are presented below. The crosswalk between the work plans and the strategies has been articulated in the Multi-year Plan for the RMP.

Dioxin Strategy

A Dioxin Strategy team was convened in September 2008 to discuss information gaps. At that time, a dioxin strategy plan was prepared including priority questions and a five-year plan. The following questions articulate the needs and priorities for obtaining information on dioxins in the Bay:

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 sediment 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?

For additional information contact Don Yee (don@sfei.org).

Mercury Strategy

The RMP Mercury Strategy was formed in 2008 to articulate key questions that scientists and managers need to answer for the best management of mercury in the Bay. The Mercury Strategy addresses five priority questions:

1. Where is mercury entering the food web?
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?

Studies supported by the Mercury Strategy team are discussed in detail in the Special Studies section of this chapter. For more information on the RMP Mercury Strategy and the methylmercury synthesis see this presentation by Jay Davis at the 2012 Annual Meeting.

For additional information, please contact Jay Davis (jay@sfei.org).

Forecasting Strategy

The Forecasting Strategy team was formed in 2009 to develop a capacity to predict the effect of different management alternatives on loads from watersheds, the recovery of contaminated areas on the Bay margin, threats from emerging contaminants, and the recovery of the Bay as a whole. The Forecasting Strategy team and the Contaminant Fate Workgroup identified the following priority questions:

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

For additional information, please contact Don Yee (don@sfei.org).

PCB Strategy

PCBs are a pollutant of high concern in San Francisco Bay. This strategy has been developed to ensure that the RMP is providing the information most urgently needed by managers to find remedies to the Bay's PCB problem. The following management questions have been articulated to identify the information most urgently needed as a basis for the decisions listed above.

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?

For more information on this, please contact the strategy lead, Jay Davis (jay@sfei.org).

Small Tributary Loading Strategy

The Small Tributaries Loading Strategy (STLS) is overseen by the Sources, Pathways, and Loadings Workgroup. The STLS focuses on loadings from small tributaries (the rivers, creeks, and storm drains that enter the Bay downstream of Chipps Island), in coordination with the Municipal Regional Permit for Stormwater (MRP). It aims to refine pollutant loading estimates for future TMDL and management decisions, identify the highest priority small tributaries for cleanup, and evaluate the best actions for small tributary management. The STLS team articulated the following high priority management questions:

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?

For additional information contact Lester McKee (lester@sfei.org).

Special Studies

Special Studies allow for adaptive management of the RMP by allowing for short-term projects based on the changing regulatory priorities, management of the Bay, and scientific understanding of the Bay. Summaries of past and current Special Studies can be found on our web site.

Special Studies

Special Studies augment Status and Trends monitoring by focusing on specific topics and by providing a proactive approach to addressing management goals and needs. They help the RMP address specific gaps in data, or management and scientific questions related to contaminants in the Bay. Special Studies may eventually be incorporated into the Status and Trends Program. For example, Special Studies identified and evaluated previously unknown organic contaminants and led to the addition of PBDEs to the RMP target analyte list to determine if they are prevalent in water, sediment, and tissue samples from the Bay. The following Special Studies were conducted in 2012:

- Dioxin Analysis in Bird Eggs, Storm water, and Sediment
- CEC Synthesis Report (Year 2) and Strategy
- Monitoring of Perfluorinated Compounds in SF Bay Biota
- Regional Loading Spreadsheet Model – Year 3
- Load Monitoring in Representative Watersheds
- POC Loads Monitoring – Land Use/ Source Area Specific EMC Development
- Sediment Quality Assessment of Toxic Hot Spots in SF Bay – Year 2
- Nutrient Strategy
- Nutrient Storm Water Sampling
- Modeling
- EEWG Moderate Toxicity and Benthic Assessment for Mesohaline Regions

Dioxin Analysis in Bird Eggs, Storm water, and Sediment

Contact: Don Yee (don@sfei.org)

San Francisco Bay was placed on the State of California's 303(d) list of impaired waters in 1998 as a result of elevated concentrations of dioxins and furans in fish. Since 1994, the RMP has monitored dioxin concentrations in sport fish; during that time period, dioxin concentrations have remained unchanged and often exceed human health thresholds. However, understanding of dioxin in the Bay is still limited. The RMP has conducted analyses of dioxin in sport fish, tributaries, surface water, shallow sediment and sediment cores in the past. This 2012 Special Study expanded the monitoring effort by analyzing dioxins in storm water samples from two urban tributaries (San Leandro Creek and Sunnyvale Channel East) and in cormorant eggs.

The tributary samples were collected in the winter of 2012 and the bird egg samples were collected in the spring of 2012. The results of the study were presented at the March 5, 2013 TRC meeting.

CEC Synthesis Report (Year 2) and Strategy

Contact: Rebecca Sutton (rebeccas@sfei.org)

Since 2006, the RMP has been collecting data on contaminants of emerging concern (CECs) to proactively identify unregulated chemicals that have the greatest potential to adversely affect the health of San Francisco Bay wildlife and humans that are linked to the Bay food chain. Over the past seven years, the RMP has conducted preliminary monitoring of pharmaceuticals and personal care products, perfluorinated chemicals, flame retardants, current use pesticides, and a variety of other CECs. The Emerging Contaminants Workgroup (ECWG) supported the completion of a summary document that synthesizes all CEC occurrence data for San Francisco Bay (including data collected by other research groups) and recommends next steps for CEC monitoring in the Bay. Upon completion of the synthesis, the ECWG called for the development of a strategy for how the RMP will address CECs.

The CEC synthesis, "Contaminants of Emerging Concern in San Francisco Bay: A Summary of Occurrence Data and Identification of Data Gaps" and the CEC Strategy, "Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations" were published in the fall of 2013.

Monitoring of Perfluorinated Compounds in San Francisco Bay Biota

Contact: Meg Sedlak (meg@sfei.org)

In previous studies, the RMP has identified elevated concentrations of perfluorinated compounds, specifically perfluorooctane sulfonate (PFOS), in apex predators from the South Bay. In 2006 and 2009, cormorant egg PFOS concentrations exceeded a predicted no effects threshold. In 2004, PFOS concentrations in seal blood were an order of magnitude higher than those observed at the reference site. This 2012 Special Study built on the two previous studies by reexamining perfluorinated compound concentrations in cormorant eggs and seals to determine if concentrations remain elevated. Small fish, water, and sediment sampling were also conducted to help identify the pathways of uptake.

The results from the 2004, 2006, and 2009 PFC sampling effort were summarized in the article "Perfluoroalkyl compounds (PFCs) in wildlife from an urban estuary" published by the Journal of Environmental Monitoring. The results of the 2012 monitoring effort will be published in February 2014.

Regional Loading Spreadsheet Model – Year 3

Contact: Lester McKee (lester@sfei.org)

The Regional Watershed Spreadsheet Model (RWSM) is being developed as a tool to refine annual regional contaminant load estimates and to assess how these loads might be reduced. The GIS-based model is being developed to calculate stormwater volumes and POC loads on a long-term average monthly basis. The RWSM will become a useful and cost-efficient tool for estimating regional scale watershed loads.

The RWSM is being developed over multiple years. In 2012, the focus was on further development of the hydrologic component of the model by refining the model's hydrology and land use calibration data sets.

The year two progress report, "Development of Regional Suspended Sediment and Pollutant Load Estimates for San Francisco Bay Area Tributaries using the Regional Watershed Spreadsheet Model (RWSM): Year 2 Progress Report" was published in 2012.

Load Monitoring in Representative Watersheds

Contact: Lester McKee (lester@sfei.org)

The Municipal Regional Permit for Stormwater (MRP) calls for better quantification of sediment and trace contaminant loads on both a watershed and regional basis. In response to the MRP, the RMP has been conducting tributary loading studies, using the turbidity surrogate method, in priority urban locations.

In 2010, the RMP conducted an evaluation of approximately 30 watersheds and identified 17 high priority watersheds that were subsequently monitored in 2011. Based on the 2011 sampling effort, the RMP's Small Tributaries Loading Strategy team decided to focus monitoring intensively on four Bay Area watersheds in 2012: Sunnyvale East Channel, Guadalupe River, Lower Marsh Creek, and San Leandro Creek. These watersheds were monitored for a variety of constituents including: PCBs, PAHs, PBDEs, pyrethroids, mercury, copper, selenium, suspended sediment, nitrate, and toxicity.

The results from the water year 2012 monitoring effort were published in the RMP Report "Pollutants of concern (POC) loads monitoring data progress report, water year (WY) 2012."

POC Loads Monitoring – Land Use/ Source Area Specific EMC Development

Contact: Lester McKee (lester@sfei.org)

The RWSM estimates annual regional contaminant loads by inputting rainfall, runoff coefficients, and land use based contaminant event mean concentrations (EMCs) data into the GIS model. Land use based contaminant EMCs are included because there is a statistical difference between contaminant loads from industrial, recreational,and open space land use classes.

The Small Tributaries Loading Strategy team is beginning to develop Bay Area specific land-based EMCs for priority pollutants. In 2012, the team performed the following tasks: conducted literature reviews to estimate EMC values based on soil type, land use, etc.; used the soil type EMCs to calibrate the suspended sediment RWSM; and developed GIS databases for proposed contaminant specific land uses or source areas.

Sediment Quality Assessment of Toxic Hot Spots in SF Bay – Year 2

Contact: Ellen Willis-Norton (ellenwn@sfei.org)

In 2009, the State Water Resources Control Board adopted Sediment Quality Objectives (SQOs) for marine (polyhaline) waters in Enclosed Bays and Estuaries. The SQOs are based on a triad evaluation of sediment chemistry, benthos, and sediment toxicity. In 2011, six sites were sampled in two previously identified hotspots, Mission Creek and San Leandro Bay.

In 2012, the SQO methodology was used to analyze the six samples and determine if the sites were still impacted. The SQO assessment results for the two creek channels were compared to 2011 and 2012 RMP Status and Trends data, for which SQOs were also performed. Comparing the study sites to those representing ambient conditions provided perspective about the respective ecological condition of sediment in the Estuary as a whole and near pollution sources. The results of the study were published in the RMP Technical Report "Applying Sediment Quality Objective Assessment Protocols to Two San Francisco Bay 303(d)-Listed Sites."

Nutrient Strategy

Contact: David Senn (davids@sfei.org)

San Francisco Bay has long been recognized as a nutrient-enriched estuary, but one that has historically proven resilient to the harmful effects of nutrient enrichment, such as excessive phytoplankton blooms and hypoxia. However, evidence is building that the historic resilience of the Bay to the harmful effects of nutrient enrichment is weakening. Therefore, the San Francisco Bay Regional Water Quality Control Board, in collaboration with Bay stakeholders, developed a San Francisco Bay Nutrient Strategy, a cost-effective program to generate the scientific understanding of nutrients in the Bay. The Nutrient Strategy will be used to support major management decisions and questions.

In 2012, the program developed a spatially and temporally explicit nutrient conceptual model; listed plausible future scenarios for the Bay based on changes in environmental factors or management scenarios; identified major knowledge gaps; and made preliminary recommendations for a nutrient monitoring program. Additionally, in 2012 and into 2013, the Nutrient Strategy team developed estimates of nutrient loads to the Bay, identified the data gaps that contributed the most uncertainty to the loading estimates, and determined the relative importance of nutrient sources including publically owned treatment works (POTW) discharges, stormwater discharges, flows from the Delta, exchange across the Golden Gate, and direct atmospheric deposition. The final task of the Nutrient Strategy team in 2012 was supporting the coordination of RMP-funded work with other nutrient related investigations in the Bay.

Both the Nutrient Conceptual Model and Quantifying External Loads reports will be published in the winter of 2014.

Nutrient Stormwater Sampling

Contact: David Senn (davids@sfei.org)

One of the key objectives of the Nutrient Strategy (see above) is quantifying nutrient loads to San Francisco Bay. Two potential sources of nutrient loads to the Bay are urban watershed runoff and riverine inputs. This study was completed by adding five nutrient parameters (nitrate, total

phosphorous, dissolved orthophosphate, ammonium, and total Kjeldahl nitrogen) to the Load Monitoring in Representative Watersheds study's analyte list.

Modeling

Contact: David Senn (davids@sfei.org)

Completing a nutrient model is another key objective of the Nutrient Strategy. In recent years, the RMP has been developing a Modeling Strategy for contaminant fate. However, given the clear and immediate need for forecasting nutrient loadings under different management scenarios, the RMP has decided to make developing a nutrient model the first priority. In 2012, the Nutrient Strategy team and Contaminant Fate Workgroup began developing a plan for moving forward with modeling nutrients. The plan was also coordinated with BACWA and with other groups that are active in modeling water and sediment fate in the Bay.

EEWG Moderate Toxicity and Benthic Assessment for Mesohaline Regions

Contact: Meg Sedlak (meg@sfei.org)

Two studies proposed by the Exposure and Effects Workgroup (EEWG) were approved for 2012: 1) understanding the causes of moderate toxicity in the Bay and 2) developing benthic community condition indices for mesohaline environments in the Bay.

Moderate toxicity has been consistently observed in the Bay and the causes of this toxicity are not well understood. In 2012, the RMP and the Southern California Coastal Water Research Project convened a workshop of national experts who identified possible reasons for the observed toxicity (e.g. grain size or amphipod health) and recommended study ideas to help determine the causes of the moderate toxicity. A summary of the workshop is available here. A selection of the proposed study ideas were approved as 2014 RMP Special Studies.

The second study (developing a mesohaline index for the Bay) was proposed because benthic community assessments are often used as indicators of ecosystem condition and have become a central element of regulatory programs. However, benthic indices have not been developed for habitats such as the low salinity mesohaline and tidal freshwater environments. The objective of the two-year study was to develop and calibrate a minimum of three benthic indices for the mesohaline environments of San Francisco Bay. In 2013 (phase one of the study), the database of San Francisco Bay benthic samples was updated, San Francisco Bay habitat definitions were refined, and a Best Professional Judgment study was performed with 20 benthic samples that covered the entire range of habitat conditions in the Bay.

Additional Reports Published in 2012

Several journal articles and RMP reports were published in 2012 that were primarily associated with 2010 and 2011 Pilot and Special Studies. All previously unnamed 2012 publications are listed below:

RMP Technical Reports:

1. "Impact of dissolved copper on the olfactory system of seawater-phase juvenile salmon"
2. "Application of Gene Expression Analysis for Sediment Toxicity Stressor Identification"
3. "Estimated Atmospheric Deposition Fluxes of Dioxins in the San Francisco Estuary"
4. "Conceptual Model of Contaminant Fate on the Margins of San Francisco Bay"
5. "Contaminants in Fish From the California Coast, 2009-2010 Summary Report on a Two-Year Screening Survey"
6. "Concentrations and Loads of Trace Contaminants in a Small Urban Tributary, San Francisco Bay, California"
7. "Contaminants of Emerging Concern in the San Francisco Estuary: Carbamazepine"
8. "Evaluation of Episodic Suspended Sediment Transport in San Francisco Bay, California through Remote Sensing"
9. "Conceptual Foundations for Modeling Bioaccumulation in San Francisco Bay"
10. "Estimation of Loads of Mercury, Selenium, PCBs, PAHs, PBDEs, Dioxins, and Organochlorine Pesticides from the Sacramento-San Joaquin River Delta to San Francisco Bay"
11. "Pollutant Monitoring in the North Richmond Pump Station: A Pilot Study for Potential Dry Flow and Seasonal First Flush Diversion for Wastewater Treatment"
12. "Contaminants of Emerging Concern in the San Francisco Estuary: Alkylphenol Ethoxylates"

Published Manuscripts:

13. Greenfield, B. K., & Allen, R. M. (2012). Polychlorinated biphenyl spatial patterns in San Francisco Bay forage fish. *Chemosphere*.

14. Davis, J. A., Looker, R. E., Yee, D., Marvin-Di Pasquale, M., Grenier, J. L., Austin, C. M., McKee, L.J., Greenfield, B.K., Brodberg, R., & Blum, J. D. (2012). Reducing methylmercury accumulation in the food webs of San Francisco Bay and its local watersheds. *Environmental research*.

15. Klosterhaus, S. L., Stapleton, H. M., La Guardia, M. J., & Greig, D. J. (2012). Brominated and chlorinated flame retardants in San Francisco Bay sediments and wildlife. *Environment international*, 47, 56-65.

Annual Monitoring Online Graphics and Data Access Tools

Web Tools: Contaminant Data Display and Download (CD3)

The 2012 data are now available online using a dynamic mapping and graphing tool. The online Contaminant Data Display and Download tool (CD3) allows water, sediment, and tissue monitoring results from 1993 to 2012 to be summarized graphically for many trace contaminants and important ancillary measures. The CD3 tool displays the data graphically on maps and in cumulative distribution function (CDF) plots (Figure 1.1).

Several software programs were used to develop the online graphics. The R statistical analysis software package *spsurvey*, which is designed specifically by EPA for GRTS sample designs was used to calculate estimates of the regional and Estuary-wide contaminant mean, variance, standard deviation, standard error, and CDFs. The R program is an implementation of the S language developed at AT&T Bell Laboratories and can be downloaded for free from the Comprehensive R Archive Network (CRAN). The *spsurvey* library for the analysis of probability surveys is available from USEPA's Aquatic Resources Monitoring - Monitoring Design and Analysis.

All RMP results, from 1993-2012, can be downloaded using the RMP CD3 web tool. The online data include only those results that have met specific data quality objectives and have passed a rigorous QA/QC evaluation as outlined in the RMP's Quality Assurance Project Plan. Values reported below the method detection limit (MDL) are estimated to be ½ of the MDL in all calculations and graphics. Some organic compounds are summed based on the target list of RMP congeners (Appendix 4) for that specific compound group (e.g., PBDEs, PAHs, and PCBs). When laboratory or field replicate data are available, the average of all the replicate concentrations is provided.

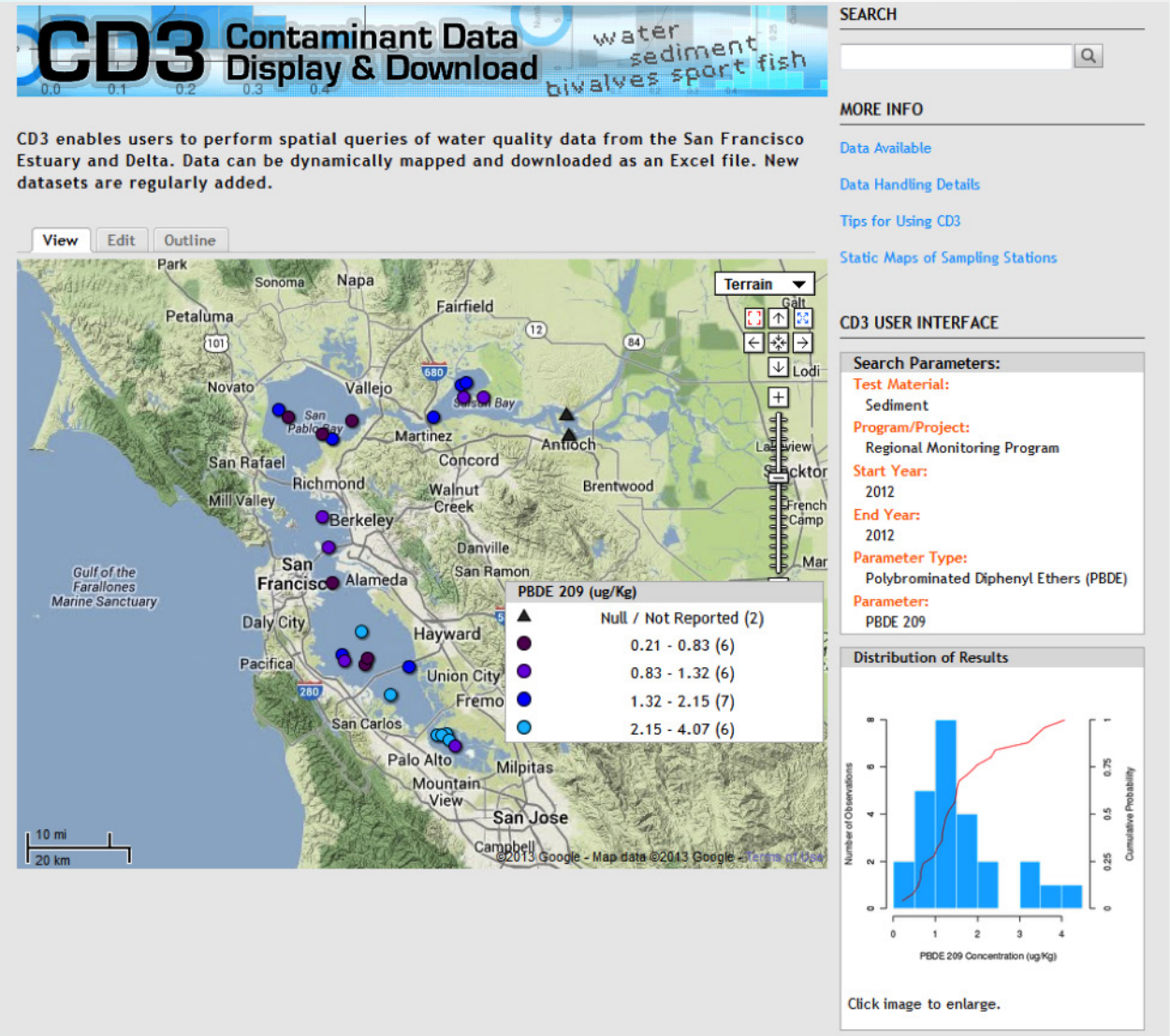

Figure 1.1 Web Map Interface Using the CD3 Tool

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2. Sediment Monitoring

Background

Since 1993, the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) has routinely monitored contaminants in surface sediment (top 5 cm) collected at stations throughout the Bay. Sediments are monitored because they are a fundamental component of the ecosystem and they play a key role in the fate and transport of contaminants. Sediment serves as contaminant sources and sinks, and many contaminants are usually found in higher concentrations in sediment than in the water column. Sediment contamination information is used in making decisions related to many important management concerns: the identification of sediment "toxic hot spots" and reference areas; the clean-up of numerous sites in the region that requires information about background contaminant levels; and the continued dredging throughout the Bay that requires testing and comparisons to ambient concentrations. Information about sediment addresses several of the key RMP management questions listed in the Introduction.

The RMP underwent a programmatic change in 2002 and the sediment sampling component was changed from 26 targeted sites sampled annually to a randomized sampling design with 47 sites sampled annually comprised of 40 random sites and 7 historic sites retained from the original sampling design. In 2010, the Steering Committee (SC) and Technical Review Committee (TRC) decided that sediment sampling would be conducted on a biennial frequency, alternating between wet season and dry season collections, with wet season collections limited to 27 sampling sites and dry season collection continuing to include 47 sites. Samples are collected for analysis of the full sediment quality triad which includes chemical analysis of target analytes, toxicity screening and benthos community assessment at 27 sites during both wet and dry season cruises. In 2012 the sampling design was again modified to alternate water and sediment sampling biennially, e.g., 2012=sediment, 2013 = water, 2014 = sediment. Alternating between seasons (wet and dry sampling) will continue to occur for sediment cruises (2012 sediment cruise = wet, 2014 sediment cruise = dry). In 2012, 27 sediment samples were collected during the wet season aboard the RV Turning Tide operated by the U.S. Geological Survey (USGS) during April 17, 2012 – April 24, 2012.

Sites

In order to allow for analysis of long-term temporal trends, the sampling design includes a rotating station revisit schedule for randomly allocated stations where pairs of stations are revisited on a specific cycle. In addition, historic sites continue to be sampled in each of the six regions. The Rivers Region has two historic sites, the Sacramento River (BG20) and the San Joaquin River (BG30). All other regions have one historic site each: Suisun Bay (Grizzly Bay - BF21), San Pablo Bay (Pinole Point - BD31), Central Bay (Yerba Buena Island - BC11), South Bay (Redwood Creek - BA41) and Lower South Bay (Coyote Creek - BA10). These seven historic sites were selected because they have long-term synoptic chemistry and toxicity measures associated with them (SFEI, 2005). Every attempt is made to procure acceptable sediment from the target coordinates. Acceptable sediment consists of at least 60% fines and is determined by qualitative analysis. In the event that acceptable sediment cannot be collected, the vessel is repositioned within a 100 m radius of the given coordinates. If sediment collection is still unsuccessful, the sampling operation proceeds to the next scheduled site and the failed site will be replaced with the next site on the list of available alternative sites, referred to as an oversample site.

In 2012, 27 sites were sampled, 20 random sites and 7 historic sites. Samples at these sites were collected for chemical analysis of target analytes, toxicity screening and benthos community assessment. Seven sites were pre-abandoned during the planning stage of the cruise due to their inaccessibility. All abandoned sites were replaced with the next available oversample site. Station names, codes, coordinates, and sampling dates for the 2012 sediment monitoring effort are listed in Appendix 3.

A map with the sampling sites is presented in Figure 2.1. The next sediment sampling cruise is scheduled for 2014 during the dry season.

Field Methods

Shipboard Measurements

Conductivity, Temperature, and Depth (CTD) measurements were taken by Applied Marine Sciences (AMS-CA) at each site. A Sea-Bird SBE19 CTD probe was used to measure water quality parameters at depths throughout the water column. At each site, the CTD probe was lowered to approximately one meter below the water surface and allowed to equilibrate to ambient temperature for 3 minutes. Following the sampling, the probe was then lowered to the bottom at approximately 0.15 meters per second and raised. However, only data from the down cast were kept. Data were downloaded onboard the ship and processed in the laboratory using Sea-Bird software.

The CTD probe measured temperature, electrical conductivity, pressure, dissolved oxygen, and backscatter at a sampling rate of two scans per second. These data were compiled and averaged into 0.25 m depth bins during processing. At this time, salinity (based on electrical conductivity measurements), and depth (based on pressure) were calculated from the recorded measurements. Although the CTD data are not available via the online Contaminant Data Display and Download tool (CD3), the RMP maintains these data in a database, and they are available upon request.

Oxidation-Reduction Potential (ORP) and pH shipboard measurements were taken by SFEI staff at each site. Two measurements of in *situ* pH were recorded onboard the sampling vessel by submerging a Hach™ pH probe directly into the sediment sample to approximately 1" in depth after the Van Veen grab was brought on deck. A total of four measurements (two from each grab) were recorded at each station. Sediment ORP was measured in a cored sub-sample of the Van Veen by a probe inserted (WTW Sentix ORP, KCl electrolyte) to depths of 1 cm and 6 cm from the sediment surface, and 1 cm from the core bottom. The probe was equilibrated for 10 minutes before recording each measurement.

Sediment Sampling Field Methods

Multiple (two to three) sediment grabs were taken at each site, with sediment sub-samples collected for ancillary, chemical and toxicity analyses. Sediment samples were collected using a Young-modified Van Veen grab with a surface area of 0.1 m^2. The grab is made of stainless steel, and the jaws and doors are coated with Dykon® (formerly known as Kynar®) to make them chemically inert. All scoops, buckets, and stirrers used to collect and homogenize sediment are constructed of Teflon® or stainless steel coated with Dykon®. Sediment sampling equipment was thoroughly cleaned (sequentially with detergent, acid, methanol, and rinsed with ultrapure water) at each sampling location prior to each sampling event. In order to further minimize sample contamination, personnel handling samples wore gloves and employed clean hands techniques.

To ensure the quality of the sediment samples, each grab must satisfy several criteria in order to be accepted: complete closure, no evidence of sediment washout through the doors, even distribution of sediment in the grab, minimum disturbance of the sediment surface, and minimum overall sediment depth appropriate for the sediment type. Overlying water was drained off an accepted grab. At 27 of the stations, Surface Water Interface Core (SWIC) samples were collected for toxicity testing using estuarine species. Due to the area requirements associated with the collection of SWICs, no sediment

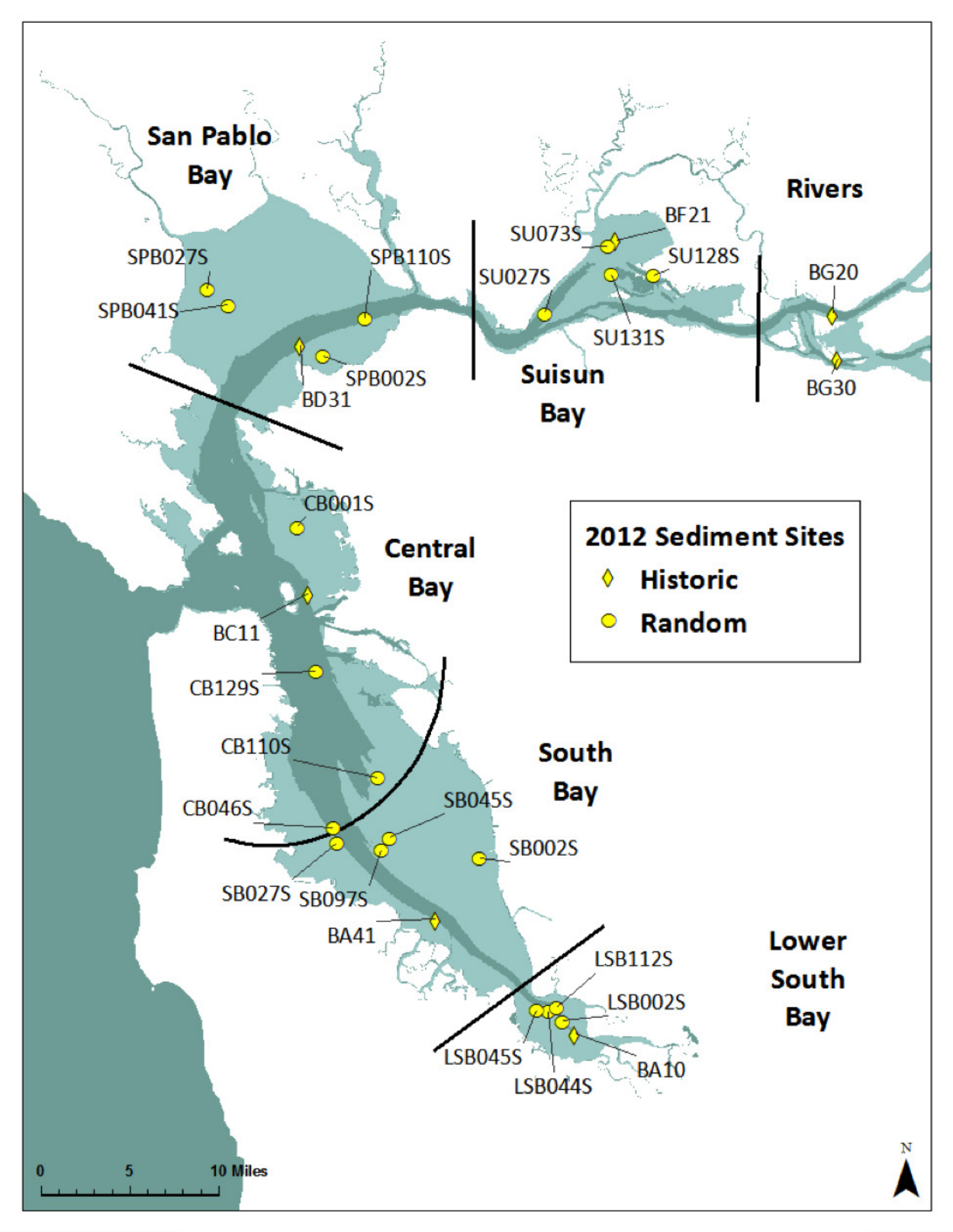

Figure 2.1 Map showing location of 2012 Sediment Stations

for chemical analysis can be collected from these grabs. The top 5 cm of sediment was collected from each of the grabs (avoiding portions cored or probed) and placed in a compositing bucket to provide a single composite sample for each site. Between sample grabs, the compositing bucket was covered with aluminum foil to prevent airborne contamination. After all sediment grabs (or at least two if complications prevent collection of sufficient material within 20 minutes) were placed into the compositing bucket, the bucket was taken into the ship's cabin and thoroughly mixed to obtain a uniform, homogeneous mixture. Aliquots were subsequently split into appropriate containers for analysis of sediment quality, trace metals, trace organics, and toxicity analyses. Samples were also collected for trace metals archive and trace organics archive. Cruise Reports documenting RMP sampling events are available on our website.

Collection of Ancillary Parameters

The RMP collected sediment at 27 sites within the Bay for grainsize, total solids, total organic carbon (TOC), and total nitrogen (TN) analysis. Moss Landing Marine Laboratories (MLML) is performing optical grainsize analysis, but results were not available at the time of writing this report due to difficulties in getting good agreement between optical and mechanical sizing methods. Sediment for grainsize analysis was collected in Whirl-pak bags and stored on wet ice. Sediment samples collected for TOC, Total Solids and TN were analyzed by ALS Laboratory Group (ALS), formerly Columbia Analytical Services. Sediment for these analyses was collected in half-filled 250 ml glass jars placed on dry ice, and kept frozen until delivery to CAS.

Collection of Trace Element Parameters

Sediment was collected at 27 Bay sites for analysis of the trace elements aluminum (Al), cadmium (Cd), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), silver (Ag), zinc (Zn), and Total Solids by the City and County of San Francisco laboratory (CCSF). CCSF supplied factory cleaned I-Chem 200 series (or equivalent) 250 ml high-density polyethylene (HDPE) containers. After collection, samples were placed on dry ice and kept frozen until delivered to CCSF.

Analysis of additional trace elements arsenic (As), mercury (Hg), methylmercury (MeHg), selenium (Se), and Total Solids was conducted by Brooks Rand Labs LLC (BR). BR provided I-Chem 300 series factory cleaned 250 ml HDPE containers. Due to special handling requirements, samples collected for MeHg analysis were placed on dry ice within 20 minutes of collection. All other samples were placed on dry ice as soon as possible. All samples were kept frozen until analyses.

Sediment was collected at 27 sites for trace metal archive. After homogenization, sediment was put into 250 ml HDPE containers and stored on dry ice until they were placed into long term storage at -18°C.

Collection of Trace Organic Parameters

Sediment was collected at 27 sites for the analysis of the trace organics parameters: polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), and pesticides by East Bay Municipal Utility District (EBMUD). EBMUD provided factory cleaned I-Chem 200 series (or equivalent) 250 ml glass containers. Samples were placed on dry ice immediately after collection and kept frozen until delivered to EBMUD.

Sediment was collected at 27 sites for analysis of pyrethroids at the California Department of Fish and Game Water Pollution Control Laboratory (CDFG-WPCL). Samples were collected in factory cleaned I-Chem 200 series (or equivalent) 250 ml glass containers and stored on dry ice after homogenization. Samples were kept frozen until analysis.

Sediment was collected at 27 sites for trace organics archive. After homogenization, sediment was put into 250 ml glass containers and stored on dry ice until they were placed into long term storage at -18°C.

Collection of Sediment for Toxicity Testing

Two types of samples were taken for analysis of sediment toxicity by the UC Davis Marine Pollution Studies Laboratory at Granite Canyon (UCD-GC). Whole sediment samples were taken from 27 stations for analysis of toxicity to *Eohaustorius estuarius*. In 2008, the RMP reinstated collection of surface water interface cores (SWICs). In 2012, SWICs were collected at 25 stations for tests examining development in the bivalve *Mytilus galloprovincialis*. Additional SWICs were collected at the two river stations for tests using the freshwater species *Ceriodaphnia dubia*.

One liter plastic containers were provided by UCD-GC for the collection of homogenized sediment for the amphipod toxicity tests. Eight-inch cores were used to collect intact cores (~1.5 inches deep) for the SWIC toxicity tests. Each core was capped with a lid that contained air holes and sealed around the edges using parafilm. The cores were kept upright and stored in a refrigerator or on wet ice until analysis by UCD-GC.

All sampling containers were pre-cleaned by the lab using the following procedures: containers were scrubbed with dilute micro solution, rinsed with deionized water (DI), rinsed with hexane, and rinsed with DI again. The containers were then soaked for 24 hours in an acid bath, rinsed with DI and then soaked for 24 hours in a DI bath. Containers were rinsed again with DI water and placed in a drying oven overnight.

Collection of Sediment Benthos

The RMP collected benthos samples at the same 27 sites where sediment toxicity was tested. Samples were screened through 0.5 and 1.0 mm nested sieves while onboard ship. The material retained on the screen was placed in sample jars, and a solution of relaxant was added to the jar. After approximately 15 minutes, 10% sodium borate buffered formalin was added to fix each sample. Samples were rinsed and transferred from formalin to 70% ethanol 3-14 days after collection. Taxonomic identification of benthic organisms is led by City and County of San Francisco – Oceanside Biology Laboratory (CCSF-OBL) with additional assistance from James Oakden and Susan McCormick (Moss Landing Marine Lab).

Laboratory Methods for Sediment Analysis

SFEI contracts with a number of laboratories that provide high quality analytical services. Qualifications for our labs include ISO registration, NELAP accreditation and certification by the California Department of Public Health. A brief overview of the laboratory methods used for RMP target analytes are described below. SFEI maintains SOPs for all laboratory analyses. Please contact Donald Yee donald@sfei.org or Cristina Grosso cristina@sfei.org for more details.

Total Solids

Total Solids are the percent content by weight of solid material in a sediment sample. Brooks Rand Labs LLC (BR) measured Total Solids in sediment using Method SM 2540G. For this method, a solid sample was homogenized, then portioned, dried, measured, and the percent of dried solid material calculated.

ALS Laboratory Group, formerly Columbia Analytical Services, analyzed Total Solids as part of their analysis of Total Organic Carbon and Total Nitrogen using EPA method 1684. Sample aliquots of 25-50 g are dried at 103 to 105 degrees C to drive off water in the sample.

City and County of San Francisco (CCSF) analyzed Total Solids as part of their analysis of trace metals using a modification of EPA method 6020A. When analyzing for trace metals in sediment a separate homogeneous aliquot of the sample must be dried to determine Total Solids.

California Department of Fish and Game Water Pollution Control Laboratory (CDFG-WPCL) analyzed Total Solids by a modification of EPA Method 8081B, as part of their analysis of pyrethroids. Sediment was weighed and allowed to dry in an oven at 70° C for 24 hours to determine moisture content. This result was later converted into Total Solids.

EBMUD analyzed Total Solids using EPA Method 160.3 as part of the analysis of trace organics.

Grainsize

Grainsize analysis prior to 2008 was conducted by the University of California Santa Cruz – Department of Environmental Toxicology (USCS-DET). In 2008 grainsize determination changed to an optical method and was analyzed by Moss Landing Marine Lab - Geological Oceanography (MLML-GeoOc) using a Beckman-Coulter laser particle size analyzer after digestion with hydrogen peroxide according to Aiello and Kellett (2006). Grainsize analysis results for 2012 sediment samples were not available at time of writing.

Total Organic Carbon (TOC) and Total Nitrogen (TN)

Analysis of TOC and TN was performed by ALS Laboratory Group, formerly Columbia Analytical Services using EPA 440. The samples were prepared for analysis by air drying followed by grinding in a mini ball mill. All samples were then analyzed for TOC and TN on HCL acidified samples using combustion at 950°C with thermoconductivity detection.

Trace Metals

Trace metals in sediment were analyzed by the City and County of San Francisco (CCSF) and Brooks Rand Labs LLC (BR).

Total trace metals analyzed by CCSF consisted of Al, Cd, Cu, Fe, Pb, Mn, Ni, Ag and Zn. These metals were measured using a modification of the EPA digest method 3050B, and modified EPA analysis method 6020A. For the digestion of samples, a representative 1 – 2 gram (wet weight) or 1 gram (dry weight) sample was digested with repeated additions of nitric acid (HNO_3) and hydrogen peroxide (H_2O_2). Samples were analyzed using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

Sediment was analyzed for mercury by BR using a modified version of EPA Method 1631. Samples were digested in HNO_3 and H_2SO_4, and then further oxidized with bromine monochloride (BrCl). Samples were analyzed with stannous chloride ($SnCl_2$) reduction, single gold amalgamation and cold vapor atomic fluorescence spectroscopy (CVAFS) detection using a BR Model III CVAFS Mercury Analyzer. All sample results for low-level mercury analysis were blank corrected.

As and Se concentrations were measured in sediment using proprietary method BR-0020 Rev 007 by BR. Samples were first oxidized by heating with specific reagents. For the analysis of arsenic, sample concentrations were determined by hydride generation – cryogenic trapping – atomic absorption spectrometry (HG-CT-AAS). For the determination of Se, samples were reduced in HCl with addition of hydroxylamine hydrochloride (NH_2OH HCl) and heating, converting all Se to Se(IV). After that HG-CT-AAS was performed.

MeHg in the sediment samples was analyzed by BR using a modified EPA Method 1630. The sediment samples were prepared by acid bromide/methylene chloride extraction. The samples were analyzed by aqueous phase ethylation, Tenax trap collection, gas chromatography separation, isothermal decomposition, and cold vapor atomic fluorescence spectroscopy (CVAFS).

Trace Organics

In 2008, pyrethroids were added to the suite of organic contaminants monitored in sediment by the RMP in order to investigate the potential toxicity of pyrethroids in the Bay. In 2012 analysis was again conducted by California Department of Fish and Game Water Pollution Control Laboratory (CDFG-WPCL). Samples were prepared using an automated extraction system and analyzed using a modified version of EPA 8081B by dual column gas chromatography with dual electron capture detectors (GC-ECD) and/or gas chromatography with triple quadruple mass spectrometry (GC-MSMS).

Sediment organics were analyzed by EBMUD. Samples are generally analyzed based on the methods followed by the National Oceanic and Atmospheric Administration's (NOAA's) National Status and Trends Program. PAHs were analyzed using gas chromatography/mass spectrometry (GC/MS), and PCBs, PBDEs, and organochlorine (OC) pesticides were analyzed using high resolution gas chromatography – mass spectrometry (HRGC-MS).

EBMUD used the following extraction and concentration procedure for all sediment trace organic compounds of interest. Samples were homogenized and then extracted using a Dionex Accelerated Solvent Extraction (ASE; EPA Method 3545). The sample extracts were dried with anhydrous granular Na_2SO_4. Extracts were cleaned up with an alumina/copper column and concentrated to 1 ml in dichloromethane (DCM).

Just prior to analysis of PAHs the sample extracts were spiked with deuterated internal standards (fluorine-d10 and benzo[a]pyrene-d12). PAHs were then analyzed using U.S. EPA Method 8270, which was slightly modified to provide sufficient sensitivity for PAHs in sediment.

Samples were analyzed for organochlorine (OC) pesticides using a modification of EPA method 1668A. Just prior to analyses, injection internal standards were added to the sample extracts, and then an aliquot of the extract was injected into the gas chromatograph. The analytes were separated by the gas chromatograph and detected by a high resolution (>8,000) mass spectrometer (HRMS). Two exact mass-to-charge ratios (m/z's) were monitored throughout a predetermined detention time.

Samples were analyzed for PCBs using EPA Method 1668A. A cleanup standard was spiked into the extract prior to analyses. The extract was then put through a drying column and concentrated. After drying and concentrating, the samples were cleaned up using gel permeation and activated alumina column chromatography. After cleanup, the solvent was exchanged to hexane. Injection internal standards were added to each extract before injection into the gas chromatograph. The analytes were separated by gas chromatography and detected by a high-resolution (>10,000) mass spectrometer (HRMS). Similar to the oc-pesticide analyses, two exact m/z's were monitored throughout a predetermined detention time.

Sediment was analyzed for PBDEs using a modification of EPA method 1614. A cleanup standard was spiked into the extract, which was then dried and concentrated. The samples were then purified using an activated alumina column, and the solvent in the samples was exchanged to hexane. Just prior to the analysis, injection internal standards were added to each extract and an aliquot was injected into the gas chromatograph. Similar to OC pesticides and PCB analyses, the PBDE congeners were separated by the gas chromatograph and detected by a high-resolution (>5,000) mass spectrometer (HRMS) with two exact m/z's monitored for each compound.

Table 3.1 Target Sediment Analytes: A summary table of the 2012 target analytes, analytical laboratories, reporting units, and method codes.

Parameter	Lab(s)	Reporting Unit	Method Code(s)
Depth	AMS-CA	m	RV Turning Tide Depth Meter
pH (porewater, interstitial sediment)	AMS-CA	pH	Cole Parmer pH meter Model 20
Total Solids	BR/ALS/CCSF/ DFG-WPCL /EBMUD	%	Various
Arsenic (As)	BR/CCSF	mg/Kg	EPA 1638 Mod./ EPA 6020A Mod.
Mercury (Hg)	BR	mg/Kg	EPA 1631 Mod.
Mercury, Methyl (MeHg)	BR	µg/Kg	EPA 1630 Mod.
Selenium (Se)	BR/CCSF	mg/Kg	EPA 1632A Mod./ EPA 6020A Mod.
Total Nitrogen (TN)	CAS	%	EPA 440
Total Organic Carbon (TOC)	CAS	%	EPA 440
Aluminum (Al)	CCSF	mg/Kg	EPA 6020A Mod.
Cadmium (Cd)	CCSF	mg/Kg	EPA 6020A Mod.
Copper (Cu)	CCSF	mg/Kg	EPA 6020A Mod.
Iron (Fe)	CCSF	mg/Kg	EPA 6020A Mod.
Lead (Pb)	CCSF	mg/Kg	EPA 6020A Mod
Manganese (Mn)	CCSF	mg/Kg	EPA 6020A Mod.
Nickel (Ni)	CCSF	mg/Kg	EPA 6020A Mod.
Silver (Ag)	CCSF	mg/Kg	EPA 6020A Mod.
Zinc (Zn)	CCSF	mg/Kg	EPA 6020A Mod.
Pyrethroids	DFG-WPCL	µg/Kg	EPA 8081B Mod.
PAHs (Low and High Molecular Weight, Alkylated)	EBMUD	µg/Kg	EPA 8270 Mod.
Cyclopentadienes	EBMUD	µg/Kg	EPA 1668A Mod.
Chlordanes	EBMUD	µg/Kg	EPA 1668A Mod.
HCHs	EBMUD	µg/Kg	EPA 1668A Mod.
Other Synthetic Biocides (Fipronil , Fipronil desulfinyl , Fipronil sulfide , Fipronil sulfone Hexachlorobenzene, Mirex)	EBMUD	µg/Kg	EPA 1668A Mod.
PBDEs	EBMUD	µg/Kg	EPA 1614 Mod.
PCBs	EBMUD	µg/Kg	EPA 1668A
Grainsize	MLML-GeoOc	%	Beckman-Coulter Laser Particle Size Analyzer
Sediment Toxicity - *Eohaustorius estuarius*	UCD-GC	%	EPA 600/R-94-025
Sediment Toxicity –			
Mytilus galloprovincialis	UCD-GC	%	EPA 600/R-95-136M
Sediment Toxicity – Fresh Water *Hyalella azteca*	UCD-GC	%	EPA 600/R-99-064
Sediment Toxicity – Fresh Water *Ceriodaphnia dubia*	UCD-GC	%	EPA 821/R-02-012M

Quality Assurance / Quality Control (QA/QC)

QA/QC of Percent Solids

Percent solids were measured individually along with analyzed samples by all chemical analytical labs in order to determine chemical concentrations on a dry weight basis. Variations of a few percent among subsamples between labs (and within labs for replicates) frequently result due to heterogeneity within samples.

QA/QC of Grain Size

Starting in 2008, grainsize for particles <2mm was determined by an optical (laser scattering) method, which measures particle size distribution as a percentage of volume (rather than mass from sieving and weighing methods in prior years). Currently, the larger than sand fraction, >2mm (typically bivalve shells and shell fragments), is determined as a percentage of bulk sediment mass, with the size distribution of the remaining (<2mm) fraction determined by the optical method. Comparisons of optical versus sieving/weighing particle size distribution determinations in the literature have shown good agreement for deep marine sediment, although RMP split samples measured by weighing in this and previous years have shown some variation between methods (% fines within 10% for most samples, but up to 30% difference in some cases). The lab has implemented a procedure of performing the optical analyses in triplicate for all samples, but there remain large variations among lab replicates for sand in some samples, so samples with large percentages of sand are currently being reanalyzed to evaluate procedures for reducing this uncertainty. Preliminary grainsize data for sites with low or no sand fractions may be available upon request.

QA/QC of Total Organic Carbon and Total Nitrogen

Analyses of TOC and TN was done by ALS Environmental (ALS) and showed no major problems. All TOC and TN results were above the detection limits. No blank contamination was observed for TOC or TN. Results on QC samples for TN were within the targeted acceptance ranges of 15%, (6% average Relative Standard Deviation (RSD) precision, and 13% average error). For TOC, average precision RSD and recovery error were each 6%, slightly above their 5% targets, so results were qualified but not censored. Average concentrations reported for TN and TOC were within similar ranges as reported by the RMP Status and Trends Program in previous years.

QA/QC of Trace Metals

Sediment sample trace elements (other than As, Hg, and Se) were measured at the City and County of San Francisco (Southeast Wastewater Treatment Plant Laboratory) and showed no major issues. Method sensitivity was sufficient for nearly all target analytes to be detected in all field samples, with only Cd not detected in two samples. Of the target analytes, only Zn was found in blanks, always at concentrations at least 3 times lower than in field samples, so results were flagged but not censored. Precision on lab replicates was good for all analytes, with RSDs <25%. Recoveries were good (<25% average error) for all target analytes except Al, which showed a low bias (<50% recovery in Certified Reference Materials (CRMs)), but it was recognized that samples were digested by a method that typically does not fully recover Al in natural minerals. Al is typically not toxic in natural mineral forms,

so this low recovery does not impact estimates of toxicity posed by sediment. Concentrations were similar to previous years' averages for the target elements.

Brooks Rand measured As, Hg, MeHg, and Se in sediment samples, with generally good data quality. Detection limits were sufficient for measurement of the analytes in nearly all samples, with MeHg and Se not detected in only one sample each. Results were reported blank corrected, with variation (standard deviation) in the blank signal always below the detection limit. Recoveries on CRMs all averaged within 25% of target values, and precisions on lab replicates were good, averaging <25% RSD. Concentrations were similar to past years, with average and maximum concentrations similar to previous 5 years. Ratios of methyl to total Hg also looked reasonable, with MeHg around 0.1% of total Hg

QA/QC of Trace Organics

PAHs, PBDEs, PCBs, and pesticides (aside from pyrethroids) were analyzed in sediment by the East Bay Municipal Utility District Treatment Plant Laboratory.

Detection limits were sufficient to measure most of the targeted PAHs in a majority of samples, but over half of the alkylated PAHs were not detected in all samples. Only Benzo(g,h,i)perylene was detected in any method blanks, with one result censored for being <3x the amount in the blank. Replicate RSDs for field samples or matrix spikes (MSs) (for analytes where ambient concentrations were too low to measure) were within the target 35% average for all analytes. Recoveries on CRMs and MSs were generally good, with only Benzo(k)fluoranthene, Chrysene, and Pyrene showing recovery errors averaging >35%, flagged but not censored. The alkylated PAHs do not have any recovery checks as groups, only for selected compounds as individual (mostly methylated) PAHs. Most of the analytes were in the same general concentration range as previous years (2004-2010), with no unusual concentration differences indicating analytical or reporting problems.

PBDE detection limits were sufficient to quantify in at least 80% of samples for the expected most abundant PBDEs (47, 99, 100, 153, 209). Only PBDE 209 was found in blanks above detection limits, with 2 samples containing <3x the amount in the blanks and censored. Average RSDs on matrix spike duplicates (MSDs) were within the target <35% for all analytes. Recoveries on MSs averaged <35% error for all reported compounds. Concentrations were generally similar to previous years for most PBDEs at the RMP S&T stations.

PCB analyses showed only minor QC issues with a few of the less abundant congeners. Detection limits were sufficient to report a majority of PCBs, with around a third of the less abundant congeners showing non-detects in a majority of samples. Six of the PCBs were found in method blanks, censored (for concentrations <3 times those in blanks) in 2/3 of the samples for PCB 16 and 18, and around 40% censored for PCBs 9, 17, 22, and 32. Replicates on field samples or MSs were generally good, within the target 35% average RSD except for PCB 52, 128, and 195, flagged but not censored for being moderately above the target. Recoveries on CRMs and MSs were good, with errors averaging <35%, except for PCB 95, averaging 37%. Most of the PCBs were in the same general concentration range as previous years. Similar to prior years, a Sum of 208 PCBs is reported due to the prevalence of PCB 11, a synthetic dye by-product. Unlike Aroclor PCB mixtures, PCB 11 does not possess dioxin-like potency. A sum of 208 PCBs (that is, excluding PCB 11) is thus expected to be a better surrogate measurement of the presence of the toxic dioxin-like PCBs, which individually are often below detection limits.

Pesticides reported by EBMUD included primarily legacy organochlorine pesticides, and fipronil. Detection limits yielded non-detects in over half the samples for 11 of the 26 pesticides, but the method was sufficiently sensitive for the remainder. Only fipronil sulfone was found in blanks, with 30% of the samples censored for concentrations less than 3 times those in blanks. Precision was within the target 35% average RSD for all analytes. Recoveries on CRMs and MSs were generally good, averaging within 35% of target values except for p,p'-DDT, trans-Nonachlor, and Fipronil desulfinyl, which were flagged but not censored for errors averaging around 45%. Heptachlor epoxide, Mirex , and Oxychlordane were over three times higher than their previous 7 years' averages, but concentrations were still low relative to expected toxicity levels.

The California Department of Fish and Wildlife Water Pollution Control Laboratory at Rancho Cordova measured sediment concentrations of 14 pyrethroid analytes (some co-eluting compounds that could not be resolved). Average detection limits ranged from 0.16 to 1.27 ng/g dw, with non-detects in 100% of samples for all analytes except bifenthrin, with non-detects in around 80% of samples. LC50s for bifenthrin in sediment are ~2-10ng/g, with slightly higher LC50s for most other pyrethroids, so despite many NDs, MDLs are probably low enough to measure levels that would be acutely toxic (the average bifenthrin MDL was 0.26 ng/g dw). None of the target compounds were found in lab blanks. Precision was good for most analytes, with RSDs averaging slightly over the 35% target in MSDs for Cyfluthrin, total Cypermethrin, total Esfenvalerate/Fenvalerate, and total lambda Cyhalothrin (all <43% RSD or better). Matrix spike recoveries had average errors slightly above the target of 35% only for Cyfluthrin. The average concentration of Bifenthrin, the only pyrethroid detected, was about 8x lower than (averaging 13% of) those in past RMP S&T sediment samples.

QA/QC for Sediment Toxicity

Whole sediment and sediment-water interface toxicity tests were performed at the University of California Davis Marine Pollution Studies Lab. Samples were tested within the recommended holding time limit of 14 days. Some water quality measures were slightly outside the recommended organism tolerance range as outlined by the test protocol and were qualified; the deviations included conductivity/salinity in two tests (one high, one low), and temperature in one test. However, the lab stated that these deviations alone were not sufficient to alter test results by causing observed responses (mortality, etc.). Reference toxicant results were within 2 standard deviations of historical control chart results, except for Hyallela, with a reference toxicant EC50 about 60% higher (less sensitive) than the control chart 2 standard deviation upper limit.

Sediment Toxicity

Two types of sediment bioassays were conducted at 27 of the RMP stations in 2012 (Figure 3.2). Homogenized whole-sediment was tested for toxicity using the amphipod *Eohaustorius estuarius* in the 10-day amphipod survival test (EPA 600/R-94-025). Sediment was re-homogenized in the sample jars by placing them on a rolling apparatus and manually stirring with a polypropylene spoon. Samples were then distributed to replicate test beakers. Overlying water was added to the test containers, and sediment was allowed to equilibrate overnight before the amphipods were added. Randomly selected amphipods were placed into replicate containers and allowed to burrow into the test sediment. Amphipods were exposed to whole sediment for ten days with percent survival as the endpoint. The negative control for the *E. estuarius* solid-phase test consisted of home sediment, which was clean, well-sorted fine-grained sand collected at the same place and time as the test amphipods.

Surface-water interface (SWICs) cores were tested using the bivalve *Mytilus galloprovincialis* in a 48-hour static embryo-larval development toxicity tests (EPA 600/R-95-136M). SWI cores were prepared for analysis by adding overlying water and allowing the cores to equilibrate overnight. Bivalve embryos were added by placing a 25 µm screen tube into each core. At the end of each test the larvae were isolated from the cores by removing the screen tubes and rinsing the larvae into 20 ml scintillation vials. The contents were preserved with formalin. The mussel larvae were counted to determine the percentage of embryos that developed into live normal larvae. The negative controls for the *M. galloprovincialis* tests consisted of SWI cores filled with clean home sediment as described above.

A sample was considered toxic if:

1. There was a significant difference between the laboratory control and test replicates using a separate variance t-test (alpha = 0.01), and

2. % survival for amphipods or % normal alive for bivalves was less than the evaluation threshold of effect (the Control minus the MSD). The difference between the mean endpoint value in the control and the mean endpoint value in the test sample was greater than the 90th percentile minimum significant difference (MSD).

A sample must meet both criteria to be considered toxic, because a t-test can often detect small differences between samples when there is low variance among laboratory replicates. One way to ensure that statistical significance is determined based on large differences between means, rather than on a small variation among replicates, is to use the MSD. MSD is a statistic that indicates the difference between the two means (the mean of the sample and control replicates) that will be considered statistically significant given the observed level of among-replicate variation and the alpha level chosen for the comparison. MSD values generated from RMP *Eohaustorius estuarius* and *Mytilus galloprovincialis* tests were used by UCD-GC to establish a 90th percentile MSD threshold. This analysis indicates that the *E. estuarius* test is capable of identifying statistically significant differences in 90% of cases, where the difference between the treatment and the control is 18.8%. The threshold is calculated by subtracting 18.8% from the control response. The bivalve larvae 90th percentile MSD is 15.2% (Phillips *et al.*, 2001). The control responses for the amphipod test were 100% and 98%, and the toxicity thresholds were 81.2% and 79.2%. Control responses for the bivalve larvae test were 84.2% and 76.5%, and the toxicity thresholds 69%, and 61.3%, respectively.

Sediment was not toxic to amphipods, *Eohaustorius estuarius*, or mussel, *Mytilus galloprovincialis*, larvae at 5 out of 25 stations (Figure 3.2). Amphipod toxicity was observed at 20 stations: Suisun Bay (Grizzly Bay (BF21), SU027S, SU073S, and SU131S), San Pablo Bay (SPB002S, SPB027S, SPB041S, and SPB110S), Central Bay (Yerba Buena Island (BC11), CB001S, CB046S, and CB110S), South Bay (Redwood Creek (BA41), SB002S, SB027S, SB045S, and SB097S), and Lower South Bay (LSB002S, LSB044S, and LSB045S). Sediment samples from 4 stations were toxic to larval mussels: Central Bay (Yerba Buena Is. (BC11), CB001S, and CB110S), and Lower South Bay (LSB045S). A toxic sample indicates the potential for biological effects to estuarine organisms. However, since sediment contain numerous contaminants, it is difficult to determine which contaminant(s) may have caused the observed toxicity. Further laboratory tests, Toxicity Identification Evaluations (TIEs), are required to investigate the potential causes of an observed toxic hit.

The RMP only performs TIEs on sediments that have less than 50% survival (or normal alive). The RMP program managers authorize these additional studies on a case-by-case basis based on the annual bioassay results. The % survival for *Eohaustorius estuarius* was lowest at station CB046S (29%), and for

Mytilus galloprovincialis larvae % normal alive was lowest at station CB001S (18%). No sediment TIEs were contracted to be performed in 2012. The Exposure and Effects Workgroup (EEWG) recommended that work to address the causes of the observed toxicity be continued over the next five years, and recommended a workgroup process to develop and oversee new studies. Please see the report RMP Sediment TIE Study 2007-2008 for a more detailed account of the initial study, and the EEWG website for an update on new RMP Special Studies addressing current issues related to the causes of toxicity.

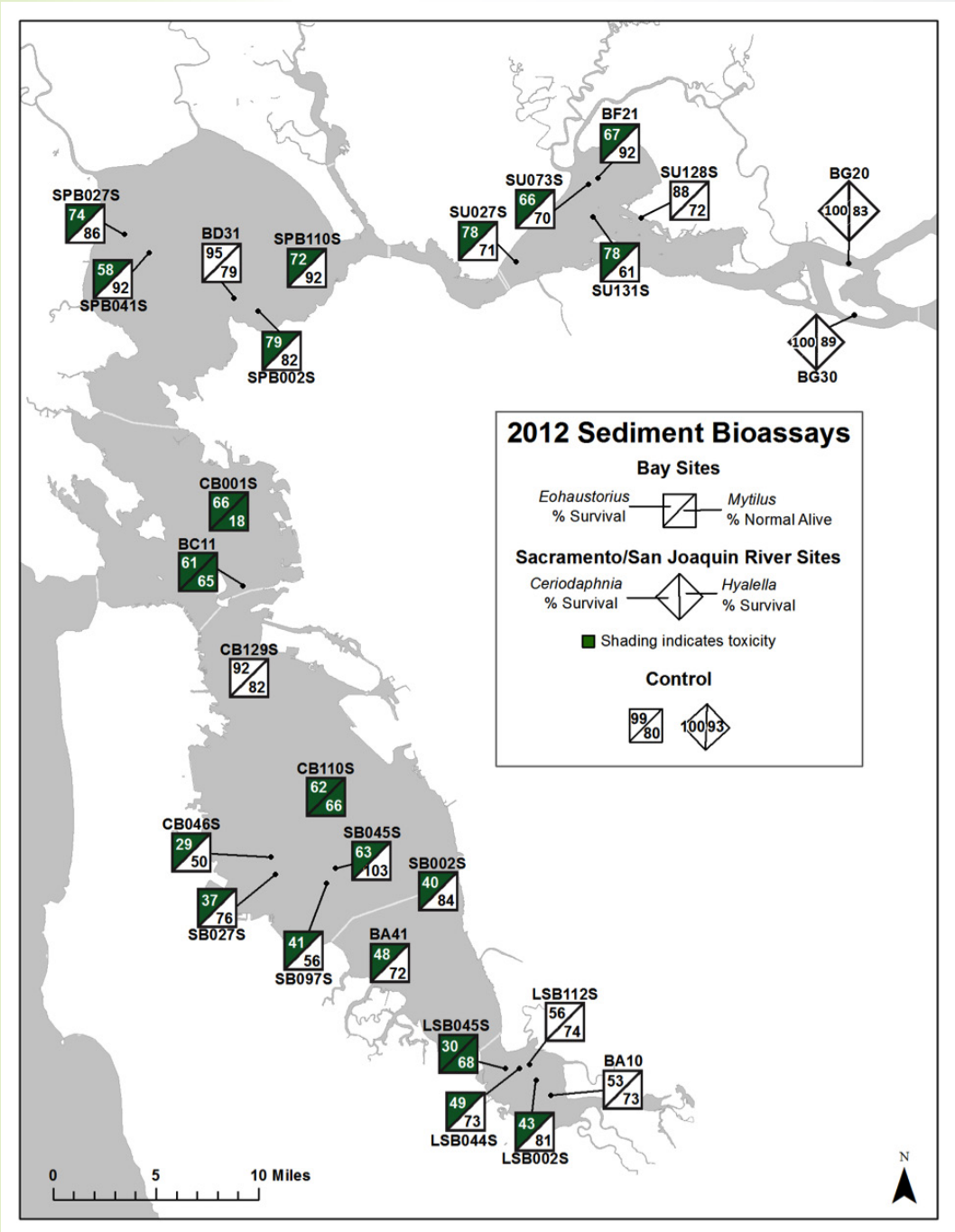

FIGURE 3.2 SEDIMENT BIOASSAY RESULTS FOR 2012

Bay sediment are evaluated through comparisons to several sets of sediment quality guidelines (Table 3.2). Although these guidelines hold no regulatory status, they are useful in assessing the potential for toxic and benthic effects.

Sediment contamination and toxicity results were used to evaluate the quality of the 2012 Regional Monitoring Program samples (Table 3.3). Sediment contamination was estimated for each site by considering the number of contaminants in a sample that exceeded the San Francisco Estuary Ambient Sediment Concentration (ASC: Gandesbery *et al.*, 1999), Effects-Range guidelines (ERL and ERM: Long *et al.*, 1995), and the ERM quotients (Long *et al.*, 1998). The number of sediment contaminants above the ERL or ERM guidelines has been used previously to predict potential biological effects (Long *et al.*, 1998). Long et al. (1998) found that samples with more than four ERM exceedances showed toxicity in 68% of amphipod tests, while 51% of samples were toxic to amphipods when more than nine ERLs were above the guidelines. Based on these results the 2012 RMP sediment samples were considered potentially toxic if either four or more ERMs, or nine or more ERLs were exceeded. Samples that did not have values for at least 80% of the parameters (24 of 30 for ERL and ERM) were not included in the calculations.

ERM values were used to calculate a mean ERM quotient (mERMq) for each sample. The mERMq has been used in previous RMP reports and San Francisco Bay publications as an index of cumulative sediment contaminant concentrations (Thompson *et al.*, 1999; Hunt *et al.*, 2001a,b; Fairey *et al.*, 2001; Thompson and Lowe, 2004). The primary reason for using the mERMq is that it provides a measure of potential additive contaminant effects. For example, amphipod survival has been found to be significantly and inversely correlated to mERMq (Thompson *et al.*, 1999), suggesting that contaminants individually present in relatively low concentrations in sediment may act together to adversely influence amphipod survival. In past reports and publications, however, the mERMq has been calculated in several different ways. However, if comparisons to other U.S. estuaries are desired, a standard method of calculation is necessary. Therefore, the calculation of mERMq was changed in order to make the RMP ERM quotients comparable to other studies from around the U.S. (Hyland *et al*., 1999; Long et al., 2002; Hyland *et al.*, 2003). The 2012 mERMqs were calculated using the 24 parameters indicated in Table 3.2 per the Hyland method (Hyland *et al.*, 1999). Samples that did not have at least 19 of the 24 parameters were not included in the calculations. Twenty-two analytes were used for all of the 2012 sediment samples; Cr and fluoranthene were not reported.

Long et al. (1998) showed that 49% of sediment samples were toxic to amphipods when mERMq values were greater than 0.5, and 71% of samples were toxic when mERMq values were greater than 1.0. Mean ERM quotients, calculated with 24 contaminants, were used in a previous study of the Bay in which values greater than 0.15 were associated with increased risks of benthic impact (Thompson and Lowe, 2004). These values were used to evaluate the 2012 RMP sediment samples for potential adverse ecological effects.

In 2012, one station was considered potentially toxic by the RMP (SB027S) because nine or more contaminant concentrations were above the ERL guidelines. No stations sampled in 2012 had four or more contaminant concentrations above the ERM guidelines (Table 3.3). Only one station had a mERMq value greater than 0.15 (SB027S) and at least 9 results above the ERL guidelines (Table 3.3).

Sediment evaluations are useful tools that incorporate sediment contamination and toxicity into a weight of evidence assessment of the condition of sediment in the Bay. Each component is analyzed independently and weighted equally, but although they should be related the results do not always agree. The complexity of sediment evaluations demonstrate the need to consider as much data as possible in assessing the condition of Bay sediment and the need for additional studies to reconcile and understand the observed contradictions.

Table 3.2 Sediment Quality Guidelines (dry weight basis)

Effects Range-Low (ERL) and Effects Range-Median (ERM) values from Long et al. (1995, 1998)
Effects Range-Low; values between this and the ERM are in the possible effects range.
Effects Range-Median; values above this are in the probable effects range.

San Francisco Bay Ambient Sediment Concentrations (ASC) from Gandesbery et al. (1999).
Ambient sediment levels from background sediments in the Estuary allow one to assess whether a site has elevated levels or is "degraded".

Background sediment concentrations for selected trace elements in the San Francisco Bay, from Hornberger et al. (1999)
Chromium and nickel concentrations observed throughout the core. All trace elements, except Ag, measured by Inductively Coupled Argon Plasma Emission Spectroscopy (ICAPES). Ag measured by Graphite Furnace Atomic Absorption Spectrometry (GFAAS).

Near total metals are extracted with a weak acid for a minimun of one month, therefore, concentrations approximate the bioavailability of these metals to Estuary biota.

Parameter	unit	ERL	ERM	ASC-sandy <40% fines	ASC-muddy >40% fines	Background Concentrations (Bay wide ranges)	
						Total	Near Total
Arsenic	mg/Kg	8.2	70 †	13.5	15.3		
Cadmium	mg/Kg	1.2	9.6 †	0.25	0.33		
Chromium	mg/Kg	81	370 †	91.4	112	110 - 170	70 - 120
Copper	mg/Kg	34	270 †	31.7	68.1	20 - 55	20 - 41
Mercury	mg/Kg	0.15	0.71 †	0.25	0.43		0.05 - 0.07
Nickel	mg/Kg	20.9	51.6	92.9	112	70 - 100	50 - 100
Lead	mg/Kg	46.7	218 †	20.3	43.2	20 - 40	10 - 20
Selenium	mg/Kg			0.59	0.64		
Silver	mg/Kg	1	3.7 †	0.31	0.58	0.7 - 0.11	0.7 - 0.11
Zinc	mg/Kg	150	410 †	97.8	158	60 - 70	50 - 100
Sum of HPAHs (SFEI)	µg/Kg	1700	9600	256	3060		
Fluoranthene	µg/Kg	600	5100 †	78.7	514		
Perylene	µg/Kg			24	145		
Pyrene	µg/Kg	665	2600 †	64.6	665		
Benz[a]anthracene	µg/Kg	261	1600 †	15.9	244		
Chrysene	µg/Kg	384	2800 †	19.4	289		
Benzo[b]fluoranthene	µg/Kg			32.1	371		
Benzo[k]fluoranthene	µg/Kg			29.2	258		
Benzo[a]pyrene	µg/Kg	430	1600 †	18.1	412		
Benzo[e]pyrene	µg/Kg			17.3	294		
Dibenz[a,h]anthracene	µg/Kg	63.4	260 †	3	32.7		
Benzo[g,h,i]perylene	µg/Kg			22.9	310		
Indeno[1,2,3-c,d]pyrene	µg/Kg			19	382		

Table 3.2 Sediment Quality Guidelines (dry weight basis) contin.

Parameter	unit	ERL	ERM	ASC-sandy <40% fines	ASC-muddy >40% fines	Background Concentrations (Bay wide ranges)	
						Total	Near Total
Sum of LPAHs (SFEI)	µg/Kg	552	3160	37.9	434		
1-Methylnaphthalene	µg/Kg			6.8	12.1		
1-Methylphenanthrene	µg/Kg			4.5	31.7		
2,3,5-Trimethylnaphthalene	µg/Kg			3.3	9.8		
2,6-Dimethylnaphthalene	µg/Kg			5	12.1		
2-Methylnaphthalene	µg/Kg	70	670 †	9.4	19.4		
Naphthalene	µg/Kg	160	2100 †	8.8	55.8		
Acenaphthylene	µg/Kg	44	640 †	2.2	31.7		
Acenaphthene	µg/Kg	16	500 †	11.3	26.6		
Fluorene	µg/Kg	19	540 †	4	25.3		
Phenanthrene	µg/Kg	240	1500 †	17.8	237		
Anthracene	µg/Kg	85.3	1100 †	9.3	88		
Sum of PAHs (SFEI)	µg/Kg	4022	44792	211	3390		
p,p'-DDE	µg/Kg	2.2	27 †				
Sum of DDTs (SFEI)	µg/Kg	1.58	46.1 †	1.58	46.1		
Total Chlordanes (SFEI)	µg/Kg	0.5	6	0.42	1.1		
Dieldrin **	µg/Kg	0.02	8	0.18	0.44		
TOTAL PCBs (NIST 18)	µg/Kg			5.9	14.8		
Sum of 40 PCBs (SFEI)	µg/Kg	22.7	180 †	8.6	21.6		

† Values used to calculate mean ERM quotients (Hyland et al. 1999).

** Method detection limit (MDL) for some April samples are greater than the ERL guideline, therefore, conclusions regarding this benchmark could not be drawn.

Table.3.3 Summary of sediment quality for the RMP in 2012

. indicates not tested, * grain size data not available, therefore, ASC guidelines could not be evaluated											
Code	Site Name	Date	% Fines	mERMq	No. of Contaminants above ASC Guidelines	No. of Contaminants above ERL Guidelines	No. of Contaminants above ERM Guidelines	Toxic to Amphipods Eohaustorius?	Toxic to Bivalves Mytilus?	Toxic to Ceriodaphnia dubia?	Toxic to Hyalella azteca?
BG20	Rivers	04/24/12	*	0.0251	*	3	2	.	.	no	no
BG30	Rivers	04/24/12	*	0.0821	*	6	2	.	.	no	no
BF21	Suisun Bay	04/23/12	*	0.0767	*	5	1	yes	no	.	.
SU027S	Suisun Bay	04/23/12	*	0.0701	*	5	1	yes	no	.	.
SU073S	Suisun Bay	04/23/12	*	0.0701	*	5	1	yes	no	.	.
SU128S	Suisun Bay	04/23/12	*	0.0519	*	5	1	no	no	.	.
SU131S	Suisun Bay	04/23/12	*	0.0703	*	5	1	yes	no	.	.
BD31	San Pablo Bay	04/20/12	*	0.0677	*	7	1	no	no	.	.
SPB002S	San Pablo Bay	04/20/12	*	0.0761	*	5	1	yes	no	.	.
SPB027S	San Pablo Bay	04/20/12	*	0.0772	*	5	1	yes	no	.	.
SPB041S	San Pablo Bay	04/20/12	*	0.0915	*	6	1	yes	no	.	.
SPB110S	San Pablo Bay	04/20/12	*	0.0482	*	5	2	yes	no	.	.
BC11	Central Bay	04/19/12	*	0.0870	*	5	1	yes	yes	.	.
CB001S	Central Bay	04/19/12	*	0.0975	*	6	1	yes	yes	.	.
CB046S	Central Bay	04/19/12	*	0.0762	*	4	1	yes	no	.	.
CB110S	Central Bay	04/19/12	*	0.0938	*	6	1	yes	yes	.	.
CB129S	Central Bay	04/19/12	*	0.0369	*	1	0	no	no	.	.
BA41	South Bay	04/17/12	*	0.0960	*	5	1	yes	no	.	.
SB002S	South Bay	04/17/12	*	0.0718	*	3	1	yes	no	.	.
SB027S	South Bay	04/17/12	*	0.1645	*	16	1	yes	no	.	.
SB045S	South Bay	04/17/12	*	0.0549	*	2	1	yes	no	.	.
SB097S	South Bay	04/17/12	*	0.0429	*	2	1	yes	no	.	.
BA10	Lower South Bay	04/18/12	*	0.0350	*	1	1	no	no	.	.
LSB002S	Lower South Bay	04/18/12	*	0.0607	*	2	1	yes	no	.	.
LSB044S	Lower South Bay	04/18/12	*	0.0881	*	5	1	yes	no	.	.
LSB045S	Lower South Bay	04/18/12	*	0.1108	*	7	1	yes	yes	.	.
LSB112S	Lower South Bay	04/18/12	*	0.0930	*	7	1	no	no	.	.

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3. Bivalve Monitoring

Background

The RMP has been analyzing bivalve tissue samples for trace contaminants since 1993. Bivalves bioaccumulate chemical contaminants through their food, by ingesting sediment and assimilating contaminants that are sorbed to particles, and by adsorbing dissolved contaminants directly from the water column. Bivalves act as transfer vectors of contaminants to higher trophic levels of the aquatic and sediment food webs. Contaminant concentrations in living organisms can accumulate to levels much greater than those found in ambient water and sediment due to an organism's inability to metabolize certain contaminants (Vinogradov, 1959) and a high affinity of some contaminants for lipid-rich tissue in bivalves (Stout and Beezhold, 1981). Biomonitoring using bivalves has been widely applied by the California State Mussel Watch Program (SWM) (Phillips, 1988; Rasmussen, 1994) and other studies (Young et al., 1976; Wu and Levings, 1980; Hummel et al., 1990; Martincic et al., 1992, Gunther et al., 1999; O'Connor, 2002). Bivalves are excellent organisms for biomonitoring of contaminants since they accumulate contaminants from the ambient environment, have limited mobility and are fairly resistant to contaminant effects (O'Connor, 2002). The RMP is continuing the long-term monitoring of the State Mussel Watch Program, which monitored sites throughout the Bay beginning in the early 1980s.

The objectives of the RMP Bivalve Bioaccumulation Monitoring Program are to:

- Describe the distribution and trends of pollutant concentrations in the Bay,
- Measure pollution exposure and effects on selected parts of the Bay ecosystem, and

The bivalve monitoring is especially valuable for determining long-term trends in contaminant levels. This Program component also complements the water and sediment sampling. Unlike the water quality sampling, which gives an indication of water quality at one particular point in time, contaminant concentrations measured in transplanted bivalves serve to integrate water quality over the period of deployment (typically 90 to 100 days). Also, while measurement of contaminant concentrations in water and sediment are useful for trend monitoring over time, they do not reveal the extent to which various contaminants are able to transfer into the food web and pose risks to consumers.

In 2001, trace metals measurements in bivalves were reduced from every year to every sixth year as a cost reduction measure for metals not on the 303(d) List or the Water Board's "pollutants of concern" for San Francisco Bay list. Trace metals were last measured in bivalve tissue in 2008.

In 2006, the RMP Status and Trends Program was re-evaluated to determine whether current sampling size and frequency was appropriate for meeting the needs of RMP stakeholders (Melwani et al., 2008). Based on this evaluation, bivalve sampling for organic parameters was modified from an annual to a biennial frequency. In 2012, bivalve sampling was completed and trace organics were measured. Microcystin and siloxanes were also analyzed as part of two pro bono RMP Special Studies.

Sites

Bivalves were initially deployed at eleven sites throughout the Bay to represent both the spine and margins of the Bay. In 1994, four deployment sites were added, for a total of 15. Specific site locations were heavily influenced by the availability of a fixed structure to easily locate the subsurface moorings.

Based on a new biogeographical delineation of the Bay, it was apparent that the newly defined segments were not represented equally by the 15-station bivalve deployment design. Consequently, an

analysis was undertaken to determine the optimum number and distribution of bivalve deployment sites needed to track trends in bioavailable contaminants in the Bay. Based on this analysis, several sites were removed from the project and, in 2003, the design was modified to its current configuration, consisting of three transplant sites within each of the Lower South Bay-South Bay, Central Bay and San Pablo Bay segments, respectively, and collection of resident bivalves at two sites within the Rivers segment for a total of 11 stations.

In 2012, Conductivity, Temperature and Depth (CTD) casts were taken at all nine transplanted sites; however, CTD information was not collected at the two Rivers stations.

Station names, codes, location, and sampling dates for the 2012 monitoring effort are listed in Appendix 3 and shown in Figure 3.1.

Field Methods

Bivalve Monitoring Field Methods

The RMP Bivalve Bioaccumulation Monitoring Program was initiated in 1993 as a transplant study in which bivalves were collected from "clean" locations (i.e., those with relatively low concentrations of specific pollutants) and transplanted to targeted sites within the Bay. Bivalves were deployed for 90 to 100-day periods with deployment beginning in February and June. These deployment periods were chosen to encompass the range of hydrographic conditions in the Bay and to allow comparisons of within-season variation in addition to long-term trend monitoring. At the conclusion of deployments, bivalves are retrieved, processed using clean techniques, and aliquoted for eventual analysis. Generally, 30–40 bivalves are composited from each site for each type of analysis, although high bivalve mortality sometimes reduces the number of organisms in a composite sample. The current RMP sampling plan stipulates that we deploy biennially during the dry season, usually in June, and retrieve the samples after approximately 100 days.

Starting with the 1999 dry season (summer) deployments, CTD profiles were collected at each bivalve site during both deployment and retrieval cruises to help determine how ambient environmental factors affect the transplanted bivalves. Salinity, dissolved oxygen, temperature, and total suspended solids impact bivalve health and could affect contaminant bioaccumulation rates.

Source of Bivalves

Bioaccumulation was evaluated by collecting mussels (*Mytilus californianus*) from Bodega Head, an uncontaminated "background" site of known chemistry, and deploying these bivalves during the dry season at nine locations in the Bay for approximately 100 days.

Prior to 2003, several different species were used in the transplant study. Beginning in 2003, the Program was modified to deploy one species, *Mytilus californianus*, in order to ensure higher comparability between sites. *Mytilus californianus* is a salt tolerant species that can also handle salinities as low as 15 ppt (Bayne, 1976). Trace element and trace organic tissue concentrations are more comparable throughout the San Francisco Bay when they are accumulated by the same species because metabolic activity is similar in all deployed organisms.

Resident clams (*Corbicula fluminea*) were also collected from one site on the Sacramento River and one site on the San Joaquin River. Resident clams were collected using a clam dredge approximately

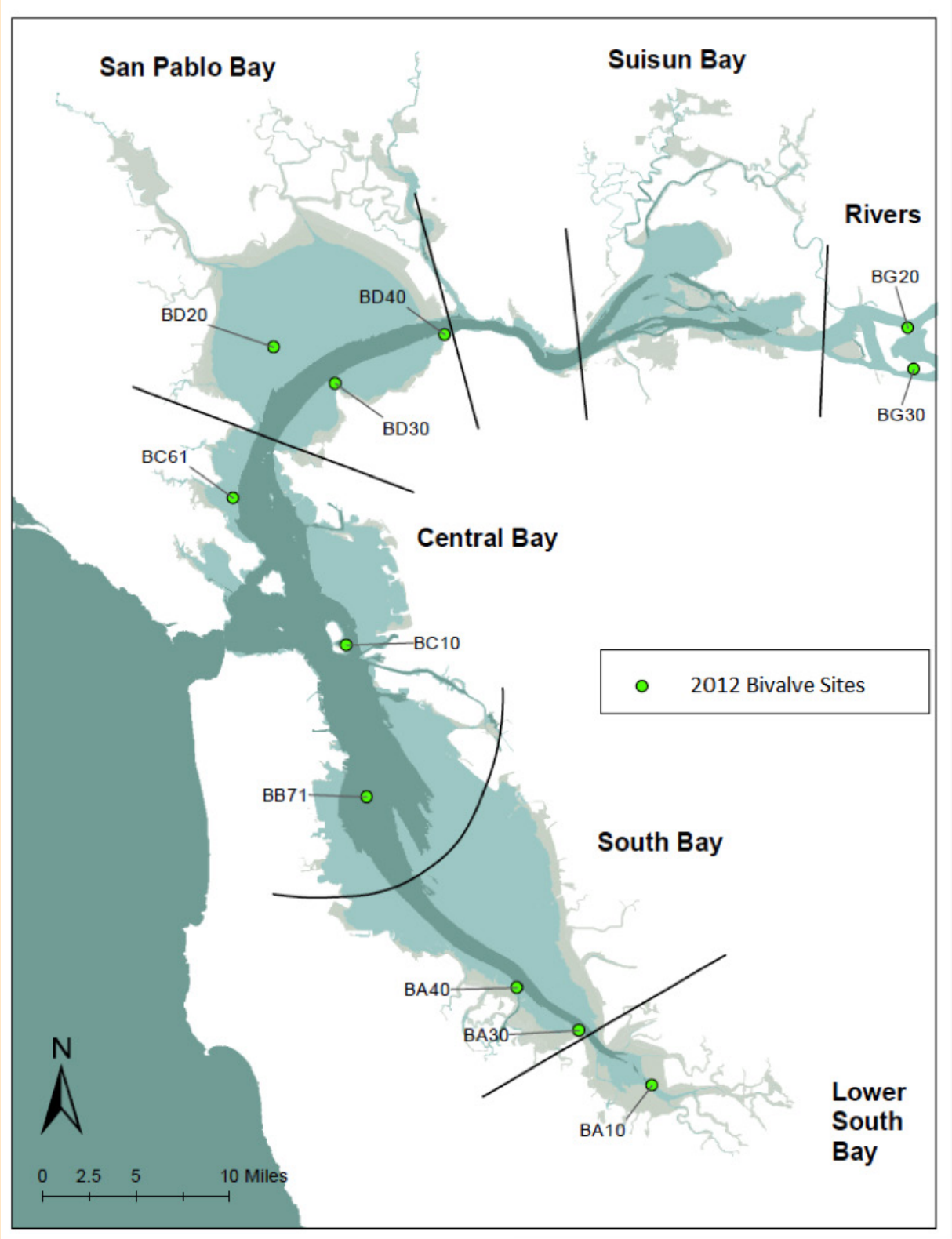

Figure 3.1 Map of 2012 Bivalve Monitoring Stations.

two feet wide by three feet long and 50 pounds in weight. The dredge was deployed from a boat and was dragged along the bottom. When brought to the surface, the clams were placed into a clean plastic container and stored for organics analysis.

In spring 2010, Bodega Head (the background site where the mussels are harvested) was designated as a marine reserve. Although collection at Bodega Head was authorized for the 2012 bivalve sampling effort, future collections may not be allowed. Therefore, 30 mussels were collected from two alternative locations to the north and south of the Reserve in 2012. The mussels from the two new sites were not transplanted to the nine Bay locations, but contaminant concentrations in the mussels were analyzed to determine if the sites could be suitable replacements for the Bodega Head collection location.

Deployment of Transplanted Bivalves

At each site, two hundred mussels were randomly allocated and placed into predator-resistant cages for deployment. Mussels of approximately the same shell length were used (49-81 mm). The same number was also used for the reference (time zero) sample, which was used to provide a baseline on "pre-deployment" tissue condition before deployment.

The cages were constructed out of rigid plastic mesh and PVC pipe. The mesh overlapped around itself to keep predators from slipping through any gaps between the edges. After the cages were built, they were soaked in water for at least a day to remove any potential signal associated with the adhesives used for the construction.

At each site, a line ran from the bottom of the fixed structure (typically a fixed buoy or marker) out to the bivalve mooring, which consisted of a large screw (earth anchor) that was threaded into the bottom sediment and was associated with pilings or other permanent structures. A large subsurface buoy was attached to the earth anchor by a one to two meter line. The bivalve cages were attached to the buoy line, which kept the bivalves off the bottom to prevent smothering. Since the beginning of the Program, loss of a mooring has occurred on only two occasions, probably due to being ripped out by a vessel anchor. Mooring installation, bivalve deployment, and retrieval were all accomplished by SCUBA divers.

Retrieval of Transplanted Bivalves

Upon retrieval, the bivalve cages were cut off the buoy line and taken to the surface. On the vessel, the number of dead organisms was recorded. Bivalves were allocated for various analyses and studies as determined by SFEI staff; the allocations are outlined in detail in the 2012 Bivalve Retrieval Report. Bivalves allocated for trace organic, microcystin, and siloxane analyses were not rinsed, wrapped in two layers of aluminum foil, placed in 2-gallon zip-top bags and placed on dry ice. Bivalves allocated for growth analysis were rinsed in the field to remove overlying mud, placed in 2-gallon zip-top bags and placed on dry ice.

Based on findings by Stephenson (1992) during the RMP Pilot Program, bivalve guts were not depurated before homogenization for tissue analyses. However, sediment in bivalve guts may contribute to the total tissue concentration for trace organic contaminants.

Analysis

Target Analysis

A summary table of target analytes is presented below. Refer to Appendix 7 for a more detailed listing of target analytes.

Table 4.1 Target Analytes: A summary table of the 2012 target analytes, analytical laboratories, reporting units, and field preparation code

Analyte	Field Prep Code	Analysis Lab	Reporting Unit
Trace organics	Not rinsed, placed on dry ice	AXYS Analytical Laboratories	ng/g (ppb)
Microcystin[a]	Not rinsed, placed on dry ice	Kudela Laboratory, UC Santa Cruz	ppb
Siloxanes[a]	Not rinsed, placed on dry ice	Environment Canada	ng/g (ppb)
Growth	Rinsed in field, placed on dry ice	Applied Marine Sciences	g
Archive	Not rinsed, placed on dry ice	N/A	N/A
a) Microcystin and siloxane are not RMP target analytes, but were sampled during the 2012 S&T cruise as part of a pro bono Emerging Contaminants Special Study.			

Trace organics and growth data are available for downloading via the RMP website using the Contaminant Data Display and Download Tool at http://www.sfei.org/rmp/wqt.

Laboratory Methods for Bivalve Analysis

SFEI maintains SOPs for all laboratory analyses. Please contact SFEI (amy@sfei.org) for more details.

Trace organics analyses of bivalve tissue samples were performed by AXYS Analytical Laboratories. In the past, trace organics analyses of bivalve tissue samples were conducted by the California Department of Fish and Wildlife Water Pollution Control Laboratory (CDFW-WPCL). A brief overview of the extraction and analyses used for the target trace organics are described below. Extract cleanup and partitioning methods are modifications of the multi-residue methods for fatty and non-fatty foods described in the U.S. Food and Drug Administration Pesticide Analytical Manual (US FDA, 1994). The laboratory SOPs that describe the methods in more detail are on file at SFEI.

Tissue Extraction

Samples are removed from the freezer and allowed to thaw. Prior to extraction, bivalve tissue samples are homogenized. For PCBs, PBDEs, and pesticides, 1-25 g sample homogenates are dried with anhydrous sodium sulfate, isotopically spiked with labeled surrogate standards, then Soxhlet extracted in toluene. For lipid analysis, a subsample is taken from the raw extract prior to cleanup.

For PAHs, 10-30 g of homogenized, wet sample is mixed with methanol and spiked with a suite of isotopically labelled surrogate standards. Potassium hydroxide solution is added, and the mixture is boiled under reflux for 1 hour. Ultra pure water is added and the boiling is continued for 1½ hour. The liquid phase is extracted by shaking with pentane. The pentane extract is washed with ultra pure water and dried over anhydrous sodium sulphate.

As appropriate and necessary for specific analyte groups, cleanup surrogates are added, and sample extracts may be cleaned up by gel permeation (Biobead) treatment before further column cleanup. For some analyses, the extract is treated with activated copper to remove sulphur, before being subjected to column cleanup, which may include silica, Florisil, alumina, carbon/Celite, and gel permeation columns.

Organochlorine Pesticide, PCB, and PBDE Analyses in Tissue

Extracts are cleaned up as needed and fractionated to remove interfering compounds. The fractions are concentrated to an appropriate volume for the final extract. The final extract is spiked with isotopically labelled recovery (internal) standards prior to instrumental analysis, and analyzed by high resolution gas chromatography (with different columns used depending on analyte group: DB-5HT for PBDEs, SPB-Octyl for PCBs, and DB-5 for pesticides) with a high resolution mass spectrometer (HRMS) operated in electron impact (EI) ionization mode using multiple ion detection (MID).

Analysis of Extractable PAH Compounds in Tissue

Cleaned up extract fractions for PAH analyses are dried to a final extract volume, and isotopically labelled recovery (internal) standards are added prior to instrumental analysis. PAHs are analyzed by GC/LRMS conducted on a gas chromatograph equipped with a Restek Rtx-5 chromatography column, with detection by a low resolution mass spectrometer (LRMS) operated in an electron impact (EI) ionization mode using multiple ion detection (MID).

Laboratory Methods for Bivalve Microcystin Analysis

Microcystin analyses of bivalve tissue samples were performed by Dr. Raphael Kudela's Laboratory at UC Santa Cruz. Bivalve tissue samples were homogenized using a Bucchi B-400 mixer. A 2-5 g sample was finely-ground with an Arrow 850 tissue grinder, followed by sonication with a Branson® 3510 Ultrasonic. The extracts were then centrifuged at 3500 rpm using a HN-S centrifuge, reduced to minimum volume, diluted with water, acidified, and cleaned-up using solid phase extraction. Tissue samples were analyzed for microcystin by Liquid Chromatography-Mass Spectrometry using an Agilent 6130 instrument equipped with a Phenomenex Kinetix C18 column.

Laboratory Methods for Bivalve Siloxane Analysis

Siloxane analyses of bivalve tissue samples were performed in the laboratory of Dr. Derek Muir of Environment Canada (Burlington, ON, Canada). Sample containers were opened in a laboratory "clean room" where siloxane levels are known to be very low, due to the carbon levels and the use of a high-efficiency particulate absorption air filter. Liquid–solid extraction technology was used to extract siloxane. Tissue was pooled from several bivalves to prepare 2 g samples. The tissue samples were then placed in a polyethylene centrifuge vial and C-D4, D5 and D6 were added to the vial. The samples were shaken with acetonitrile/pentane (1:1) on an orbital shaker for 60 min. The mixture was then centrifuged and the pentane drawn off into a gas chromatography vial. Prior to analysis, 1-ug naphthalene-D8 in 10 µL of pentane was added to each vial as the performance standard. The samples were analyzed using large volume injection-GC- lower resolution mass spectrometry.

Bivalve Growth and Survival

Applied Marine Sciences (AMS-CA) conducted the bivalve health measure evaluations as in previous years.

Analysis of contaminant concentrations was conducted on a subset of the transplanted bivalves (composites contain 40-60 individual bivalves from each site) prior to deployment in Estuary locations (T-0) and after the 100-day deployment period. The differences between pre- and post-deployment concentrations allow determination of contaminant uptake during the period of deployment. Unlike in previous years, in 2012 no T-1 bivalves (controls from the original collection sites) were collected at the end of the deployment period due to restrictions placed upon collections within the Marine Protected Area. This analysis will likely be resumed for future years of the program, either from within the Reserve (if permission granted) or at alternative bivalve collection locations.

Since 2002, the RMP has discontinued the condition index (CI) measure in favor of the growth mean as the only health indicator. Reasons for the discontinuation of CI are given in the footnote * below. The growth mean is a measure of growth of the composite of bivalves at a particular site in comparison to the T-0. The growth mean was determined by taking the dry weight of each individual and subtracting the mean dry weight of the T-0 for that species. This calculation was done for each individual bivalve. The mean of the difference of all the individuals at a particular site was then calculated to give the growth mean, and the standard error of the growth was also reported as a measure of inter-individual variability (but does not distinguish between variations in initial weight, as only an average initial (T-0) weight is reported for collected bivalves in an approximate size class) .

Footnote:*The CI interpretation of bivalve health can be confounding when ambient conditions (i.e., salinity) are more uniform such as during the summer deployment period. Because the CI is the ratio of dry tissue weight to shell cavity volume, it could be affected by changes in either tissue weight or shell size. For example, either a decrease in tissue weight with stable shell size or an increase in shell size with stable tissue weight could be interpreted as a decrease in CI. Consequently, the interpretation of CI as an indicator of health can be problematic.

Quality Assurance / Quality Control (QA/QC)

QA/QC Bivalve Growth and Survival

Growth and survival were reported for caged transplanted bivalves maintained and monitored by AMS-CA, and resident bivalves were collected from river stations not suitable for the transplants. Bivalve weights and growth (for transplants) were in line with previous results (~1 g dw for transplants, and 0.05 g dw for residents) for their respective species. Survival was generally ~70% or higher, which provided enough material for chemical analyses with some left to archive. Measurements of these ancillary parameters typically do not include any external QC samples, although the internal consistency of reported values was reasonable; the ratios of the standard errors to the means for the stations were generally between 5 to 10%.

QA/QC PAHs, PBDEs, PCBs and pesticides

Detection limits were sufficient to measure 85% of the targeted PAHs in a majority of samples, and all alkylated Polycyclic Aromatic Hydrocarbons (PAHs) were detected in at least half the samples. Nearly two-thirds (25 of 40) analytes were detected in method blanks, with results for 8-100% (depending

on analyte) of samples censored for being <3x the amount in the blank for 9 PAHs and 10 alkylated PAHs). Replicate relative standard deviations (RSDs) for field samples or matrix spikes were within the target 35% average for most analytes, but two analytes were flagged for being moderately above that limit in field samples and two analytes (Fluoranthene and Pyrene) censored for being greatly above the limit (>70% RSD). Recoveries on spiked samples were generally good, with only 2,3,5- and 2,3,6-Trimethylnaphthalene showing moderate recovery errors (averaging >35% but <70%), flagged but not censored. The alkylated PAHs do not have any recovery checks as groups, only for selected compounds as individual (mostly methylated) PAHs. Most of the analytes were in the same general concentration range as previous years (2002-2010), although several analytes with large proportions of non-detects showed lower averages than in the past. Sums of PAHs could not be generated for samples because PAHs (notably Fluoranthene and Pyrene) usually together accounting for over 30% of sum PAHs could not be quantified in samples due to QC issues."

Results were generally good for Polybrominated Diphenyl Ethers (PBDEs) in bivalves aside from PBDE 209. Detection limits were sufficient to quantify in all samples for the expected most abundant PBDEs (47, 99, 100, 153), except PBDE 209 which was not detected in 60% of samples. Of the major congeners, 99, 153, and 209 were found in blanks above detection limits, with most samples containing PBDE 209 <3x the amount in the blanks and censored, and one sample each censored for PBDE 99 and 153. Average RSDs on matrix spike replicates were within the target <35% for all analytes except PBDE 207 and 209, with very high variability (>70% RSD) and censored. Recoveries on spiked blanks averaged <35% error for all reported compounds. Concentrations were generally lower than previous years for most PBDEs at the RMP S&T stations.

Polychlorinated Biphenyl (PCB) detection limits were sufficient to quantify the most abundant PCBs in the majority of samples, although many congeners were not detected in all samples. Only PCB 28 was found in method blanks, but its concentrations in field samples were always over 3x higher. Replicates on field samples or matrix spikes were generally good, within the target 35% average RSD for all analytes. Recoveries on spiked blanks were good, with errors averaging <35% for all congeners. Most of the PCBs were in the same general concentration range as previous years, although averages were slightly lower for many of the lighter congeners. Similar to sediment, a Sum of 208 PCBs is reported due to the prevalence of PCB 011, a synthetic dye by-product unrelated to Aroclor PCBs.

Pesticides reported by AXYS in bivalve tissue included primarily legacy organochlorine pesticides. Detection were sufficient to get <50% NDs for most pesticides in both bivalve species. Only Hexachlorobenzene was found in blanks, with most samples censored for concentrations less than 3 times those in blanks. Precision was good, with average RSDs of 12% or better for all analytes. Recoveries on spiked blanks were also good, averaging 17%, well within 35% of target values. Average concentrations were similar to previous years for analytes that were frequently detected, although alpha HCH was 4 times higher than previous years' averages.

Bivalve Trends

The RMP currently monitors contaminant accumulation in bivalve tissue at nine sites distributed throughout the Bay (Figure 4.1). Many of these sites have been monitored since 1980 by the State Mussel Watch (SMW) Program and, consequently, by the RMP. Additionally, the NOAA National Mussel Watch (NMW) Program has monitored resident mussel contamination levels at several sites in San Francisco Bay since 1986. Two of the NMW sites are located near RMP bivalve sampling sites. The data from these co-located sites have been included to corroborate trends seen in SMW and RMP bivalve data. The 2010 NMW data is not yet available at http://ccma.nos.noaa.gov/about/coast/nsandt/download.as

To look at trends of trace organics concentrations in bivalves, linear regressions of log-transformed tissue concentrations over time were generated for the nine sites. The contaminants analyzed were Sum of PCBs, Sum of DDTs, Sum of PAHs, and Sum of PBDEs. Bivalve tissue concentration data from the RMP and the SMW were plotted normalized to lipid weight, while the NMW data were plotted as dry weight (due to high variability in their lipid measurements over the years, making them unreliable). The different data point markers represent different monitoring programs and analysis labs, as shown in the legends. For each linear regression, the slope, significance level and estimated half-life are shown in the tables below. The estimated half-life (if applicable) is also shown on each graph, but is marked with an asterisk when derived from a regression that is not significant at the 0.05 level.

Polychlorinated Biphenyls (PCBs) in Bivalves

The PCB data from the State Mussel Watch Program are sum of Aroclors and the RMP PCB data are sum of 40 congeners. Both datasets were normalized to bivalve lipid content. The PCB data from the National Mussel Watch Program are sum of congeners in dry weight due to unexplained variation in lipid data obtained from different labs over the years.

RMP and SMW – Sum of PCBs data (ng/lipid g)

Figure 3.2 PCB concentrations (ng/g lipid) in transplanted mussels (RMP and SMW data), 1979-2012

c) Trends calculated on resident clams, Corbicula fluminea, rather than transplanted mussels.

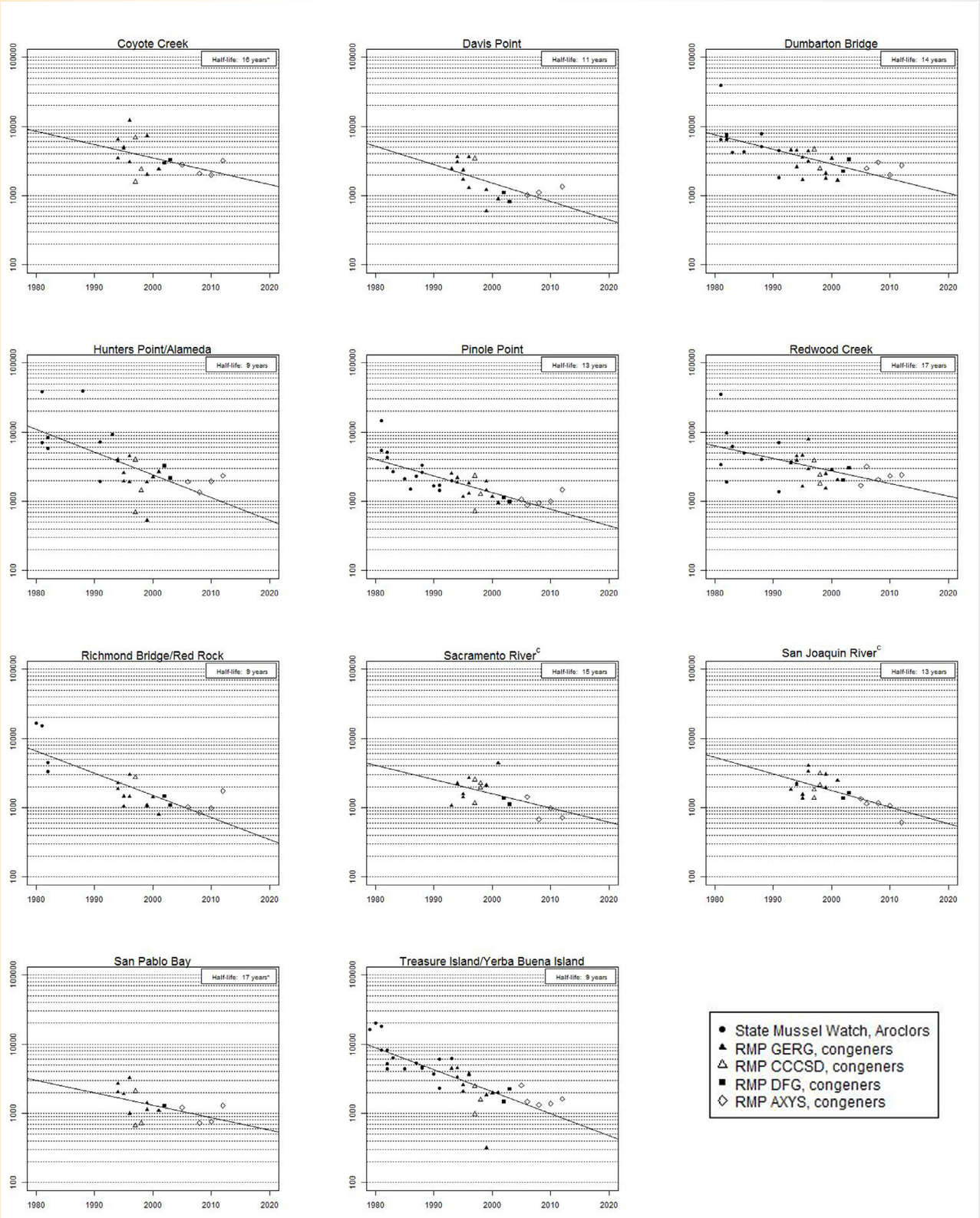

Table 3.2 Linear regression statistics for PCB concentrations over time (RMP and SMW data)
c) Trends calculated on resident clams, *Corbicula fluminea*, rather than transplanted mussels.

Code	Site Name	N	Years	Trend	Half-life (years)	Slope	p-value	R^2
BG20	Sacramento River	19	1993 - 2012	▼	15	-0.02	0.013	0.31
BG30	San Joaquin River	21	1993 - 2012	▼	13	-0.02	< 0.001	0.47
BD40	Davis Point	16	1993 - 2012	▼	11	-0.03	0.016	0.35
BD20	San Pablo Bay	16	1994 - 2012	NS	17	-0.02	0.055	0.24
BD30	Pinole Point	35	1981 - 2012	▼	13	-0.02	< 0.001	0.59
BC61	Richmond Bridge/Red Rock	21	1980 - 2012	▼	9	-0.03	< 0.001	0.65
BC10	Treasure Island/Yerba Buena Island	37	1979 - 2012	▼	9	-0.03	< 0.001	0.62
BB71	Hunters Point/ Alameda	27	1981 - 2012	▼	9	-0.03	< 0.001	0.41
BA40	Redwood Creek	31	1981 - 2012	▼	17	-0.02	0.002	0.29
BA30	Dumbarton Bridge	30	1981 - 2012	▼	14	-0.02	< 0.001	0.45
BA10	Coyote Creek	18	1994 - 2012	NS	16	-0.02	0.059	0.2

Nine of the eleven RMP-monitored sites show statistically significant declines in PCB concentrations in bivalve tissue. The ostensible decline in PCB concentrations at station BD20 in San Pablo Bay and at station BA10 in Coyote Creek were not statistically significant. The estimated half-lives for bivalve PCB concentrations range from 8 to 17 years by site.

NMW – Sum of PCBs data (ng/dry g

Figure 3.3 PCB concentrations (ng/g dry wt.) in transplanted mussels (NMW data), 1988-2009

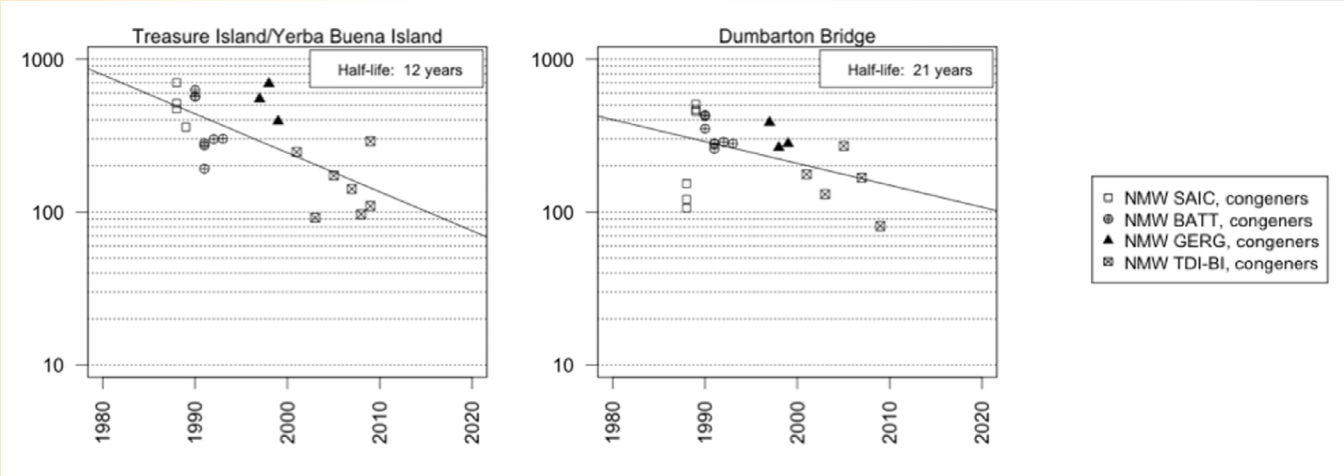

Table 3.3 Linear regression statistics for PCB concentrations over time (NMW data)

Code	Site Name	N	Years	Trend	Half-life (years)	Slope	p-value	R^2
BC10	Treasure Island/ Yerba Buena Island	22	1988-2009	▼	**12**	**-0.03**	**< 0.001**	**0.49**
BA30	Dumbarton Bridge	22	1988-2009	▼	**21**	**-0.01**	**0.048**	**0.18**

Both National Mussel Watch sites show statistically significant declines in PCBs concentrations in bivalve tissue. However, the NMW data suggest slower rates of decline than the SMW and RMP data. For the Treasure Island site, the NMW data gives an estimated 12 years for bivalve PCBs concentrations to decrease by half versus the 9-year half-life estimated by the combined SMW and RMP data. Similarly, for the Dumbarton Bridge site, the NMW data gives an estimated 21-year half-life versus the 14-year half-life estimated by the SMW and RMP data.

DDTs Trends in Bivalves

The DDTs data from the RMP, the SMW and the NMW are the sum of six DDTs [o,p'-DDD; o,p'-DDE; o,p'-DDT; p,p'-DDD; p,p'-DDE; p,p'-DDT]. The RMP and the SMW DDTs data sets were normalized to bivalve lipid content, while the NMW DDTs data are presented as portion of dry tissue weight.

RMP and SMW – Sum of DDTs data (ng/g lipid)

Figure 3.4 DDT concentrations (ng/g lipid) in transplanted mussels (RMP and SMW data), 1979-2012

c) Trends calculated on resident clams, *Corbicula fluminea*, rather than transplanted mussels.

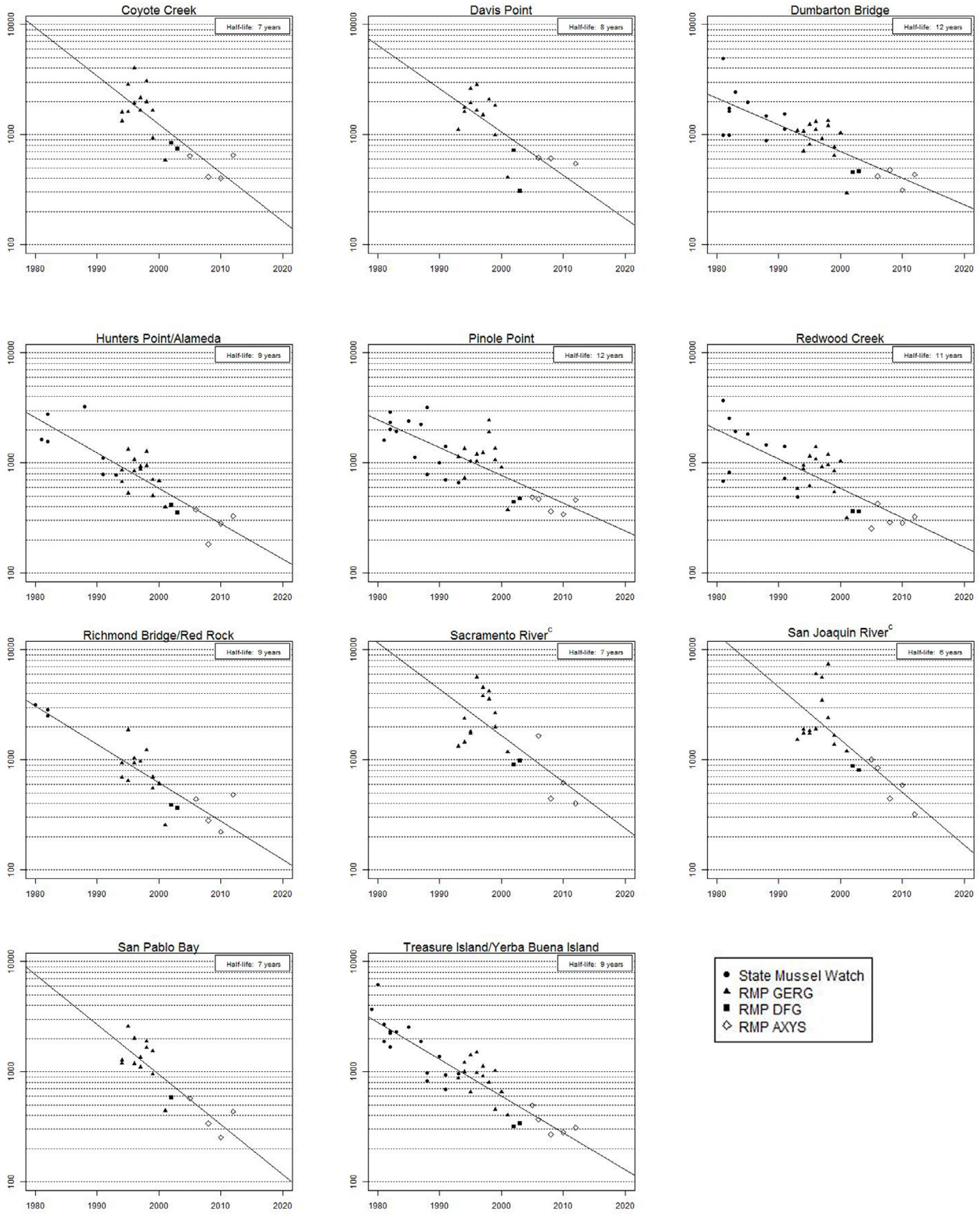

Table 3.4 Linear regression statistics for DDT concentrations over time (RMP and SMW data)
c) Trends calculated on resident clams, Corbicula fluminea, rather than transplanted mussels.

Code	Site Name	N	Years	Trend	Half-life (years)	Slope	p-value	R2
BG20	Sacramento River	19	1993 - 2012	▼	7	-0.04	< 0.001	0.51
BG30	San Joaquin River	21	1993 - 2012	▼	6	-0.05	< 0.001	0.56
BD40	Davis Point	17	1993 - 2012	▼	8	-0.04	< 0.001	0.53
BD20	San Pablo Bay	17	1994 - 2012	▼	7	-0.05	< 0.001	0.72
BD30	Pinole Point	35	1981 - 2012	▼	12	-0.03	< 0.001	0.58
BC61	Richmond Bridge/Red Rock	21	1980 - 2012	▼	9	-0.03	< 0.001	0.78
BC10	Treasure Island/Yerba Buena Island	37	1979 - 2012	▼	9	-0.03	< 0.001	0.82
BB71	Hunters Point/ Alameda	27	1981 - 2012	▼	9	-0.03	< 0.001	0.73
BA40	Redwood Creek	31	1981 - 2012	▼	11	-0.03	< 0.001	0.59
BA30	Dumbarton Bridge	31	1981 - 2012	▼	12	-0.02	< 0.001	0.63
BA10	Coyote Creek	19	1994 - 2012	▼	7	-0.04	< 0.001	0.65

All of these monitored Bay sites show statistically significant declines in bivalve tissue DDT concentrations. The estimated half-lives for bivalve DDT concentrations at these sites range from 6 to 12 years.

NMW – Sum of DDTs data (ng/dry g)

Figure 3.5 DDT concentrations (ng/g dry wt.) in transplanted mussels (NMW data), 1986-2009

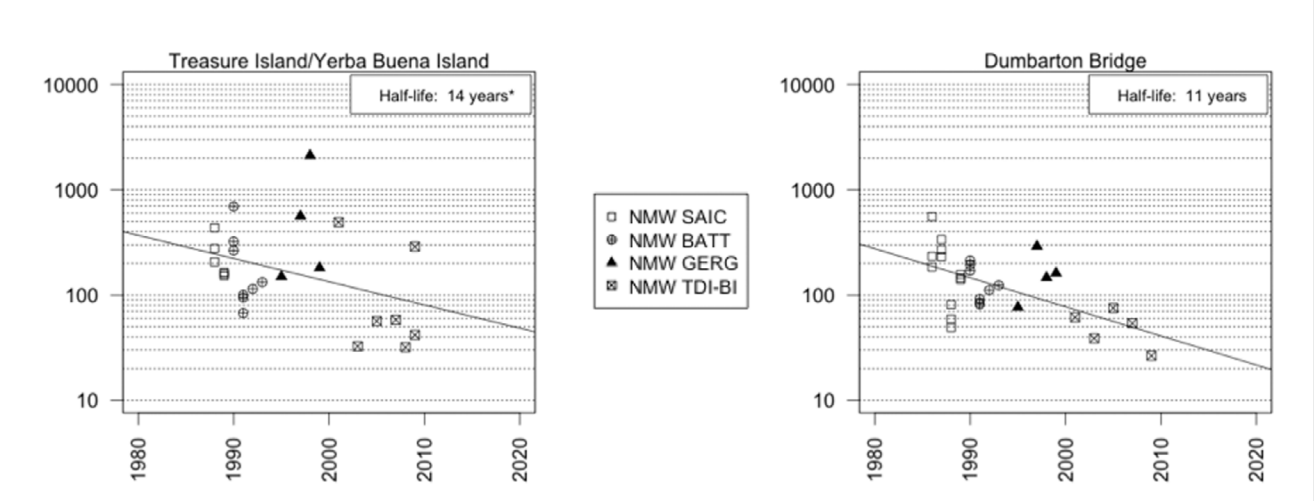

Table 3.5 Linear regression statistics for DDT concentrations over time (NMW data)

Code	Site Name	N	Years	Trend	Half-life (years)	Slope	p-value	R2
BC10	Treasure Island/ Yerba Buena Island	25	1988-2009	?	14	-0.02	0.067	0.14
BA30	Dumbarton Bridge	29	1986-2009	▼	**11**	**-0.03**	**< 0.001**	**0.37**

Both of these National Mussel Watch sites show declines in DDTs concentrations in bivalve tissue, but only one trend is statistically significant. The NMW data and the combined RMP and SMW data both give similar half-life estimates for bivalve DDTs concentration at the Dumbarton Bridge site.

Polycyclic Aromatic Hydrocarbons (PAHs) in Bivalves

The RMP PAHs data set was normalized to bivalve lipid content, while the NMW PAHs data are presented as portion of dry tissue weight. No SMW data were available for PAHs. Both the RMP and the NMW data sets consisted of sums over low and high molecular weight PAHs, but not alkylated PAHs.

The 2012 bivalve tissue PAH concentrations were not included in the above linear regression graphs or statistics. Only the 1994-2010 RMP data are presented because all of the 2012 PAH sums were rejected for either blank contamination or for excessive relative percent differences in the QA samples.

Figure 3.6 PAH concentrations (ng/g lipid) in transplanted mussels (RMP data), 1993-2010

c) Trends calculated on resident clams, Corbicula fluminea, rather than transplanted mussels.

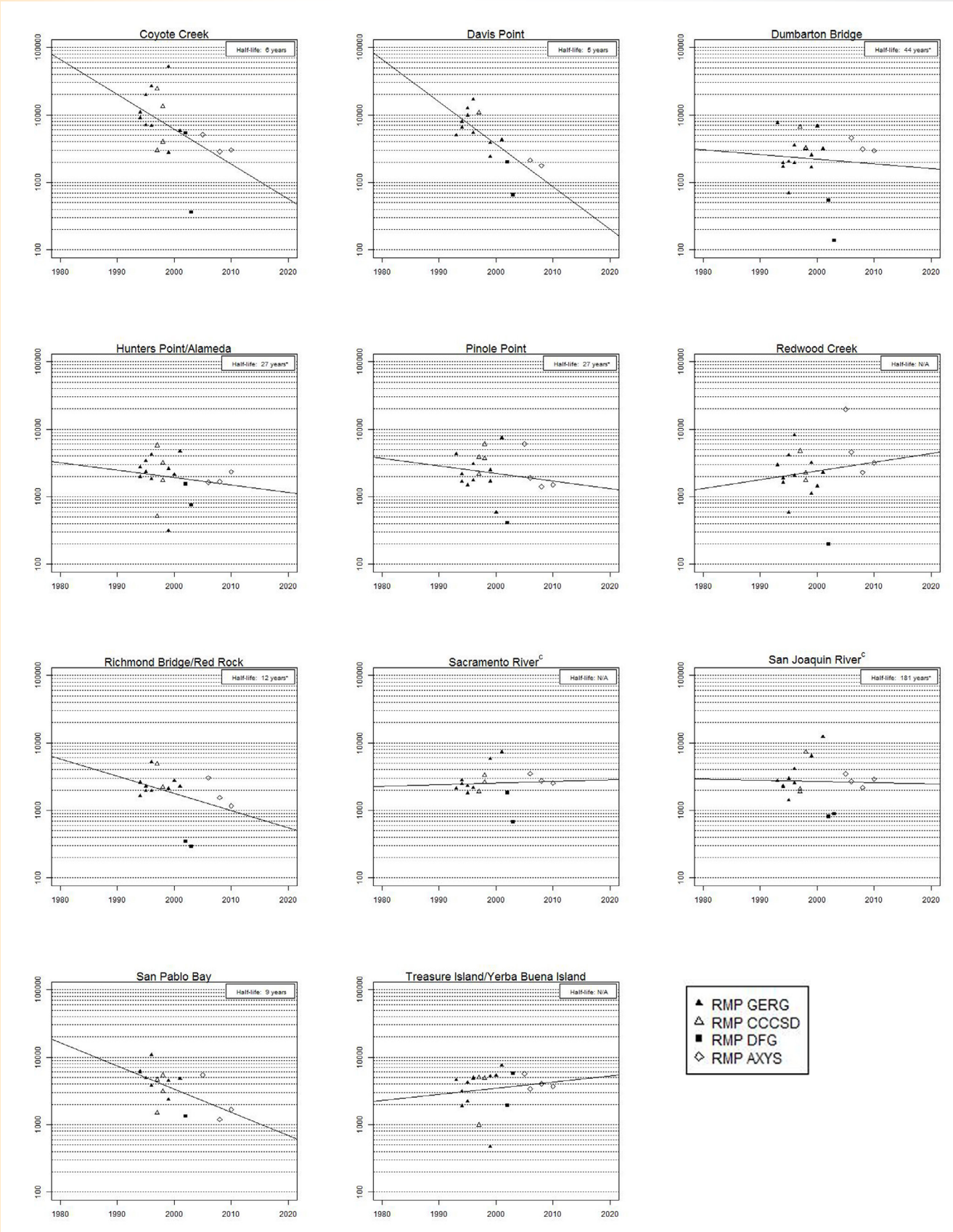

Table 3.6 Linear regression statistics for PAH concentrations over time (RMP data)
c) Trends calculated on resident clams, Corbicula fluminea, rather than transplanted mussels.

Code	Site Name	N	Years	Trend	Half-life (years)	Slope	p-value	R^2
BG20	Sacramento Riverc	16	1993-2010	?	(-132)	0	0.847	0
BG30	San Joaquin Riverc	18	1993-2010	?	181	0	0.908	0
BD40	Davis Point	15	1993-2008	▼	**5**	**-0.06**	**0.001**	**0.57**
BD20	San Pablo Bay	16	1994-2010	▼	**9**	**-0.03**	**0.016**	**0.35**
BD30	Pinole Point	19	1993-2010	?	27	-0.01	0.486	0.03
BC61	Richmond Bridge/ Red Rock	17	1994-2010	?	12	-0.03	0.136	0.14
BC10	Treasure Island/ Yerba Buena Island	20	1993-2010	?	(-33)	0.01	0.519	0.02
BB71	Hunters Point/ Alameda	19	1994-2010	?	27	-0.01	0.509	0.03
BA40	Redwood Creek	19	1993-2010	?	(-23)	0.01	0.532	0.02
BA30	Dumbarton Bridge	19	1993-2010	?	**44**	**-0.01**	**0.747**	**0.01**
BA10	Coyote Creek	18	1994-2010	▼	**6**	**-0.05**	**0.037**	**0.25**

The 1994-2010 RMP data show mixed trends for PAH concentrations in bivalve tissue. Only three of the monitored Bay sites show statistically significant trends in bivalve tissue PAHs concentrations. For the statistically significant trends, the estimated half-lives for bivalve PAH concentrations range from 5 to 9 years. It should be noted that the RMP PAH data set is about a decade shorter than the PCB and DDT data sets.

NMW – Sum of PAHs data (ng/dry g)

Figure 3.7 PAH concentrations (ng/g dry wt.) in transplanted mussels (NMW data), 1989-2009

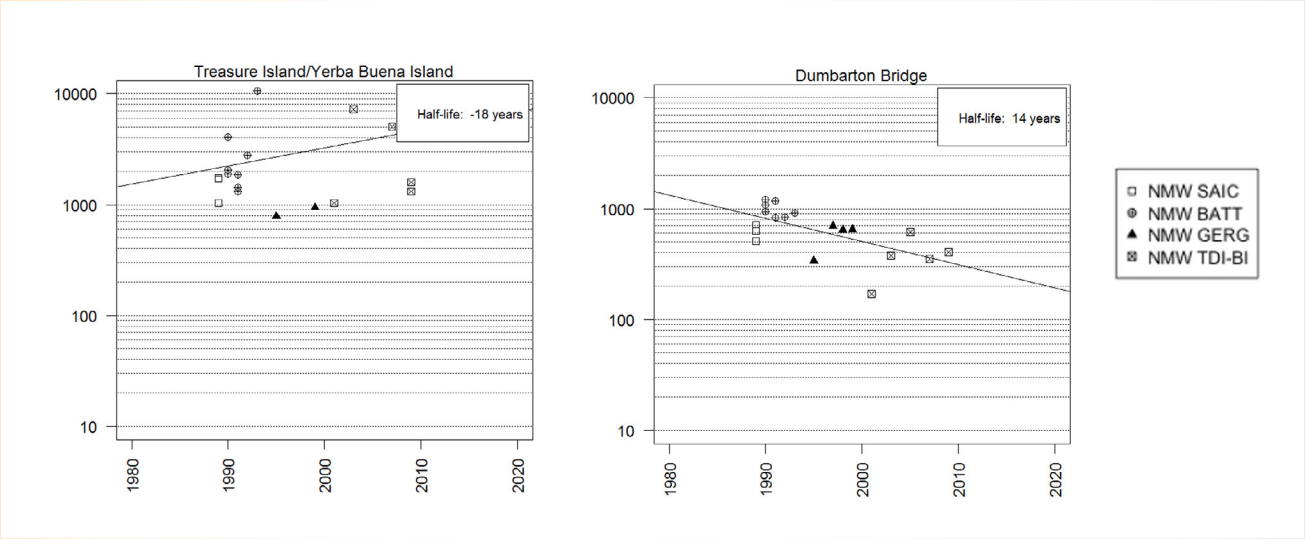

Table 3.7 Linear regression statistics for PAH concentrations over time (NMW data)

Code	Site Name	N	Years	Trend	Half-life (yrs)	Slope	p-value	R^2
BC10	Treasure Island/ Yerba Buena Island	22	1989-2009	?	(-18)	0.02	0.226	0.07
BA30	Dumbarton Bridge	20	1989-2009	?	14	-0.02	0.002	0.41

The NMW data set, which extends back further in time and includes many more samples per site, also shows mixed trends for PAH concentrations in bivalve tissue. Neither of the NMW sites shows a statistically significant trend; but, the ostensible increase in bivalve PAH levels at the Treasure Island site corroborate with the RMP data set, which also suggests that bivalve PAH concentrations are increasing at this site. Likewise, the NMW data does not show a statistically significant trend for the Dumbarton Bridge site, but both the RMP and NMW data sets suggest that PAH concentrations are decreasing.

Polybrominated Diphenyl Ethers (PBDEs) Trends in Bivalves

The RMP PBDEs data set was normalized to bivalve lipid content. No SMW data were available for PBDEs, and NMW data were not included since only one data point was available for each NMW site. The RMP Sum of PBDEs data set consists of the sum of over 50 different PBDE compounds.

RMP – Sum of PBDEs data (ng/lipid g)

Figure 3.8 PBDE concentrations (ng/g lipid) in transplanted mussels (RMP data), 2002-2012

c) Trends calculated on resident clams, *Corbicula fluminea*, rather than transplanted mussels.

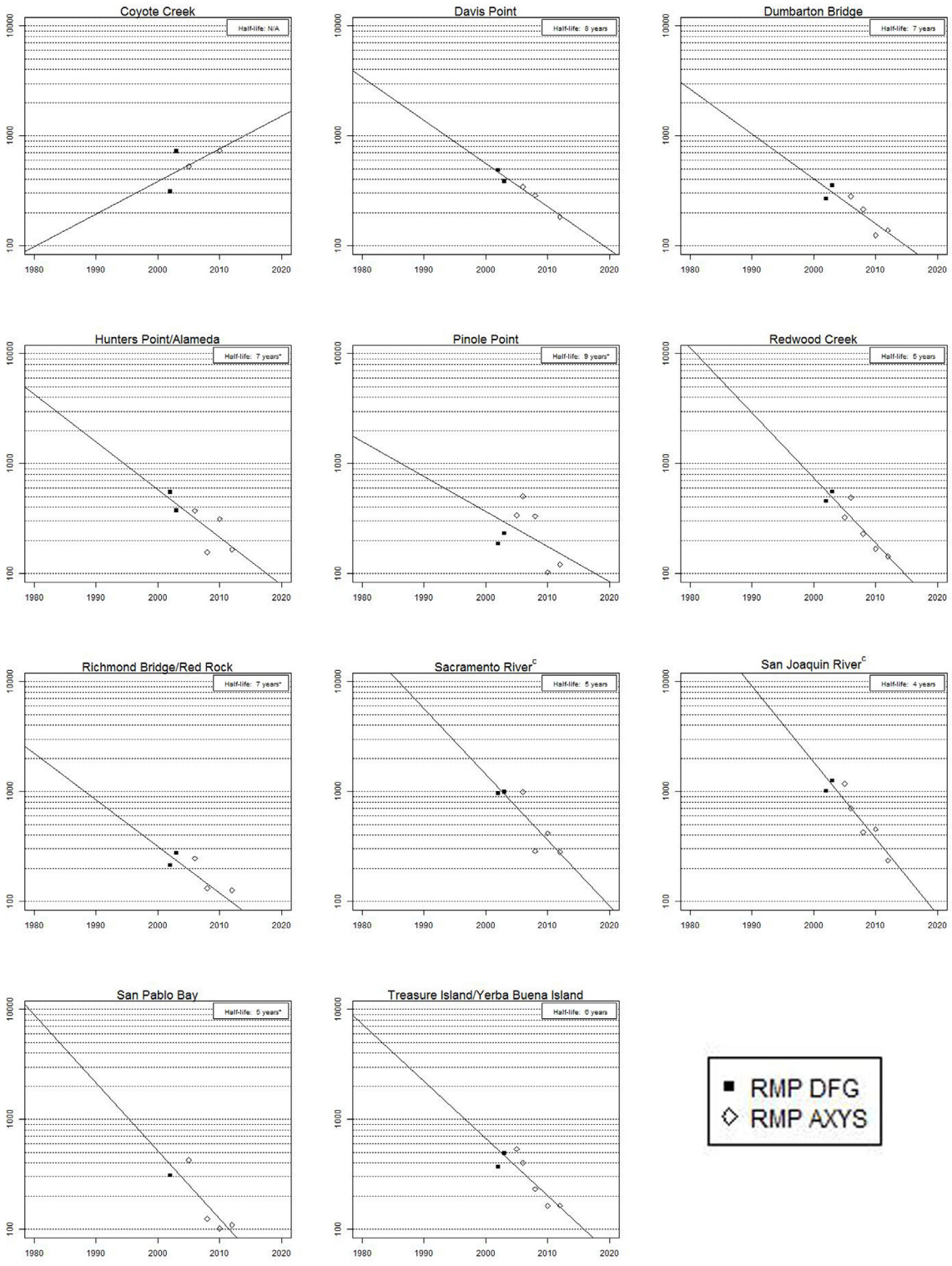

Table 3.8 Linear regression statistics for PBDE concentrations over time (RMP data)

c) Trends calculated on resident clams, *Corbicula fluminea*, rather than transplanted mussels.

Code	Site Name	N	Years	Trend	Half-life (yrs)	Slope	p-value	R^2
BG20	Sacramento River	6	2002 - 2012	▼	5	-0.06	0.027	0.74
BG30	San Joaquin River	7	2002 - 2012	▼	4	-0.07	0.002	0.87
BD40	Davis Point	5	2002 - 2012	▼	8	-0.04	0.003	0.96
BD20	San Pablo Bay	5	2002 - 2012	?	5	-0.06	0.064	0.73
BD30	Pinole Point	7	2002 - 2012	?	9	-0.03	0.297	0.21
BC61	Richmond Bridge/Red Rock	6	2002 - 2012	?	7	-0.04	0.059	0.63
BC10	Treasure Island/Yerba Buena Island	7	2002 - 2012	▼	6	-0.05	0.012	0.75
BB71	Hunters Point/ Alameda	6	2002 - 2012	?	7	-0.04	0.064	0.62
BA40	Redwood Creek	7	2002 - 2012	▼	5	-0.06	0.003	0.85
BA30	Dumbarton Bridge	6	2002 - 2012	▼	7	-0.04	0.02	0.78
BA10	Coyote Creek	4	2002 - 2010	?	-10	0.03	0.394	0.37

Despite the comparatively shorter time series (2002-2012), six out of the eleven RMP-monitored sites show statistically significant declines in PBDE concentrations. The observed declines may already be statistically significant because of PBDEs' relatively short half-lives (4-9 years).

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4. Appendix Tables

RMP Program Participants in 2012

Municipal Dischargers

Burlingame Waste Water Treatment Plant
Central Contra Costa Sanitary District
Central Marin Sanitation Agency
City of Benicia
City of Calistoga
City of Palo Alto
City of Petaluma
City of Pinole/Hercules
City of Saint Helena
City and County of San Francisco
City of San Jose/Santa Clara
City of San Mateo
City of South San Francisco/San Bruno
City of Sunnyvale
Delta Diablo Sanitation District
East Bay Dischargers Authority
East Bay Municipal Utility District (SD#1)
Fairfield-Suisun Sewer District
Las Gallinas Valley Sanitation District
Marin County Sanitary District #5, Tiburon
Millbrae Waste Water Treatment Plant
Mountain View Sanitary District
Napa Sanitation District
Novato Sanitation District
Rodeo Sanitary District
San Francisco International Airport
Sausalito Sanitation District
Sewer Agency of Southern Marin
Sonoma County Water Agency
South Bayside System Authority
Town of Yountville
Union Sanitary District
Vallejo Sanitation & Flood Control District
West County Agency

Cooling Water

GenOn Energy

Industrial Dischargers

C & H Sugar Company
Chevron Products Company
Crockett Cogeneration
Shell Oil Products - Martinez Refinery
Rhodia, Inc.
Tesoro Golden Eagle Refinery
USS – POSCO Industries
Valero Refining Company

Dredgers

Alameda Point
BAE Systems
Chevron Richmond Long Wharf
City of Benicia Marina
Conoco Phillips (Tosco-Rodeo)
Marin Yacht Club
Marina Bay Yacht Harbor
Marina Vista Harbor Homeowners Association
Napa Yacht Club
Port of Oakland
Port of San Francisco
San Francisco Marina
San Rafael Yacht Harbor
Sausalito Yacht Harbor
US Army Corps of Engineers
Vallejo Ferry Terminal
Valero Refining Co.

Storm Water

Alameda Countywide Clean Water Program
California Department of Transportation
City and County of San Francisco
Contra Costa Clean Water Program
Fairfield-Suisun Urban Runoff Management Program
Marin County Stormwater Pollution Prevention Program
San Mateo Countywide Stormwater Pollution Prevention Program
Santa Clara Valley Urban Runoff Pollution Prevention Program
Vallejo Sanitation and Flood Control District

RMP Contractors AND Principal Investigators in 2012

Logistical Coordinator; Shipboard Conductivity, Temperature, and Depth (CTD) Readings	Mr. Paul Salop Applied Marine Sciences (AMS), Livermore, CA
Ship Captain - Sediment Cruise	Mr. Chris Vallee Captain, *RV Turning Tide* United States Geological Survey
Ship Captain – Bivalve Cruise	Mr. David Morgan Captain, *RV Questuary* Romberg Tiburon Center
Sediment Trace Element Chemistry - As, Se, Hg, and Methyl Mercury	Ms. Tiffany Stilwater Brooks-Rand Lab LLC. (BR), Seattle, WA
Sediment Trace Element Chemistry - Ag, Al, Cd, Cu, Fe, Mn, Ni, Pb, Zn	Mr. Anthony Rattonetti City and County of San Francisco Laboratory
Sediment Trace Organics Chemistry	Ms. Nirmela Arsem East Bay Municipal Utility District (EBMUD), Oakland, CA
Bivalve Trace Organics Chemistry	Ms. Cynthia Tomey AXYS Analytical Services, Ltd., British Columbia, Canada
Sediment Toxicity Testing	Dr. John Hunt, Dr. Brian Anderson, and Dr. Bryn Phillips Marine Pollution Studies Laboratory (MPSL), Granite Canyon, CA
Sediment Ancillary Measurements - Grainsize	Sediment Grainsize Dr. Ivano Aiello Geological Oceanography Lab at Moss Landing, Moss Landing, CA
Sediment Ancillary Measurements - TOC, TN	Mr. Ralph Poulsen ALS Group, Tucson, AZ
Benthos	Ms. Dorothy NorrisCity and County of San Francisco Laboratory – Oceanside Biological Laboratory
	Ms. Susan McCormick, taxonomist
	Ms. Kamille Hammerston Moss Landing Marine Laboratories-Benthic Laboratory
USGS Water Quality	Dr. James Cloern, USGS, Menlo Park, CA
USGS Sediment Transport	Dr. David Schoellhamer, USGS, Sacramento, CA

Summary of 2012 RMP Sampling Stations

Cruise Type	Region	Site Code	Site Type	Collection Date	Latitude	Longitude	Site Depth (m)
SEDIMENT	Lower South Bay	BA10	Historical	2012-04-18	37.46873	-122.06427	3.3
SEDIMENT	South Bay	BA41	Historical	2012-04-17	37.55928	-122.2101	8
SEDIMENT	Central Bay	BC11	Historical	2012-04-19	37.82231	-122.34862	5.5
SEDIMENT	San Pablo Bay	BD31	Historical	2012-04-20	38.02473	-122.36319	5.5
SEDIMENT	Suisun Bay	BF21	Historical	2012-04-23	38.11562	-122.04009	2
SEDIMENT	Sacramento River	BG20	Historical	2012-04-24	38.05906	-121.81464	9.1
SEDIMENT	San Joaquin River	BG30	Historical	2012-04-24	38.02286	-121.80855	5.5
SEDIMENT	Central Bay	CB001S	Random	2012-04-19	37.87629	-122.36216	2.7
SEDIMENT	Central Bay	CB046S	Random	2012-04-19	37.63193	-122.31791	9.5
SEDIMENT	Central Bay	CB110S	Random	2012-04-19	37.67343	-122.27385	4.3
SEDIMENT	Central Bay	CB129S	Random	2012-04-19	37.75936	-122.34027	13.4
SEDIMENT	Lower South Bay	LSB002S	Random	2012-04-18	37.47893	-122.07776	10
SEDIMENT	Lower South Bay	LSB044S	Random	2012-04-18	37.48705	-122.09278	2.3
SEDIMENT	Lower South Bay	LSB045S	Random	2012-04-18	37.48711	-122.10515	2
SEDIMENT	Lower South Bay	LSB112S	Random	2012-04-18	37.49007	-122.08407	2.7
SEDIMENT	San Pablo Bay	SPB002S	Random	2012-04-20	38.01627	-122.34101	2.7
SEDIMENT	San Pablo Bay	SPB027S	Random	2012-04-20	38.06807	-122.46224	1.2
SEDIMENT	San Pablo Bay	SPB041S	Random	2012-04-20	38.05553	-122.43995	1.8
SEDIMENT	San Pablo Bay	SPB110S	Random	2012-04-20	38.04721	-122.29796	9.1
SEDIMENT	South Bay	SB002S	Random	2012-04-17	37.6103	-122.16728	1.6
SEDIMENT	South Bay	SB027S	Random	2012-04-17	37.61996	-122.31321	3.4
SEDIMENT	South Bay	SB045S	Random	2012-04-17	37.62508	-122.26039	9.3
SEDIMENT	South Bay	SB097S	Random	2012-04-17	37.61452	-122.26767	4
SEDIMENT	Suisun Bay	SU027S	Random	2012-04-23	38.05511	-122.11179	10.4
SEDIMENT	Suisun Bay	SU073S	Random	2012-04-23	38.11075	-122.04866	2
SEDIMENT	Suisun Bay	SU128S	Random	2012-04-23	38.08817	-122.00105	1.3
SEDIMENT	Suisun Bay	SU131S	Random	2012-04-23	38.08824	-122.04386	1.6
BIOACCUMULATION	Lower South Bay	BA10	Historic	2012-09-20	37.46983	-122.06383	4.5
BIOACCUMULATION	South Bay	BA30	Historic	2012-09-20	37.51333	-122.13467	2.5
BIOACCUMULATION	South Bay	BA40	Historic	2012-09-20	37.547	-122.195	3
BIOACCUMULATION	Central Bay	BB71	Historic	2012-09-19	37.6955	-122.33967	10.3
BIOACCUMULATION	Central Bay	BC10	Historic	2012-09-19	37.81392	-122.35873	3
BIOACCUMULATION	Central Bay	BC61	Historic	2012-09-19	37.92833	-122.46883	3.8
BIOACCUMULATION	San Pablo Bay	BD20	Historic	2012-09-18	38.059	-122.42367	2.5
BIOACCUMULATION	San Pablo Bay	BD30	Historic	2012-09-18	38.01667	-122.3675	4.3
BIOACCUMULATION	San Pablo Bay	BD40	Historic	2012-09-18	38.054433	-122.2605	6.5
BIOACCUMULATION	Sacramento River	BG20	Historic	2012-09-21	38.0557	-121.80593	-88
BIOACCUMULATION	San Joaquin River	BG30	Historic	2012-09-21	38.02362	-121.80048	-88
BIOACCUMULATION	Reference Site	T-0Bodega	Historic	2012-06-14	38.30477	-123.06563	0

RMP Target Parameter List in 2012

Field Measures – CTD Meter (Water, Sediment and Bivalve Cruises)	Reporting Units
Backscatter	Ftu
ElectricalConductivity	S/m
Temperature	Deg C
Density	kg/m^3
Oxygen, Dissolved	mg/L
Pressure	Db
Salinity	Psu
Field Measures - Shipboard (Water Cruise)	**Reporting Units**
Oxygen, Dissolved	mg/L
pH	pH
Salinity	Ppt
SpecificConductivity	uS/cm
Temperature	Deg C
Field Measures - Shipboard (Sediment Cruise) *pH from interstitial water in undisturbed section of sediment grab	**Reporting Units**
pH*	pH
Eh	mV
Conventional Water Quality Parameters *'Phosphate as P' updated to 'Orthophosphate as P' 6/2012	**Reporting Units**
Ammonium as N	mg/L
Chlorophyll a	mg/m3
Dissolved Organic Carbon	ug/L
Hardness as CaCO3	mg/L
Nitrate as N	mg/L
Nitrite as N	mg/L
Oxygen, Dissolved	mg/L
Particulate Organic Carbon	ug/L
pH	pH
Pheophytin a	mg/m3
OrthoPhosphate as P*	mg/L
Salinity	psu
Silica as SiO2	mg/L
SpecificConductivity	umho
Suspended Sediment Concentration	mg/L
Temperature	Deg C
Water Toxicity Parameters – Homogenate (*Americamysis bahi*)	**Reporting Units**
Cell Count	-
Mean % Normal Development	%
Mean % Survival	%
SWI Mean % Normal Alive	%
Sediment Quality Parameters	**Reporting Units**
% Solids	%
Collection Depth	m
Nitrogen, Total	% dw
Total Organic Carbon	% dw

Grainsize Parameters [**Sum of Clay and Silt]	Fraction	Reporting Units
Clay	<0.0039 mm	% dw
Fine**	<0.0625 mm	% dw
Granule + Pebble	2.0 to <64 mm	% dw
Sand	0.0625 to <2.0 mm	% dw
Silt	0.0039 to <0.0625 mm	% dw

Sediment Toxicity Parameters – Homogenate (RMP tests CHIR, EOHA and HYAL) SD = Standard Deviation	Reporting Units
Mean % Survival	% dw
SD - Mean % Survival	% dw
Mean mg/Individual (af growth)	mg
Mean mg/Individual (growth)	mg
Sediment Toxicity Parameters - Surface Water Interface (RMP tests MCAL)	**Reporting Units**
SWI Mean % Normal Alive	% dw
SWI SD - Mean % Normal Alive	% dw
Bivalve Tissue Parameters 1. Reported with Trace Metals 2. Reported with Trace Organics	**Reporting Units**
% Solids[1]	% dw
% Survival per Species	% dw
% Survival per Species (caged)	% dw
Dry Weight	g
Dry Weight Standard Error	g
Growth Mean	g
Growth Standard Error	g
Lipid	% dw
Moisture[2]	% dw
Fish Tissue Parameters	**Reporting Units**
Lipid	% dw or % ww
Moisture	% dw or % ww
Length	cm

Trace elements analyzed in water, sediment, and tissue samples:
Target Method Detection Limits (MDLs) are in parentheses following the reporting units.
Basis codes: dw=dry weight, ww=wet weight.
- Parameter is not sampled for the matrix.
* Dry and wet weight mercury concentrations are reported for fish tissue.

	Water	Sediment	Bivalve Tissue	Fish Tissue
Aluminum	-	mg/Kg dw (200)	ug/g dw (1)	-
Arsenic	ug/L (0.1)	mg/Kg dw (0.2)	-	-
Cadmium	ug/L (0.001)	mg/Kg dw (0.001)	ug/g dw (0.01)	-
Cobalt	ug/L (.0005)	-	-	-
Copper	ug/L (0.01)	mg/Kg dw (2)	ug/g dw (0.2)	-
Cyanide	ug/L (0.4)	-	-	-
Iron	ug/L (10)	mg/Kg dw (200)	-	-
Lead	ug/L (0.001)	mg/Kg dw (0.5)	ug/g dw (0.01)	-
Manganese	ug/L (0.01)	mg/Kg dw (20)	-	-
Mercury*	ug/L (.0001)	mg/Kg dw (0.00001)	-	ug/g ww
Mercury, Methyl	ng/L (0.005)	ug/Kg dw (0.005)	-	ug/g ww
Mercury, Acid Labile	ug/L	-	-	-
Mercury (II)R	ug/L	-	-	-
Nickel	ug/L (0.01)	mg/Kg dw (5)	ug/g dw (0.2)	-
Selenium	ug/L (0.02)	mg/Kg dw (0.01)	ug/g dw (0.01)	ug/g ww
Silver	ug/L (0.0001)	mg/Kg dw (0.001)	ug/g dw (0.001)	-
Zinc	ug/L (0.005)	mg/Kg dw (5)	ug/g dw (10)	-

Trace organic parameters (reporting units) analyzed in water (pg/L), sediment (ug/Kg), and bivalve tissue (ng/g dw)

Note: PAHs, Pesticides and PCBs are reported biennially in water. Sums calculated by SFEI.
Organochlorines in tissue from CDFG analyzed by GC-ECD will be determined using two columns of differing polarity.

Polycyclic Aromatic Hydrocarbons (PAHs)
(Target MDLs: water – 200 pg/L, sediment -- 5 ug/Kg, tissue – 5 ng/g)

[1]Sum of LPAHs and HPAHs
[2]Reported in sediment only
[3]Reported in water only

Low molecular weight PAHs	High molecular weight PAHs	Alkylated PAHs
Acenaphthene	Benz(*a*)anthracene	Benz(a)anthracenes/Chrysenes, C1 -[3]
Acenaphthylene	Benzo(*a*)pyrene	Benz(a)anthracenes/Chrysenes, C2-[3]
Anthracene	Benzo(*b*)fluoranthene	Benz(a)anthracenes/Chrysenes, C3-[3]
Biphenyl	Benzo(*e*)pyrene	Benz(a)anthracenes/Chrysenes, C4-[3]
Dibenzothiophene	Benzo(g,h,i)perylene	Chrysenes, C1-[2]
Dimethylnaphthalene, 2,6-	Benzo(k)fluoranthene	Chrysenes, C2-[2]
Fluorene	Chrysene	Chrysenes, C3-[2]
Methylnaphthalene, 1-	Dibenz(*a,h*)anthracene	Chrysenes, C4-[2]
Methylnaphthalene, 2-	Fluoranthene	Dibenzothiophenes, C1-
Methylphenanthrene, 1-	Indeno(1,2,3-c,d)pyrene	Dibenzothiophenes, C2-
Naphthalene	Perylene	Dibenzothiophenes, C3-
Phenanthrene	Pyrene	Fluoranthene/Pyrenes, C1-
Trimethylnaphthalene, 2,3,5-	Sum of HPAHs (SFEI)	Fluorenes, C1-
Sum of LPAHs (SFEI)	Sum of PAHs (SFEI)[1]	Fluorenes, C2-
		Fluorenes, C3-
		Naphthalenes, C1-
		Naphthalenes, C2-
		Naphthalenes, C3-
		Naphthalenes, C4-
		Phenanthrene/Anthracene, C1-
		Phenanthrene/Anthracene, C2-
		Phenanthrene/Anthracene, C3-
		Phenanthrene/Anthracene, C4-

SYNTHETIC BIOCIDES

(Target MDLs: water – 2 pg/L, sediment - 1 ug/Kg dw, tissue – 1 ng/g dw)t

[1]Parameter reported for water matrix only.
[2]Parameter reported for sediment matrix only.
Sums calculated by SFEI.

Cyclopentadienes	Chlordanes	DDTs	HCH	Other Synthetic Biocides
Aldrin	Chlordane, cis-	DDD(o,p')	HCH, alpha	Chlorpyrifos[1]
Dieldrin	Chlordane, trans-	DDD(p,p')	HCH, beta	Dacthal[1]
Endrin	Heptachlor	DDE(o,p')	HCH, delta	Diazinon[1]
	Heptachlor Epoxide	DDE(p,p')	HCH, gamma	Endosulfan I[1]
	Nonachlor, cis-	DDT(o,p')	Sum of HCHs (SFEI)	Endosulfan II[1]
	Nonachlor, trans-	DDT(p,p')		Endosulfan sulfate[1]
	Oxychlordane	Sum of DDTs (SFEI)		Fipronil desulfinyl[2]
	Sum of Chlordanes (SFEI)			Fipronil sulfide[2]
				Fipronil sulfone[2]
				Fipronil[2]
				Hexachlorobenzene
				Mirex

Polychlorinated Biphenyls (PCBs)
(Target MDLs: water – 2 pg/L, sediment - 1 ug/Kg dw , tissue – 1 ng/g dw)
IUPAC numbers listed. Sums calculated by SFEI.
*Congeners included in the Sum of 40 PCBs (SFEI).
[1]Coplanar PCBs

PCB 001	**PCB 031***	PCB 061	PCB 091	PCB 121	**PCB 151***	PCB 181
PCB 002	PCB 032	PCB 062	PCB 092	PCB 122	PCB 152	PCB 182
PCB 003	**PCB 033***	PCB 063	PCB 093	PCB 123[1]	**PCB 153***	PCB 183*
PCB 004	PCB 034	PCB 064	PCB 094	PCB 124	PCB 154	PCB 184
PCB 005	PCB 035	PCB 065	**PCB 095***	PCB 125	PCB 155	PCB 185
PCB 006	PCB 036	**PCB 066***	PCB 096	PCB 126[1]	**PCB 156*1**	PCB 186
PCB 007	PCB 037	PCB 067	**PCB 097***	PCB 127	PCB 1571	PCB 187*
PCB 008*	PCB 038	PCB 068	PCB 098	**PCB 128***	**PCB 158***	PCB 188
PCB 009	PCB 039	PCB 069	**PCB 099***	PCB 129	PCB 159	PCB 189[1]
PCB 010	PCB 040	**PCB 070***	PCB 100	PCB 130	PCB 160	PCB 190
PCB 011	PCB 041	PCB 071	**PCB 101***	PCB 131	PCB 161	PCB 191
PCB 012	PCB 042	PCB 072	PCB 102	**PCB 132***	PCB 162	PCB 192
PCB 013	PCB 043	PCB 073	PCB 103	PCB 133	PCB 163	PCB 193[1]
PCB 014	**PCB 044***	**PCB 074***	PCB 104	PCB 134	PCB 164	PCB 194*
PCB 015	PCB 045	PCB 075	**PCB 105*1**	PCB 135	PCB 165	PCB 195*
PCB 016	PCB 046	PCB 076	PCB 106	PCB 136	PCB 166	PCB 196
PCB 017	PCB 047	PCB 0771	PCB 107	PCB 137	PCB 167[1]	PCB 197
PCB 018*	PCB 048	PCB 078	PCB 108	**PCB 138***	PCB 168	PCB 198
PCB 019	**PCB 049***	PCB 079	PCB 109	PCB 139	PCB 169[1]	PCB 199
PCB 020	PCB 050	PCB 080	**PCB 110***	PCB 140	**PCB 170*[1]**	PCB 200
PCB 021	PCB 051	PCB 0811	PCB 111	**PCB 141***	PCB 171	PCB 201*
PCB 022	**PCB 052***	PCB 082	PCB 112	PCB 142	PCB 172	PCB 202
PCB 023	PCB 053	PCB 083	PCB 113	PCB 143	PCB 173	PCB 203*
PCB 024	PCB 054	PCB 084	PCB 114[1]	PCB 144	**PCB 174***	PCB 204
PCB 025	PCB 055	PCB 085	PCB 115	PCB 145	PCB 175	PCB 205
PCB 026	**PCB 056***	PCB 086	PCB 116	PCB 146	PCB 176	PCB 206
PCB 027	PCB 057	**PCB 087***	PCB 117	PCB 147	**PCB 177***	PCB 207
PCB 028*	PCB 058	PCB 088	**PCB 118*[1]**	PCB 148	PCB 178	PCB 208
PCB 029	PCB 059	PCB 089	PCB 119	**PCB 149***	PCB 179	PCB 209
PCB 030	**PCB 060***	PCB 090	PCB 120	PCB 150	**PCB 180*[1]**	Sum of 40 PCBs (SFEI)
						Sum of 209 PCBs (SFEI)

Polybrominated Diphenyl Ethers (PBDEs)
(Target MDLs: water – 1 pg/L, sediment – 1 ug/Kg dw, tissue – 1 ng/g dw)
IUPAC number listed.
***Only analyzed in sediment.**

PBDE 007	PBDE 035	PBDE 105	PBDE 183
PBDE 008	PBDE 037	PBDE 116	PBDE 190
PBDE 010	PBDE 047	PBDE 119	PBDE 196*
PBDE 011	PBDE 049	PBDE 120	PBDE 197
PBDE 012	PBDE 051	PBDE 126	PBDE 203
PBDE 013	PBDE 066	PBDE 128	PBDE 204
PBDE 015	PBDE 071	PBDE 138	PBDE 205
PBDE 017	PBDE 075	PBDE 140	PBDE 206
PBDE 025	PBDE 077	PBDE 153	PBDE 207
PBDE 028	PBDE 079	PBDE 154	PBDE 208
PBDE 030	PBDE 085	PBDE 155	PBDE 209
PBDE 032	PBDE 099	PBDE 166	
PBDE 033	PBDE 100	PBDE 181	

Pyrethroids
(Target RDLs: sediment – 1 to 10 ug/kg dw)
*Sum of individual isomers.
Sums calculated by SFEI.

Allethrin	Deltamethrin/ Tralomethrin	Phenothrin
Bifenthrin	Esfenvalerate/Fenvalerate, total*	Prallethrin
Cyfluthrin, total*	Fenpropathrin	Resmethrin
Cyhalothrin, lambda, total*	Permethrin, cis-	Tetramethrin
Cypermethrin, total*	Permethrin, trans-	Sum of Pyrethroids (SFEI)

Dioxins and Furans (PCDD/F)
(sediment and tissue – ug/Kg dw; water – pg/L)

Dioxins	Furans
HpCDD, 1,2,3,4,6,7,8-	HpCDF, 1,2,3,4,6,7,8-
HxCDD, 1,2,3,4,7,8-	HpCDF, 1,2,3,4,7,8,9-
HxCDD, 1,2,3,6,7,8-	HxCDF, 1,2,3,4,7,8-
HxCDD, 1,2,3,7,8,9-	HxCDF, 1,2,3,6,7,8-
OCDD, 1,2,3,4,6,7,8,9-	HxCDF, 1,2,3,7,8,9-
PeCDD, 1,2,3,7,8-	HxCDF, 2,3,4,6,7,8-
TCDD, 2,3,7,8-	OCDF, 1,2,3,4,6,7,8,9-
Sum of Dioxins (SFEI)	PeCDF, 1,2,3,7,8-
Sum of Dioxins-Furans (SFEI)	PeCDF, 2,3,4,7,8-
Sum of Dioxin-Furan TEQs (WHO 2005;ND=0 SFEI)*	TCDF, 2,3,7,8-
	Sum of Furans (SFEI)

* NDs should be set to zero as the default

Perfluorinated Compounds (PFC) (Target RDLs: water – 1 ng/L or * 2 ng/L; tissue – ng/g dw; sediment ug/Kg dw)	
Carboxylic Acids	**Sulphonic Acids**
Perfluorobutanoate	Perfluorobutanesulfonate*
Perfluorodecanoate	Perfluorohexanesulfonate*
Perfluorododecanoate	Perfluorooctanesulfonamide
Perfluoroheptanoate	Perfluorooctanesulfonate* (PFOS)
Perfluorohexanoate	
Perfluorononanoate	
Perfluorooctanoate (PFOA)	
Perfluoropentanoate	

Analytes reported in water samples (1993-2012)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Water Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Ammonium as N	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Chlorophyll a	ANC		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
CTD*	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Dissolved Organic Carbon	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Hardness as CaCO3	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Nitrate as N	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Nitrite as N	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Oxygen, Dissolved	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	
Particulate Organic Carbon	ANC												■	■	■	■	■	■	■	■	
pH	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	
Pheophytin a	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Phosphate as P	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Salinity (by salinometer)	ANC	■		■	■	■	■	■	■	■	■	■	■	■	■						
Salinity (by SCT)	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Salinity (by Solomat)	ANC					■															
Silica	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
SpecificConductivity	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	
Suspended Sediment Concentration	ANC												■	■	■	■	■	■	■	■	
Temperature	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	
Total Suspended Solids	ANC										■	■	■			■	■	■	■	■	
Alkanes (C10-C34)	ORGS																				
Dioxins/Furans	ORGS																	■		■	
PAHs (biennially beginning 2008)	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	
PAHs Alkylated (biennially beginning 2008)	ORGS						■	■	■	■	■	■	■	■	■	■	■			■	
PBDEs (annually)	ORGS										■	■	■	■	■	■	■	■	■	■	
PCBs 209 (biennially beginning 2008)	ORGS																	■		■	

Analytes reported in water samples (1993-2011) (cont.)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Water Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
PCBs 40 (biennially beginning 2008)	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Pharmaceuticals	ORGS														■						
Phthalates	ORGS										■	■									
Chlordanes	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Chlorpyrifos	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■						■	
Cyclopentadienes	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Dacthal	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
DDTs	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Diazinon	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■				■		■	
Endosulfan I	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Endosulfan II	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Endosulfan Sulfate	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
HCHs	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Hexachlorobenzene	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Mirex	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■	
Oxadiazon	PESTs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
p-Nonylphenol	SYN										■	■									
Triphenylphosphate	SYN										■										
Arsenic	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Cadmium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Chromium	TE	■	■	■	■	■	■	■		■											
Cobalt	TE								■	■	■	■	■	■	■	■	■	■	■	■	
Copper	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	

Analytes reported in sediment samples (1993-2012)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Sediment Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012[1]
% Solids	ANC		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Ammonia	ANC			■	■	■	■	■	■	■											
CTD*	ANC			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Eh*	ANC											■	■	■	■	■	■	■	■	■	■
Grainsize - Clay <0.0039 mm	ANC																■	■	■	■	
Grainsize - Clay <0.005 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	■	
Grainsize - Fine <0.0625 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Grainsize - Granule + Pebble 2.0 to <64 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	
Grainsize - Sand 0.0625 to <2.0 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Grainsize - Silt 0.0039 to <0.0625 mm	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Hydrogen Sulfide	ANC			■	■	■	■	■	■	■											
pH	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total Nitrogen	ANC	■					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total Organic Carbon	ANC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total Sulfide	ANC			■	■	■	■	■	■	■											
Benthos	Benthos																■	■	■	■	■
Dioxins/Furans	ORGS																	■	■		
PAHs	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PAHs Alkylated	ORGS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
PBDEs	ORGS										■										
PCBs 209	ORGS																	■	■	■	■
PCBs 40	ORGS	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
Phthalates	ORGS										■	■									
Chlordanes	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
Cyclopentadienes	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
DDTs	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
Fipronil	PESTs																	■	■	■	■
HCHs	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
Hexachlorobenzene	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
Mirex	PESTs	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■
Pyrethroids	PESTs																■	■	■	■	■
Mean % Normal Alive	SedTox	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
Mean % Survival	SedTox	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
p-Nonylphenol	SYN										■	■									
Aluminum	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Arsenic	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cadmium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Analytes reported in sediment samples (1993-2012)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters, WaterTOX = Toxicity Parameters
* Data available upon request

Reportable Sediment Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012[1]
Copper	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Chromium	TE	■	■	■	■	■	■	■	■	■											
Iron	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Lead	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Manganese	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mercury	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mercury, Methyl	TE								■	■	■	■	■	■	■	■	■	■	■	■	■
Nickel	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Selenium	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Silver	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Zinc	TE	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

[1]Grainsize samples were collected and analyzed but were samples were being reanalyzed at time of AMR publication.

Analytes Reported in Bivalve Samples (1993-2012)

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, EC=Emerging Contaminants, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SedTOX = Toxicity Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters
* Data available upon request

Reportable BivalveTissue Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[1]	2008	2009	2010	2011	2012
% Moisture	ANC																				
% Solids	ANC																				
% Survival per Species	ANC																				
% Survival per Species (caged)	ANC																				
Condition Index Mean	ANC																				
CTD*	ANC																				
Dry Weight	ANC																				
Gonad Index CI Mean	ANC																				
Growth Mean	ANC																				
209 PCBs	ORGS																				
40 PCBs	ORGS																				
Alkanes (C10-C34)	ORGS																				
Musk	ORGS																				
PAHs	ORGS																				
PAHs Alkylated	ORGS																				
PBDEs	ORGS																				
Phthalates	ORGS																				
Chlordanes	PESTs																				
Cyclopentadienes	PESTs																				
DDTs	PESTs																				
HCHs	PESTs																				
Hexachlorobenzene	PESTs																				
Mirex	PESTs																				
p-Nonylphenol	SYN																				
Triphenylphosphate	SYN																				
Aluminum	TE																				

Analytes Reported in Bivalve Samples (1993-2012) contin.

Shaded areas indicate that results are available for RMP Status and Trends Sampling.
Parameter Type Codes: ANC = Ancillary Parameters, EC=Emerging Contaminants, ORGS = Organic Parameters, PESTs = Pesticide Parameters, SedTOX = Toxicity Parameters, SYN = Synthetic Parameters, TE = Trace Metal parameters
* Data available upon request

Reportable BivalveTissue Parameter	Parameter Type	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[1]	2008	2009	2010	2011	2012
Arsenic	TE	■	■	■	■	■	■	■													
Cadmium	TE	■	■	■	■	■	■	■	■	■							■				
Copper	TE	■	■	■	■	■	■	■	■	■							■				
Chromium	TE	■	■	■	■	■	■	■													
DBT (Dibutyltin)	TE	■	■	■	■	■	■	■	■	■											
Iron	TE						■	■									■				
Lead	TE	■	■	■	■	■	■	■	■	■							■				
Manganese	TE						■	■									■				
MBT (Monobutyltin)	TE	■	■	■	■	■	■	■	■	■											
Mercury	TE	■	■	■	■	■	■	■													
Methyl Mercury	TE	■																			
Nickel	TE	■	■	■	■	■	■	■	■	■							■				
Selenium	TE	■	■	■	■	■	■	■	■	■							■				
Silver	TE	■	■	■	■	■	■	■	■	■							■				
TBT (Tributyltin)	TE	■	■	■	■	■	■	■	■	■											
TTBT (Tetrabutyltin)	TE		■	■	■	■	■	■	■	■											
Zinc	TE	■	■	■	■	■	■	■	■	■							■				

[1]Beginning in 2007, bivalve monitoring occurs biennially for trace organics and every 6 years for trace metal parameters.

Changes to the RMP Program 1993-2012

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Action Code	Year	Action	Detail/Rationale
D	1993-1998	CTD data are not available for tissue	CTD cast was not deployed.
D	1999-2001	CTD data are available for Deployment, maintenance and retrieval tissue cruises	Began deploying CTD casts during tissue cruises.
D	1998-1999	Iron in bivalves is a non-target analyte and not reported via WQT	Iron in bivalves reported by lab, but is not available via WQT.
D	2004-2005	Tissue PAHs analyzed by CDFG were rejected due to the method sensitivity	Most PAH measurements in transplant bivalve samples were below detection limits and thus not usable for trends analysis.
A	1993	MeHg in bivalve tissue samples was only analyzed in 1993.	Since this was part of a pilot study, the results are not displayed via the WQT. Total mercury was analyzed each year through 1999.
P	1993	Implemented Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP). Samples collected three times per year for conventional water quality parameters and trace analytes.	Samples were collected during the rainy season (March), during declining Delta outflow (May), and during the dry season (Aug - Sept).
P	1993	Implemented Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP) samples. Samples collected twice a year for sediment quality parameters and trace analytes.	Samples were collected during the rainy season (March) and during the dry season (Aug-Sept).
P	1993	Implemented Regional Monitoring Program for Trace Substances in the San Francisco Estuary (RMP). Bivalve samples collected twice a year for transplanted, bagged bivalve bioaccumulation and condition.	Samples were deployed during the rainy season (March-May) and during the dry season (Aug-Sept) and retrieved between 90 and 100 days after deployment.
S	1993	Collected samples along the spine of the estuary at 16 set stations for water and sediment; toxicity was measured at 8 of these stations for each matrix. Bivalves were deployed at 11 of the stations.	Original RMP sampling design.
D	1994	Prior to 2003, there are no records for individual fish stored in the database. Therefore, there are no records in the POE Fish table.	Only composite information is available.
P	1994	Status and Trends Sport Fish Monitoring	Sport fish monitoring began as a pilot study funded by the Bay Protection and Toxics Cleanup Program. All fish were analyzed as individuals for mercury, PCBs, pesticides, and selenium
S	1994	Added 2 stations for water and sediment sampling (previously 22) as part of the Local Effects Monitoring Program (LEMP): C-1-3 (Sunnyvale) and C-3-0 (San Jose)	Sites located by water pollution control plants. Added on a trial basis by Water Board. Sites were treated identically as RMP stations. Total water stations =24.
S	1994	Added 4 stations (previously 11) for bivalve tissue sampling	Total bivalve stations = 15.
S	1994	Added 6 stations for water and sediment sampling (previously 16): San Bruno Shoal (BB15), Alameda (BB70), Red Rock (BC60), Honker Bay (BF40), Petaluma River mouth (BD15), Coyote Creek mouth (BA10)	Sites selected to fill large areas in Estuary where no samples were taken and to better monitor areas around tributaries. Total water stations = 22.

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Action Code	Year	Action	Detail/Rationale
A	1996	Added trace organics analysis for Southern Slough stations Sunnyvale (C-1-3) and San Jose (C-3-0)	Trace organics were not analyzed for Sunnyvale (C-1-3) during the July 1996 or August 1997 rainy season cruises, however samples were analyzed for trace metals and ancillary parameters.
S	1996	1996-04 Corbicula fluminea (CFLU) clams were collected from Putah Creek.	1996-04 Corbicula fluminea (CFLU) couldn't be retrieved from Lake Isabella so clams were collected from Putah Creek. Due to concerns with contamination, both pre- and post-depuration analysis was performed, but only the post-depurated results were reported. In September 1996, only post-depurated analysis was performed.
S	1996	Added 2 stations for water and sediment sampling (previously 24) as part the Estuary Interface Pilot Study: Standish Dam (BW10) and Guadalupe River (BW15)	Added as part of the Estuary Interface Pilot Study. Total water and sediment stations = 26.
A	1997	Identified 40 target PCB congeners for labs to report: PCB 008, 018, 028, 031, 033, 044, 049, 052, 056, 060, 066, 070, 074, 087, 095, 097, 099, 101, 105, 110, 118, 128, 132, 138, 141, 149, 151, 153, 156, 158, 170, 174, 177, 180, 183, 187, 194, 195, 201, 203	Analysis of RMP data collected from 1993-1995 showed 40 congeners consistently quantified in Bay samples. It was found that 40 congeners would be a good representation (~80% representative) of the total mass of PCBs in the bay.
D	1997	Prior to 2003, there are no records for individual fish stored in the database. Therefore, there are no records in the POEFish table.	Only composite information is available.
D	1997	Total salinity measurements taken in the field are not available for the April cruise.	Measurements not available.
L	1997	Changed analytical lab for analysis of PCBs and PAHs in bivalve tissue samples	Central Contra Costa Sanitary District began analysis of PCBs and PAHs in bivalve tissue.
P	1997	Implemented Sport Fish Contaminant Study - Sport Fish will be collected on a three year cycle and analyzed for mercury, PCBs, legacy pesticides (DDT, dieldrin, chlordane), and Se	Study implemented as a follow up to a 1994 study conducted by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB).
P	1997	Status and Trends Sport Fish Monitoring	A Special Study was done to compare skin-on versus skin-off organics concentrations in white croaker. Analytes measured: mercury, PCBs, DDT's, chlordanes, dieldrin, dioxin and dioxin-like compounds, and selenium. Most samples were analyzed as composites except for mercury in striped bass and California halibut, and selenium in white sturgeon. EWG analyzed some archive 1997 RMP samples for PBDEs in 2002. These data are not available on the WQT.
A	1998	T-1 samples analyzed for trace organics and trace elements	While T-0 samples have been consistently analyzed throughout the years, T-1 samples were analyzed for only two cruises: 1998-04 and 2001-09. The decision to analyze was because a lot of the transplants died during deployment.
D	1998	Status and Trends Sport Fish Monitoring	Bivalves and crustaceans were analyzed as part of the sport fish study.
D	1998	Tissue results are not available for Sept. 1998 for BF20 (Grizzly Bay)	The bivalves *CORBICULA FLUMINEA* (CFLU) could not be found at the reference site Lake Chabot

Changes to the RMP Program 1993-2012 contin.

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Action Code	Year	Action	Detail/Rationale
D	1999	Status and Trends Sport Fish Monitoring	Bivalves and crustaceans were analyzed as part of the sport fish study.
L	1999	Changed analytical lab for analysis of mercury in water samples	University of Maryland, Center of Environmental Studies began analysis of Hg in water.
S	1999	Removed 1 station (previously 15) for bivalve tissue sampling BF20 (Grizzly Bay)	A bivalve reference site could not be found for CORBICULA FLUMINEA (CFLU). Total bivalve tissue stations = 14.
A	2000	Added Cobalt (Co) analysis in water and sediment samples	Co is a useful marker of geochemical processes in the Estuary, particularly as an indicator of metal fluxes from sub-oxic sediments. Added as part of the Fe/Mn/Co group.
A	2000	Added gonadal index and growth analysis in bivalve tissue samples	Growth analysis calculated by SFEI in 2000 and 2001. AMS started calculating growth analysis in 2002.
A	2000	Added Methyl Mercury analysis in water and sediment samples	Ratios of Methyl Mercury to Total Mercury can be used to determine environments that methylation is most likely to occur in.
A	2000	Removed Mercury (Hg) and Arsenic (As) analysis in bivalve tissue samples	RMP results (1993-99) indicated that there was very little bioaccumulation of Hg beyond background concentrations and there was an absence of serious As contamination.
D	2000	Prior to 2003, there are no records for individual fish stored in the database. Therefore, there are no records in the POEFish table.	Only composite information is available.
L	2000	Changed analytical lab for analysis of PCBs and PAHs in bivalve tissue samples	Texas A&M Geochemical and Environmental Research began analysis of PCBs and PAHs in bivalve tissue.
P	2000	Changed frequency of water sampling to twice a year for ancillary and trace metal analytes	Discontinued sampling during declining Delta outflow (May). Samples were collected during the rainy season (March) and during the dry season (Aug-Sept). It was determined that samples collected during the dry season were most indicative of ambient concentrations.
P	2000	Changed frequency of sediment sampling to once a year for ancillary, trace metal and organic analytes	Samples collected during the dry season (Aug-Sept).
P	2000	Changed frequency of water sampling to once a year for organic analytes	Samples collected during the dry season were analyzed for organic contaminants. Most organic contaminants are legacy pollutants which degrade slowly so analyzing more that once a year for these analytes was found to be unnecessary.
P	2000	Status and Trends Sport Fish Monitoring	A Special Study was done to compare organics concentrations across time during one year in the Oakland Inner Harbor. This study was to look at the seasonal variation of organic contaminants pre- and post-spawning. Analytes measured: mercury, PCBs, DDTs, chlordanes, dieldrin, PBDEs (qualitative), dioxin and dioxin-like compounds, and selenium. The 1998 crab data and 1999 clam data were reported in the 2000 report. Most samples were analyzed as composites except for mercury (California halibut, white sturgeon, leopard shark and striped bass) and selenium in white sturgeon.
A	2001	Removed Gonadal Index analysis in bivalve tissue samples	Unable to obtain sufficient level of precision in separating somatic and gonadal tissue.

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Action Code	Year	Action	Detail/Rationale
A	2001	T-1 samples analyzed	While T-0 samples have been consistently analyzed throughout the years, T-1 samples were analyzed for only two cruises: 1998-04 and 2001-09. No rational was found for analyzing these samples.
D	2001	PBDE Tissue Data not reported	A minimum amount of QA/QC was conducted. Dataset was missing replicates and SRMs. Data was treated as a Special Study and not added to S&T db.
D	2001	Status and Trends Sport Fish Monitoring	Bivalves and crustaceans were analyzed as part of the sport fish study.
A	2002	Added PBDEs, phthalates, and p-nonylphenol analysis in water and sediment samples	Added potential persistent pollutants with the ability to bioaccumulate and cause toxicity.
A	2002	Added PBDEs, phthalates, p-nonylphenol, triphenylphosphate and nitro and polycyclic musks analysis in bivalve tissue samples	Added potential persistent pollutants with the ability to bioaccumulate and cause toxicity.
A	2002	Changed health indicator from Condition Index Mean to Growth Mean in bivalve tissue samples	Condition index is the ratio of tissue mass to shell volume and may be affected by factors other than health. Growth compares the pre- and post- deployment weight of each mussel and is a more direct measurement of health.
A	2002	Reduced bivalve Trace Metals (Ag, Al, Cd, Cu, Ni, Pb, Se, Zn) analysis in bivalve tissue samples to 5 year cycle and removed tributyltin analysis in bivalve tissue samples	RMP results indicated that Trace Metals and tributyltin do not appreciably accumulate in bivalve tissue. Report link: http://www.sfei.org/sites/default/files/RMP_2002_No109_RedesignProcess.pdf
A	2002	Removed chromium analysis in water, sediment and bivalve tissue samples	Technical Review Committee made decision based on findings by Khalil Abu-Saba that stated that the chromium found in the estuary was mostly of the trivalent form and none of the hexavalent form was detected. The concentrations in water and sediment were found to be essentially the same as those from the soils in the watersheds draining into the estuary.
D	2002	CTD casts were not taken during 2002 bivalve tissue maintenance cruise	The water and bivalve maintenance cruise occurred concurrently and it was decided that it was more important to take casts on the water cruise.
D	2002	Data unavailable/rejected for BDEs 82, 128, 203, 204, 205, 206, 207, and 209 for bivalve tissue samples	BDEs 82, 128, and 209 not part of standard mix reported by lab. BDEs 203, 204, 205, 206, 207 and 209 do not elute off of the GC-ECD columns.
D	2002	Data unavailable/rejected for PCB 132 analyzed in bivalve tissue samples	PCB 132 not analyzed in the lab due to co-elution problems.
L	2002	Changed analytical lab for analysis of mercury and methyl mercury in water	University of California, Santa Cruz Dept. of Environmental Toxicology began water Hg and MeHg analysis (formerly conducted by University of Maryland).
L	2002	Changed analytical lab for analysis of trace organics in bivalve samples	California Dept. of Fish and Game, Marine Pollution Control Laboratory began analysis of trace organics in bivalve tissue (including pesticides, PAHs, and PCBs).
L	2002	Changed analytical lab for water trace organics to AXYS	Analysis formerly conducted by University of Utah Energy and Geoscience Institute (UUEGI)
L	2002	Changed method for analysis of Total Suspended Solids (TSS) in water to Suspended Solid Content (SSC) in water	The SSC method analyzes the whole sample while TSS is a subsetting method. SSC poses less variability by human interference and attains better precision because heavier sand and sticky clay particles are not lost during analysis.

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Action Code	Year	Action	Detail/Rationale
P	2002	Changed Aquatic Toxicity Testing from yearly to a five year cycle	From 1993 to 2002, a noticeable decline in aquatic toxicity to organisms was observed, especially during the dry season.
P	2002	Implemented new random sampling design. Random sampling design based on spatially balanced probabilistic sampling design. The bay was divided into 5 hydrographic regions plus the Rivers segments. 7 Historic RMP sites were maintained in the program for sediment trends analysis and 3 (now 5) historic sites were maintained for water analysis	Sampling design will provide better statistical basis to answer regulatory questions. Will provide unbiased estimate of ambient conditions.
P	2002	Status and Trends Sport Fish Monitoring	The Environmental Working Group collected fish in 2002 from fishing piers around the Bay and analyzed fish for PBDE levels. SFEI reviewed this data set and added it to our Sportfish database. The data are not currently being included in the WQT due to some issues with the data. EWG also analyzed some archive RMP samples (1997) for PBDEs. These data are also not being displayed externally.
P	2002	Stopped Bivalve Maintenance Cruise	Cruise was found to be unnecessary.
A	2003	Added PBDE analysis in sport fish samples collected for the Sport Fish Contaminant Study	Increasing PBDE concentrations in the bay area coupled with concern about the health effects on humans and wildlife led to adding PDBEs.
A	2003	CTD casts were not taken during 2003 bivalve tissue maintenance cruise	The water and bivalve maintenance cruise occurred concurrently and it was decided that it was more important to take casts on the water cruise.
D	2003	Data rejected for PAHs in bivalve tissue	Data was rejected by SFEI QA Officer due to many samples being qualified as Non Detect.
D	2003	Data unavailable/rejected for pesticide, PCB, and PBDE sediment samples	Samples are to be reanalyzed using HRGC/MS since there has been a change in analytical method.
P	2003	Changed container for bivalves deployed from bags to cages. Some of the cages were maintained and some were un-maintained at each site	Findings from side by side deployment of bivalves in cages and in bags indicated that cages reduced the effects of bivalve predation. Report link: http://www.sfei.org/sites/default/files/431_AMS_bivalvestudies.pdf.
P	2003	Status and Trends Sport Fish Monitoring	A Special Study to do preliminary screening of additional species began in 2003. Additional species were analyzed for mercury and PCBs. Species included anchovy, barred surfperch, black surfperch, brown rockfish, herring, Chinook salmon, diamond turbot, sardine, smooth hound shark, starry flounder, and walleye surfperch. Analytes measured: mercury, PCBs, DDT, chlordane, dieldrin, PBDEs. Most samples were analyzed as composites except for mercury (California halibut, striped bass, leopard shark, white sturgeon) and selenium in white sturgeon.
P	2003	Stopped deployment of bivalves *CORBICULA FLUMINEA* (CFLU) in the estuary. CFLU collection was continued in the delta by trawling at the Rivers sites BG20 (Sacramento River) and BG30 (San Joaquin River)	Findings from 2000-2002 Special Studies concluded that bioaccumulation of contaminants in the estuary could be monitored using only one species *MYTILUS CALIFORNIANUS* (MCAL).
S	2003	Removed three stations (previously 14) BD50 (Napa River), BD15 (Petaluma River in San Pablo Bay), and BC21 (Horseshoe Bay in Central Bay) for bivalve tissue monitoring	Findings indicated that only 2-3 stations were required to track long term changes in contaminant concentrations in bivalves. Stations = 11.

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Action Code	Year	Action	Detail/Rationale
S	2003	Removed two water and sediment stations (previously 24) C-1-3 (Sunnyvale) and C-3-0 (San Jose), part of the Local Effects Monitoring Program (LEMP)	Funding ended for monitoring of trace organics in water and sediment which began in 1996 at these stations as part of the NPDES. Stations = 24.
S	2003	Removed water sampling from one random site in the South Bay segment and one random site in the Lower South Bay segment in order to add water sampling at historic sites BA30 (Dumbarton Bridge) in the South Bay and BC10 (Yerba Buena Island) in the Central Bay	Dropping these two random sites enabled the two historic sites to be added back into the sampling design at no additional cost to the program. These sites, along with BG20 (Sacramento River) are used by the Water Board for NPDES permit processing
A	2004	Added Particulate Organic Carbon (POC) analysis in water samples	Began analyzing for POC in order to be able to calculate Total Organic Carbon values (DOC+POC).
A	2004	Data unavailable for pesticides, PAHs, PCBs, and PBDEs in bivalve tissue samples	Poor recovery and high detection limits created "too many holes in the dataset". Samples will be archived but not re-analyzed.
A	2004	Removed PBDEs, phthalates, p-nonylphenol, triphenylphosphate and nitro and polycyclic musks analysis in bivalve tissue samples	These analytes posed low levels of concern for the San Francisco Bay Region based on current literature.
A	2004	Removed phthalates and p-nonylphenol analysis in water and sediment samples	These analytes posed low levels of concern for the San Francisco Bay Region based on current literature.
D	2004	Bivalve Organics data are not available for pesticides, PAHs, PCBs, and PBDEs	Poor recovery and high detection limits created "too many holes in the dataset". Samples will be archived but not re-analyzed.
A	2005	Expanded target BDE analyte list for sediment and water samples	Based on results from BDEs sampled in previous years and capabilities of the RMP laboratories, increased number of analytes.
A	2005	Removed Toxicity Identification Evaluations (TIEs) from sediment toxicity analysis	Method development is needed to aid in understanding the toxicity found in the bay sediments. Toxicity Identification Evaluations (TIEs) will be conducted using contingency funds when sufficient toxicity is observed.
D	2005	2005 Bivalve samples were analyzed for orgaincs by CDFG. PAHs were rejected. PBDEs, PCBs and PESTS were approved.	About half the analytes in each group were NDs.
D	2005	7 archived bivalve samples (T-0,BA10,BA40,BC10,BD20,BD30,BG30) were reanalyzed in 2007 by AXYS for PBDES, PCBs, Pests and PAHs. 3 samples (BA40, BD20, BD30) were reanalyzed for PAHs using Base Extraction Method as a demonstration of appropriate lab method. Results were approved. Samples not reanalyzed included BB71, BC61, BG20, BD40, BA30. Due to lack of archived material not all samples were re-analyzed.	Reanalyzed in 2007 by AXYS as part of Intercomparison study with CDFG. The data available on the WQT include the 7 reanalyzed samples from AXYS and 5 samples analyzed in 2005 by CDFG.
D	2005	Mallard Island PBDE Data for study year 2005 – 2006 should not be used in load calculations due to blank contamination and missing samples (especially 209).	Data should not be used in load calculations. Flagged during internal ratio review due to blank contamination and missing samples (especially 209).
L	2005	2005-09 archived bivalve tissue samples reanalyzed for organics by AXYS and CDFG in 2007	Data analyzed by two different labs: 5 samples were analyzed by CDFG and 7 samples reanalyzed by AXYS.
L	2005	Changed method for extraction of organic analytes in water samples	High blank contamination in 2003 PAH samples led to a change from the Soxhlet extraction method to an ambient temperature extraction method.

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A	2006	Began collecting hardness data for all water stations where salinity <5ppt	Previously hardness data was collected at riverine stations where salinity <1ppt and estimated for estuarine sites.
A	2006	Removed BDE 82 from target analyte list	BDE 082 is not in any commercial mixtures and its rationale for reporting it was unclear as it is not a major congener.
D	2006	Analyses of 2006 bivalves for trace organics data were delayed until 2008.	Analysis was delayed pending a decision regarding a demonstration of lab capabilities.
D	2006	Tissue data are unavailable for Coyote Creek (BA10)	Nearly full mortality (1% survival) due to heavy biofouling and sedimentation
D	2006	Tissue data are unavailable for San Pablo Bay (BD20)	Mooring was removed during deployment period
D	2006	Water diazinon and chlorpyrifos data are not available	Initially, samples were not analyzed due to analytical issues. These issues were resolved. In 2010, the TRC decided to cancel the analysis due to the high cost and the lack of a pressing need for the data
L	2006	Changed lab for the water diazinon and chlorpyrifos analysis from CDFG to AXYS	Changed labs based on new method development for this analysis and difficulties with prior method for analyzing these compounds.
L	2006	Changed method for analysis of arsenic in water samples	Method changed from HGAA to ICP-MS as a cost saving measure for method development.
P	2006	Annual Bivalve Maintenance Cruise discontinued and biannual cruise implemented	TRC approved dropping the maintenance cruise after a study conducted from 2002-2005 showed no significant difference in survival of bivalves in maintained and non-maintained cages
P	2006	Changed program name to Regional Monitoring Program for Water Quality in the San Francisco Estuary	Previous name was the Regional Monitoring Program for Trace Substances in the San Francisco Estuary. This change is intended to more adequately express the objectives of the RMP.
P	2006	Status and Trends Sport Fish Monitoring	The Special Study to look at contaminants in other species continued in 2006. Barred surfperch, brown rockfish, black surfperch, Chinook salmon, rubber lip surfperch, walleye surfperch, and northern anchovy were analyzed for PCBs, PBDEs and mercury. Analytes measured: mercury, PCBs, PBDEs, dioxins, DDTs, dieldrin, chlordane, dioxin, and selenium. Archived 2003 white croaker samples were analyzed and reported with 2006 white croaker data in the 2006 report. Jacksmelt, leopard shark, and California halibut were discontinued as status and trends species. Most samples were analyzed as composites except for mercury in striped bass and selenium in white sturgeon.
P	2006	Stopped analyzing the dissolved water fraction for organics in water	California Toxics Rule (CTR) has only been established for the total fractions of organic contaminants. The dissolved fraction was removed as a cost saving measure. At three stations, the RMP will report our dissolved and particulate fractions separately for comparative purposes.
S	2006	Changed bivalve tissue site BD20 (San Pablo Bay) by a nautical mile. BD20 will be renamed.	USGS replaced the channel marker where bivalve mooring BD20 was attached. The site was moved from Petaluma Light 1 to Petaluma Light 4. A new mooring will be installed at that site.
A	2007	Added BDE 197 to target analyte list for water and sediment and BDE 196 for sediment only.	This will provide a more accurate estimate of total PBDEs since these congeners constitute a relatively high percentage of the Deca-BDE mix.

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A	2007	Nitrogen results will be reported as "Nitrogen, Total Kjeldahl" in sediment. This is different from the historical RMP data.	Lab changed from UCSCDET to AMS-Texas.
D	2007	No bivalves data for 2007	Bivalves were not deployed in 2007. Sampling was changed to every other year.
D	2007	Water diazinon and chlorpyrifos data are not available	Initially, samples were not analyzed due to analytical issues. These issues were resolved. In 2010, the TRC decided to cancel the analysis due to the high cost and the lack of a pressing need for the data.
L	2007	Changed lab for the bivalve tissue analysis from CDFG to AXYS	2006 tissue analyses were conducted by AXYS. A subset of 2005 archive bivalves were reanalyzed by AXYS in 2007 and results much improved.
L	2007	Changed lab from UCSCDET to AMS-Texas for analysis of sediment quality samples	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.
L	2007	Intercomparison study with UCSC (POC only) and AMS-Texas (POC/DOC) for ancillary analytes in water	UCSC sampled 9 of the 22 sites, AMS-Texas sampled all 22 sites.
L	2007	Intercomparison study with UCSC and AMS-Texas for grainsize, Total Organic Carbon and Total Nitrogen in sediment	UCSC sampled 9 of the 47 sites; AMS-Texas sampled all 47 sites.
L	2007	Intercomparison study with UCSC and BR for trace metals in water samples	UCSC sampled 9 of the 22 sites, BR sampled all 22 sites.
L	2007	Intercomparison study with UCSC and EBMUD for analysis of SSC, Pigments Nutrients, salinity, and hardness in water	UCSC sampled 9 of the 22 sites, EBMUD sampled all 22 sites. (Pigments (Chlorophyll & phaeophytin) & Nutrients (ammonia, phosphate, nitrate/nitrite, silica))
L	2007	SFEI begins taking shipboard total salinity measurements.	Switched labs for water ancillary data; new lab does not participate in cruises. UCSC used to also report salinity by SCT along with their analytical measurements.
P	2007	Modified sediment toxicity sampling design.	During 2002-2006, every other sediment sample was analyzed for toxicity, which spatially biased the samples to the Lower South Bay
P	2007	The number of water sites was changed from 31 to 22. Sampling will occur at 3 sites in each of the upper 4 segments and 5 sites in the Lower South Bay segment. The 5 historic sites will continue to be sampled.	The power analysis from San Jose suggests that this change will be able to detect about a 1 ug/L change (give or take) in dissolved copper in every segment at a very high 99% power. The TRC approved this change in December 2006.
P	2007	The S&T monitoring program was expanded to triennial bird egg monitoring (cormorant and tern).	Part of the redesign process implemented in 2006.
P	2007	Water toxicity sampling occurred in 2007. Toxicity sampling has been changed to a screening effort approximately every five years	RMP S&T aquatic toxicity monitoring in the Estuary has shown no toxicity over the past several years. Next scheduled sampling will occur in 2012.
A	2008	Added benthos analysis (CCSF) and (MLML)	The addition of benthos collection will enable sediment assessments in accordance with the SQOs which use three lines of evidence, benthos, sediment chemistry and sediment toxicity.
A	2008	Added pyrethroids analysis in sediment (CDFG)	To investigate the potential toxicity of pyrethroids in the Bay.
A	2008	Added selenium analysis in tissue (BR)	Added to provide information for the Selenium TMDL

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A	2008	PCBs were not analyzed in water. PAHs and Pesticides in water were not scheduled to be analyzed but were added into the sampling plan.	PCBs, PESTS, PAHs will be sampled every other year in water (on a biennial basis) based on recommendations from the redesign process. PAHs were analyzed because of the Cosco Busan oil spill, and PESTS were analyzed to validate the detection level for AXYS Analytical's MRES method using both whole water samples and 100L High volume extracts. Pesticide results were not reported because they were part of the Intercomparison study.
D	2008	2008 grainsize granule fraction is not available	Granule fraction was not analyzed. In 2008, RMP switched labs from UCSC-DET to MLML-Aiello. MLML did not analyze larger grainsize fractions, and only fractions <2mm are available.
D	2008	Grainsize determination changed to an optical method.	In 2008, RMP switched grainsize labs from UCSC-DET to MLML-Aiello where they employ a different method.
D	2008	Grainsize for 2008 are not comparable to previous years.	Grainsize in 2008 and later is reported for fractions 2mm and smaller, as a percentage of total volume determined by an optical (laser) method, as opposed to gravimetric measurement (as a percentage of mass) for mechanically separated samples used prior. Additionally, split samples analyzed mechanically in 2009 showed poor comparability to the optical method due to possible artifacts of handling in the mechanical separation method, usually yielding higher apparent coarse material due to aggregation of smaller particles during the drying of samples. The lab is currently testing a wet seiving method to resolve these artifacts.
D	2008	Manganese and iron in bivalves are non-target analytes and not reported via WQT	Manganese and iron are not reported as target analytes via WQT.
D	2008	Missing % Lipids for the trace metals bivalve analysis	Lab could not analyze for this.
D	2008	MRS Pesticide Results should not be combined with prior years for Trends Analysis.	Axys switched to a multiple residue (MRES) method for pesticides. Whole water MRES samples typically showed higher concentrations than in solid phase (XAD) extracted samples, due to only partial retention of pesticides by the XAD. Interannual trends should therefore be evaluated only within any given collection type (i.e. whole water 2008 and later or XAD 2007 and before).
D	2008	Oxadiazon was not reported	The MRES method cannot analyze for Oxadiazon and because the 2008 demonstration project used only the MRES method, it was not possible to collect this data.
D	2008	Pyrethroid tralomethrin not analyzed in sediment samples	Tralomethrin was not analyzed in 2008 by CDFG, but will be in the future.
D	2008	Water MRES pesticide data	The 2008 samples were part of a demonstration project for the MRES method and were conducted on a subset of stations using whole water grabs (7 samples). These results were then compared to the extracts from the 100-liter infiltrex samples at the same location. These results will not be reported on the web.
L	2008	Added sediment-water interface cores exposure (SWIC) toxicity testing method for bivalve larval (MYTILUS GALLOPROVINCIALIS) SWIC will be analyzed for toxicity by UCD-GC.	The Sediment Quality Objectives recommend using sediment–water interface core exposure (SWIC) for bivalve larva toxicity instead of elutriate testing for toxicity. Toxicity testing for amphipods will continue to be conducted using the elutriate method. TIEs will be conducted in samples that show significant toxicity.
L	2008	Changed lab for analysis of Total Organic Carbon and Total Nitrogen in sediment from UCSC to MLML – Hunter	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.

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L	2008	Changed lab for analysis of grainsize in sediment from UCSC to MLML - Aiello	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.
L	2008	Changed lab for analysis of SSC, Pigments, Nutrients, salinity, and hardness in water from UCSC to EBMUD	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities.
L	2008	Changed lab for POC and DOC analysis from UCSC and AMS-Texas to Columbia Analytical Services	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities/ AMS-Texas went out of business.
L	2008	Changed principle lab for trace metals in water from UCSC to BR and changed principle lab for trace metals in tissue from UCSC to BR (Se) and CCSF (other metals)	Changed labs based on an evaluation of turn around time, cost, and analytical capabilities such as elevated methyl mercury quantitation limits. Due to BR's method, metals (Al, Cd, Cu, Fe, Pb, Mn, Ni, Ag, and Zn) are no longer reported as near-total concentrations. UCSC extracted with a weak acid (pH < 2) for a minimum of one month, resulting in measurements that approximate bioavailability of these metals to Estuary organisms. BR used reductive precipitation according to EPA Method 1640.
L	2008	Intercomparison study with BR and City and County of San Jose for Copper and Nickel in water	Samples were analyzed by both labs at all 22 sites.
L	2008	Pesticide water analysis conducted by AXYS was performed using MRES method on samples collected on 100L infiltrix system. In previous years pesticides were analyzed using GC/LRMS which could not detect chlorpyrifos/diazinon.	The MRES method is able to detect the standard suite of RMP pesticides including chlorpyrifos/diazinon (oxadiazon is not tested for using MRES).
P	2008	Began reporting water particulate trace organic results.	New design of web query tool makes it easier to post particulate results.
P	2008	Benthos sampling was added as part of the sediment sampling cruise.	With all three lines of evidence (i.e., benthos, sediment chemistry and sediment toxicity), it will be possible to conduct sediment assessments in accordance with the Sediment Quality Objectives (SQOs), which are scheduled to be promulgated in 2008.
T	2008	Bivalve Trends	These are available in the AMR beginning in 2008 for years bivalves are collected, biennially for trace organic contaminants and every five years for trace metal contaminants.
A	2009	Cyanide was analyzed in water.	New site specific objective was developed for cyanide in water in San Francisco Bay.
A	2009	Dioxins were added as part of the Small Tributary Loading Study.	Data will fill the dearth of information that currently exists for dioxin. This is a Special Study.
A	2009	Dioxins were analyzed for all 22 water stations, all 47 sediment stations, and in sportfish.	Data will fill the dearth of information that currently exists for dioxin. This is a 5 year Special Study that is not a part of the Status and Trends Component.
A	2009	Oxadiazon was dropped from the RMP target analyte list.	The different MRES method for analyzing pesticides in water adopted by the RMP doesn't include oxadiazon. Since concentrations of oxadiazon have remained relatively constant over time, the TRC approved removing it from the target list in July 2009.
A	2009	PFC analysis was added to bird samples.	Part of Exposure and Effects Pilot Study.
A	2009	PFC analysis was added to sportfish samples.	Part of Emerging Contaminants Special Study.

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A	2009	PFC samples were collected at a subset of water stations.	Special Study - Added because of concern over elevated concentrations found in Bay Area tissue samples as compared to reference samples from Tomales Bay.
A	2009	The RMP PCB list was expanded from 40 congeners to 209 congeners for all matrices.	The non-Aroclor PCB, PCB 11, was unexpectedly observed in air and effluent samples outside the Bay Area in significant concentrations, prompting the expansion of the RMP PCB congener list to include all possible congeners.
A	2009	Water PAHs were not analyzed.	Due to the Cosco Busan oil spill, PAHs were analyzed in 2008. Because no significant changes in the water column were identified, PAH sampling was skipped in 2009 and 2010. Water PAHs are scheduled to be sampled again in 2011.
A	2009	Whole water samples were collected at 22 sites for analysis of pesticides.	Whole water samples are collected for the analysis of pesticides using MRES methods. Beginning in 2009, pesticides analyzed using the MRES method are considered the RMP's target analytes.
D	2009	2009 total cyanide water results are not reported.	The RMP's previous California Toxics Rule (CTR) work was based on the Weak Acid Dissociable (WAD) fraction. Total cyanide will most likely give an over-estimation of the bio-available fraction. Several of the 2009 total cyanide water results were above the cyanide trigger level (1.0 ug/L) for ambient monitoring as stated in the Basin Plan Amendment, which is based on the WAD fraction. Hence, at the request of the Water Board these samples were not reported to avoid confusion.
D	2009	Water PBDEs 196, 201, and 202 are not available.	AXYS has not developed a method for detecting these PBDEs in water.
L	2009	Contra Costa County Sanitation District will analyze water for cyanide.	New analyte for analysis in water only.
P	2009	Added Pesticides Fipronil, Fipronil desulfinyl, Fipronil sulfide, and Fipronil sulfone for sediment analysis	These pesticides are highly used in the Bay Area and are of emerging concern. Fipronil is widely-used in flea/tick applications. It is exceedingly toxic to insects/crustaceans. There is relatively little Bay Area data so it would be very helpful to report these data when available.
P	2009	Changed the statistical design for sediment sampling from five-year panels to six-year panels	Changed to incorporate rainy season sediment sampling which will occur every other year starting in 2010. Rainy season sediment sampling will occur at 20 random sites and 7 historic sites. Dry season sediment sampling will continue to occur at 40 random sites and 7 historic sites.
P	2009	Dioxins were analyzed in water, sediment, sediment core, bird egg, small tributary loading, and sportfish samples.	The Dioxin Pilot Study is not part of the Status and Trends component, but samples were collected during regular RMP sampling events.

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P	2009	Status and Trends Sport Fish Monitoring	The 2009 monitoring effort was combined with the BOG coast year 1 sampling effort. This resulted in adding one additional species to the RMP list: Jacksmelt. Most samples were analyzed as composites except for mercury in striped bass and selenium in white sturgeon. Analytes measured: mercury, PCBs, DDTs, dieldrin, chlordanes, PBDEs, dioxins, PFCs, and selenium. There were two side-by-side studies in 2009: Comparison of selenium concentrations in filet, muscle plug, and liver of white sturgeon. This was done for the development of the North Bay selenium TMDL. The comparison was also to determine if we could use muscle plugs (nonlethal) instead of filet (lethal) to determine selenium levels in white sturgeon. Comparison of skin-on and skin-off PCBs, legacy pesticides, PBDEs, and dioxin concentrations in white croaker. Starting in 2009, white croaker will be analyzed skin-off.
T	2009	Sport Fish	SWAMP/RMP/Bight Program Report on Contaminants in Fish from the California Coast. 2011.
A	2010	Began reporting Sum of PCBs 208 (SFEI)	This sum provides an index of the PCBs present in Aroclor mixtures. PCB-11 is excluded from the sum because it is a by-product of dye manufacturing and is not related to Aroclors. PCB 11 does not have dioxin-like potency and has different sources than Aroclors.
A	2010	Pyrethroids Tetramethrin and piperonyl butoxide moved to a status of "Information only" by analytical lab	Compounds have a history of persisting high variability in Ongoing Precision and Recovery (OPR) and linearity data. Results are estimated to be accurate only within an order of magnitude.
D	2010	Added new PrepPreservation Code: FieldFiltered,FieldSolventPres,FieldFrozen	This code is used for Chlorophyll-a and Pheophytin samples beginning in 2010. We will not update previous years' sample records which have codes "FieldFiltered, LabAcidified" and "FieldFiltered, FieldFrozen" because it was determined that the benefit does not justify the time and effort at this time.
D	2010	Bivalve data not available for BD40 Davis Point Station because it was not sampled.	BD40 was not sampled due to terminal construction and weather issues.
D	2010	TRC cancelled scheduled analysis of archived 2006 and 2007 water samples for Diazinon and Chlorpyrifos	Initially, water samples were stored during method development for analysis once analytical issues were resolved. These issues have since been resolved. In 2010, TRC decided to cancel the analysis due to the high cost ($60,000) and the lack of a pressing need for the data.
D	2010	Whole water PBDE sample results are not available through the Web Query Tool.	In 2010, 4L whole water samples were analyzed for PBDEs as part of an intercomparison study. The Web Query Tool Does note report data from Intercomparison studies.
D	2010	YSI data collected by SFEI on water cruise are not available for 2010	Data were inadvertently deleted from YSI machine by staff working on another project before it was downloaded.
L	2010	Began adding LabPoisoned to the PrepPreservation code for organic water samples when samples tested positive for residual chlorine.	It was decided that we will not update the PrepPreservation code for samples prepped with poison from 2002-2009 because the benefit does not justify the time and effort at this time.

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P	2010	Sediment samples will be collected in alternate seasons starting with a rainy season (winter) sampling event in February 2010.	There appears to be a seasonal element to sediment toxicity with winter sampling exhibiting higher toxicity. 27 samples will be collected during the dry season and 47 samples will be collected during the rainy season. February of 2010 was the first rainy season collection. The next sampling event is August 2011.
A	2011	Range dropped from grainsize parameter names and is now stored in fraction field.	Changed as part of effort to incorporate SWAMP comparability to SFEI data reporting.
A	2011	Sediment toxicity test organisms changed at select sites.	The TWG and EEWG recently decided to change the test organisms at the fresh water river sites to Hyalella and Ceriodaphnia for 2011. Prior years used Eohaustorius and Mytilus.
A	2011	Three sums of PCBs: 40, 208, 209 will be reported through the Web Query Tool.	Three sums of PCBs: RMP 40, 208, 209 for all matrices and all studies. Sum of 209 PCBs is provided solely for comparison to other studies that use this statistic. SFEI does not recommend using this sum for comparison to any Aroclor-based thresholds (the TMDL target, OEHHA thresholds, etc.) - the Sum of 208 PCBs is better for that purpose because the sum of 208 does not include PCB 11.
D	2011	SWAMP has changed the definition of LCS Sample Type. The new definition indicates that LCS samples have gone through the entire QA process.	SWAMP has provided a new definition for samples that have not gone through the entire QA process. The new sample type code is 'UnkAcc' – Control Sample used to assess accuracy, unknown whether or not taken through the full analytical process. We will not go back and update the database for samples previously called LCS since we do not always know whether the samples have gone through the entire analytical process but in future data sets we will use the code 'UnkAcc'.
D	2011	Updated coelution flag for PCB 156(Surrogate) to DO156L. In previous years, the flag DO156 was reported.	The L indicates that it is a labeled compound. Including the 'L' in the coelution flag increases accuracy.
L	2011	Beginning in 2011, the MDLs from EBMUD for sediment trace organics are all 40CFRs.	EBMUD wanted to provide consistent MDLs between analytes.
P	2011	the name of the Web Query Tool (WQT) changed to Contaminant Data Download and Display (CD3).	This name is more descriptive and is more representative of what the SFEI data query tool does.
T	2011	Small fish Trends Report.	Report by Ben Greenfield will be published in 2011.
D	2011	Cyanide results are not available for SB061W	The sample was not analyzed due to hold time violations.
A	2011	The Steering Committee and Technical Review Committee made the decision to collect water organics every four years. Organic water samples were collected in 2011.	Since most of the organics are hydrophobic, we don't see much of them in the water column and there is no clear trend in the data. It is better to track these compounds in sediment and biota.
A	2012	Updated the parameter name for 'Phosphate as P' to 'Orthophosphate as P'.	Orthophosphate as P specifically indicates the type of phosphate being measured, removing all ambiguity as to what was measured.
P	2012	In 2012 the sampling design was modified to alternate water and sediment to biennial sampling, e.g., 2012=sed, 2013 = water, 2014 = sed. Alternating between seasons (wet and dry sampling) will continue to occur for sediment (2012 Sed = wet, 2014 sed = dry).	The purpose for alternating seasons is to assess the potential for increased toxicity in the winter months.

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L	2012	Beginning in 2012, EBMUD will increase the batch size to reduce the number of QA samples they need to analyze.	Change in laboratory methodology.
P	2012	Whole bivalves will no longer be stored in short term archive storage.	Whole bivalves were subject to prevalent degradation. Homogonized bivalves will be stored in long term archive storage at NIST and if enough sample material remains, aliquots will be kept in short term storage.
L	2012	AXYS analytical samples that have been qualified in the LABQA Code field with 'G' - lockmass interference present, are given a QA code 'LRJA' - Data rejected - Analyte positively identified but quantitation is an estimate, flagged by laboratory.	This flag alerts data users to an increased uncertainty in the value where the severity of the impact cannot be categorized. This change was applied beginning with WY2012 POC data and 2012 RMP data.
D	2012	1993-03 sediment Mn results have been updated to have a QACode of "VRVQ", a CompCode of "Rej", and a DisplayCode of "-40".	An external user noticed that the numbers looked unusually high for two stations, suspecting a subscription error. Since we do not have the raw results to verify that unit conversion calculations were done correctly and because the numbers are so much different than other years (about 10X higher than all other sediment Mn numbers reported by the same lab) the QA officer decided to flag and censor these results.

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