

Regional Monitoring Program for Water Quality in the San Francisco Estuary

2008 Program Plan

OVERVIEW OF THE 2008 PROGRAM

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) is entering its 16th year of monitoring and synthesis. As the Program matures, it is important that Program elements are periodically evaluated to assure that they are answering the important questions in a cost-effective manner. The RMP convened a series of meetings with RMP participants, regulators and interested stakeholders in 2006 and 2007 to discuss optimization of the core annual monitoring program, Status and Trends. Based on the results of statistical analyses, and evaluation of program objectives and participant and regulator needs, a number of changes were recommended for the program. Many of these will be implemented in 2008.

Changes to Status and Trends in part reflect a need to better understand and to monitor the flow of contaminants into the Estuary. Loading studies of both small and large tributaries are now being included in the annual Status and Trends program to help us understand the sources of contaminants and the pathways by which they reach the Bay. Other key questions concern the spatial patterns of contaminant uptake into the food web, and trends in biota over time. Status and Trends is being expanded to include small fish and bird egg monitoring to address this question. In addition, monitoring of key biological species will continue to be the focus of several pilot and special studies.

Biological measurements such as small fish, sport fish, and bird egg monitoring is also in keeping with the new focus of regulations on more direct measurements of beneficial uses that are being impaired. An example of this is the Mercury Total Maximum Daily Load (TMDL) released in August 2006. The four-day marine mercury water quality objective was vacated and replaced with numeric mercury objectives for fish (i.e., a 0.2 mg/kg objective for sport fish to protect human health and a 0.03 mg/kg objective for small fish to protect piscivorous fish and wildlife). In addition, the RWQCB identified bird eggs as a mercury monitoring target.

Small fish monitoring, bird egg monitoring, and loading studies began as RMP pilot and special studies. As pilot and special studies are incorporated into Status and Trends, the RMP workgroups will continue to review, provide oversight, and make recommendations to assure that the studies are addressing the highest priority RMP objectives and management questions. The role of the workgroups will therefore expand in 2008 to include oversight of Status and Trends elements as well as pilot and special studies.

As part of the expansion of the role of workgroups in the RMP, a key focus in 2007 was to articulate and prioritize the specific questions that the four RMP workgroups are seeking to answer. Each of the four RMP workgroups - Contaminant Fate, Sources Pathways, and

Loadings, Exposure and Effects, and Emerging Contaminants- began development of five-year plans in 2007 that identified and prioritized key questions. In 2008, these workplans and the Status and Trends program will be synthesized into a five-year plan for the whole program.

In addition to the workgroup five-year plans, the TRC requested the development of a mercury strategy for the RMP. Another subcommittee was formed to complete this task. The mercury strategy is still being finalized. The top priority elements of the strategy for the immediate future are to answer the following two questions:

- Where is mercury entering the food web?
- Which processes, sources, and pathways contribute disproportionately to food web accumulation?

The first question will be addressed through an expanded and refined small fish monitoring program. The second question will be addressed through an RFP to be issued in late 2007 by the Contaminant Fate workgroup and the mercury subcommittee. Approximately \$200,000 has been set aside for this RFP. Other priorities for the Contaminant Fate workgroup include understanding contaminant depth profiles in Bay sediments and expanding the multi-box model to pollutants beyond PCBs. The results of the analysis of the results of the sediment coring project, available in 2008, will be important in understanding future loads to the Bay.

As mentioned above, one of the key questions for the RMP is the potential effect of chemical contamination on biota. This question has largely been addressed through activities conducted under the auspices of the Exposure and Effects Workgroup. In 2008, the Exposure and Effects pilot study will fund two studies: a study of the interaction of mercury and selenium on bird egg hatchability and survival (USGS) and the impact of polyaromatic hydrocarbons on the early life stages of flatfish (NOAA). Although earmarked funding for this pilot study (Exposure and Effects) will cease at the end of 2008, the Workgroup will continue to provide oversight to the biological elements that have been incorporated into Status and Trends including small fish and cormorant and tern egg monitoring, and for future pilot and special studies relating to effects.

The RMP is expanding the measurement of watershed loadings to the Bay. To date, the RMP has developed a good understanding of loads from the largest source of freshwater to the Bay, the San Joaquin and Sacramento Rivers. Urban runoff is a primary source of pollutants to the Bay and characterizing loads from small urban tributaries is critical to the understanding this input. Through the Status and Trends program, we will continue to annually characterize loads from urban watersheds. In 2007, characterization of a small industrial urban watershed was undertaken (Hayward Zone 4 Line A). This work will continue in 2008 under the Status and Trends program.

The RMP and other programs have collected sediment loading, fish, and water quality data for the Guadalupe River. In 2008, data from the Guadalupe watershed will be synthesized into a model as part of a proposed pilot and special study. The model will be used to evaluate management actions to reduce loadings or mitigate adverse impacts. Collection of watershed data can be difficult and costly. Through a second proposed study, the RMP is evaluating the use of proxy methods such as satellite imagery for measuring suspended sediment loads.

Several of the other proposed pilot studies for 2008 address the question of the impact of chemicals on biota, specifically emerging contaminants. At the molecular level, researchers at California State University – Long Beach are examining effects to the hormonal system of two species of San Francisco Bay fish, Pacific staghorn sculpin and shiner surfperch. A number of emerging contaminants such as polybrominated diphenyl ethers are known to disrupt the endocrine system. This study will correlate changes in hormones to concentrations in individual fish in attempt to establish causality and to identify biomarkers. Two other proposed studies are collaborative projects with the Marine Mammal Center to evaluate perfluorinated compounds and alternative flame retardants in resident Bay harbor seals.

Part of the key for successfully managing the Bay is providing data and information in a timely manner. In 2007, the RMP was able to collect, format, and report the S&T data within our goal of one year. This one-year turnaround continues to be a goal for all 2008 elements. In addition to providing data in a timely manner, the RMP also sponsors meetings and workshops to provide an opportunity for regulators, managers, and the public to: learn about recent scientific advances; engage in dialogues on select technical topics; and foster collaboration and communication among different groups. In 2008, we will continue to sponsor meetings and workshops on key issues such as mercury.

In 2008, we will begin the process of implementing the redesigned Status and Trends program. It will be an exciting time as we implement the new program, continue to refine the questions through the workgroups, and begin to develop a long-term master plan for the RMP. The challenge for the Program is being responsive enough to address short term needs while maintaining sufficient long-term monitoring to be able to detect trends. Since the budget for the RMP remains relatively constant, the prioritization of these competing needs will require a team effort from all participants in the RMP.

TASKS

1. Program Management

The administration and management of the RMP requires a substantial effort from SFEI staff. Costs for this component of the RMP reflect the staff time required to manage finances and contracts, plan and coordinate internal activities and external workgroup, and technical oversight of RMP products.

1.1 Internal Coordination

This category provides SFEI staff time for coordination and liaison to program participants, program collaborators, Regional Water Quality Control Board, and Steering and Technical Review Committees. This coordination is necessary to keep everyone involved in the RMP satisfied with the organization and efficiency of the RMP, to prepare for and facilitate critical decisions, outline issues, and to ensure that RMP activities complement and enhance other scientific efforts by Program Participants and

the Regional Board. This task also includes the internal coordination of RMP staff (e.g., the coordination and technical oversight of different RMP tasks).

1.2 External Coordination

External coordination promotes a comprehensive and coordinated understanding and monitoring of the Estuary through participation in work groups and committees outside of the RMP umbrella. Members of RMP staff participate in the Interagency Ecological Program (IEP), the Surface Water Ambient Monitoring Program (SWAMP), Regional Board 5 activities, Sacramento River Watershed Program, Northern California SETAC, CALFED, BASMAA, BACWA, LTMS, and various TMDL work groups and committees. In addition to the above, the RMP staff is frequently asked to present guest lectures at universities and national and international working group meetings and to serve on advisory boards. RMP staff also provide peer review of documents from other relevant non-RMP programs and projects.

1.3 Contract and Financial Management

Tasks in this category include all efforts related to tracking progress and expenditures on all budgeted items, including invoicing of Program Participants, tracking incoming and outgoing funds, accounting and working with the SFEI auditor, working with the Fiscal and Administration Subcommittee of the SFEI Board of Directors, providing financial status updates, and communicating with the Steering Committee on financial matters as needed. It also includes preparation of contracts after scopes of work have been negotiated, scientific oversight of products, coordination of field and laboratory components, trouble-shooting, scheduling, and implementing course adjustments as necessary, cost-effectiveness/performance evaluations of existing contractors and identifying potential new subcontractors as needed.

1.4 Program Planning

Program planning for the RMP involves several tasks including Program Plan and Project Plan development, updating the five-year plan, proposal writing, RFP development, and development of scopes of work, both for in-house staff and subcontractors. With procedures in place for Pilot and Special Study selection and data interpretation, we will continue to place emphasis on documenting planning steps and assisting the Steering Committee and the Regional Board in prioritizing information needs, and adapting the Program to evolving management priorities.

In 2007, the RMP focused considerable attention into preparing five-year plans for each of the four workgroups: Contaminant Fate workgroup, Sources, Pathways, and Loadings workgroup, Exposure and Effects workgroup and the Emerging Contaminants workgroup. As part of this process each workgroup developed a list of prioritized questions to be answered and the work plans outlined a strategy for answering these questions. The purpose of these five-year plans is to develop a coherent strategy to address the management questions and objectives that guide the RMP. The five-year

plans will allow the RMP to prioritize research and monitoring needs, to coordinate with other research/monitoring activities that are being undertaken in the Estuary, to solicit input from experts on a longer term, and to enable long-term financial planning. In early 2008, a master plan for the RMP summarizing all of the workgroup five-year plans will be prepared.

In addition in 2007, the role of workgroups was expanded to include the review of pilot studies and special studies as well as portions of the Status and Trends program area that were germane to respective workgroups. The workgroups will continue to remain active in 2008 in their review and oversight of the RMP.

In 2007, the RMP completed a redesign of the Status and Trends program to optimize program elements. A summary of the process is provided in a draft document which is currently under review.

2. Information Management and Dissemination

To meet the RMP Objective 6: “Effectively communicate information from a range of sources to present a more complete picture of the sources, distribution, fate, and effects of contaminants in the Estuary ecosystem”, all activities related to data management, RMP web-site maintenance, development of newsletters, the RMP Annual Meeting, presentations, and information transfer to a variety of audiences, including preparation of the RMP Annual Monitoring Results and the “Pulse of the Estuary”, are included in this category.

2.1 Data Management

The primary objective of this task is to manage, maintain, and improve the RMP database and to enable greater accessibility of data results. The information management and dissemination goals for 2008 are as follows (listed in order of priority):

- Upload RMP analytical results from laboratories into the new database format (the State SWAMP database format) and continue to QA/QC these data to assure they are of high caliber;
- Continue maintenance of the web-based data access tool that was developed in 2004;
- Develop tools to increase the efficiency of QA/QC review; and
- Upload select datasets from RMP Pilot & Special Studies (or other studies) into the new RMP SWAMP database.

2.2 RMP Web Site

The RMP web site is assuming an ever-increasing role in making data, technical reports, newsletters, workshops, bibliographies, Powerpoint presentations, and other documents available to the public. We will continue the process of improving the website in 2008.

The tasks to be conducted include: 1) posting agendas, minutes, and attachments from all workgroups and RMP committees on the web for easy access; 2) posting the RMP Annual Monitoring Results, which is distributed solely via the RMP web site; 3) converting RMP reports into appropriate publication quality formats for quality printing and/or for distribution on the SFEI website, 4) maintaining web directories and updating the RMP publications list to allow easy access; and 5) maintaining and improving the overall design of the RMP web site.

2.3 Information Dissemination

The RMP produces newsletters, inserts, and other documents for dissemination. We will continue to take advantage of existing publications for information distribution, such as newsletters of participating agencies, the NEP newsletter, ESTUARY, and the IEP newsletter. As appropriate, fact sheets, briefing papers, and formal presentations to community groups and other organizations, and scientific conferences will also provide information about the RMP and its findings. This task also includes work related to planning and executing the RMP Annual Meeting which occurs in early fall.

2.4 Annual Reporting

This task includes preparing the Annual Monitoring Results for distribution on the web and writing, editing, and publishing the "Pulse of the Estuary." It continues to be a goal for the program of reporting out data within a one-year time frame.

2.5 Quality Assurance and Quality Control

This task includes three main elements: 1) evaluating the quality of data generated by analytical labs; 2) updating the QAPP and protocol documentation; and 3) coordinating intercomparisons and other efforts to improve the quality of RMP data. In 2007, the QA officer began revising the QAPP to incorporate revisions made to state-wide QAPPs. This effort will continue in 2008. At present, we are envisioning two meetings with RMP subcontracting laboratories and SWAMP personnel to solicit input and to revise the QAPP.

2.6 Data Integration

This category provides resources for staff activities that focus on integration of data from the RMP and non-RMP studies of contaminants in the Bay, and on synthesis of all of this information in evaluations of past trends, present status, and projected future trends. Other sources of information on Bay contamination include USGS studies, SWAMP, CALFED, EMAP, and NOAA's Status and Trends Program. Data integration plans are currently still in development, in consultation with the Contaminant Fate Workgroup and TRC. Development of a conceptual model for methylmercury and preliminary evaluation of mass budgets for other pollutants using the PCB multibox model as a foundation are likely to be the primary elements of the data integration plan for 2008.

3. Status and Trends Monitoring

In years past, the Status and Trends (S&T) monitoring program was composed primarily of four program elements: long-term water, sediment, and bivalve monitoring; episodic toxicity monitoring; sport fish monitoring; and the USGS hydrographic and sediment transport studies. In 2007 as part of the redesign process, the S&T monitoring program was expanded to include the following elements: triennial bird egg monitoring (cormorant and tern); annual small fish monitoring; annual small tributary loading; triennial large tributary loading; and triennial studies of the Guadalupe River.

In keeping with the optimization and redesign of the program, portions of the core Status and Trends program were modified in 2007. The number of water sites and the frequency of the bivalve monitoring program were both reduced. The goal of the episodic toxicity program was refined to address the question of what is causing the sediment toxicity in the Bay; the element renamed to identifying the Cause of Toxicity; and the frequency reduced to a biennial program.

The S&T monitoring program for water and sediment was last revised in 2002 to include a randomized design suited to addressing questions related to a representative characterization of contaminant concentrations in water and sediment. The bivalve bioaccumulation component of the S&T, however, does not use a randomized design but rather continues to sample 11 historical sites.

Water sampling for the S&T monitoring program occurs once a year in the summer. In 2007, the number of stations was reduced from 31 to 22. Summer has been selected for sampling because inter-annual variation due to natural variables, primarily freshwater inflow, is minimized during this period. The RWQCB is reviewing its needs for seasonal sampling (i.e., wet weather sampling); for 2008, no wet weather water sampling is planned.

In 2007 as part of the redesign process, a recommendation was made to alternate seasons in which sediment is sampled. A primary goal of the sediment sampling is to begin to understand what is causing the sediments to be toxic. In addition, there appears to be a seasonal aspect with winter sampling exhibiting higher toxicity. In 2008, sediment will be collected in summer as in prior years; however, starting in 2009, sediment samples will be collected in alternate seasons starting with a wet season (winter) collection event. It was also recommended by the Exposure and Effects workgroup that sediment be analyzed for benthos in addition to sediment chemistry and toxicity. 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.

The number of S&T monitoring stations varies by segment for water and sediment measurements based on current Regional Board management priorities, statistical power achieved for key contaminants, and fiscal considerations. In addition, five historical water stations and seven historical sediment stations are sampled to maintain time series for long-term trend analyses. In 2007, as part of the program redesign, statistical power analyses were

conducted to determine the optimal number of stations to detect trends and exceedances of water quality objectives.

3.1 Water and Sediment Chemistry and Bivalve Bioaccumulation

Water Chemistry

Conventional water quality, trace metals, and trace organics sampling in water will occur during the dry season at 22 stations throughout the Estuary. In 2008, based on a recommendation from the redesign process, water samples will be analyzed for only PBDEs. Pesticides, PAHs, and PCBs will be analyzed every other year (a biennial basis). PBDEs extracts (dissolved and particulate) will not be combined to aid in our understanding of the partitioning of PBDEs.

Sediment Chemistry

Sediment samples will be collected during the dry season. Sediment chemistry will be analyzed at 40 random sites and seven fixed sites. The 2008 analyte list for sediment will remain unchanged from 2007.

Bivalve Bioaccumulation

The bivalve monitoring component maintains the long-term time series started by the State Mussel Watch Program in the early 1980s. Because of logistical complexities, a randomized design is not feasible. Transplanted bivalves will be deployed at nine stations, using the mussel species, *Mytilus californianus*. As has been done since 1999, resident *Corbicula* will be collected from the Sacramento and San Joaquin River stations (BG20 and BG30). Based on the results of the redesign process, tissue concentrations in bivalves will be analyzed once every two years during the dry season when Estuary conditions are more consistent on an interannual basis, to meet the trend evaluation and guideline comparison objectives. Bivalves are analyzed for organics and this list remains unchanged from 2005. Trace element analysis has been reduced to a five-year interval. This analysis was most recently completed in 2001. Trace elements will be included in 2008, pending TRC discussion and approval.

Toxicity

Because the RMP S&T aquatic toxicity monitoring in the Estuary has shown little toxicity over the past several years, aquatic toxicity sampling has been scaled back to a screening effort approximately every five years. Aquatic toxicity sampling was conducted in 2007 and, assuming no significant toxicity is observed in the 2007 samples, will not be conducted again until 2012.

RMP S&T sediment toxicity monitoring will continue as in previous years. Sediment toxicity measurements will be made at 27 sites in the Estuary (20 randomly allocated sediment chemistry stations and seven historical RMP sampling sites). Toxicity tests will be conducted with *Eohaustorius* (a solid phase test with survival as the endpoint) and *Mytilus* (an elutriate test with normal larval development as the endpoint). Toxicity Identification Evaluations (TIEs) will be conducted in samples that show significant toxicity.

3.2 Causes of Toxicity Monitoring

In 2007, the RMP began a study to determine the causes of the persistent sediment toxicity that is observed in the Bay. Since the program began, we have consistently seen toxicity to bivalves and amphipods in the Bay. Toxicity to amphipods exhibits a seasonality aspect with samples collected in the winter exhibiting a much higher mortality; toxicity to bivalves remains unaffected by seasons.

In 2007, the RMP began a study to identify toxic sediments and to elucidate the underlying causes of toxicity. In the Spring, four estuarine sites located at the mouth of Bay tributaries were sampled to identify toxicity. One of the four sites (Mission Creek) was observed to have sufficient toxicity to conduct Toxicity Identification Evaluation (TIE) testing and sediment chemistry to elucidate the cause of toxicity. In the Fall of 2007, four more sites will be sampled. Depending on the results of this testing, an additional four sites may be sampled in the Spring of 2008.

3.3 Sport Fish Bioaccumulation Monitoring

Sport fish sampling in the RMP began in 1997 and occurs on a triennial basis. The results of the 2006 sampling season are currently being reviewed and will be summarized in a report that will be released late 2007. The next sampling event is scheduled for 2009. Resources for the 2009 fish tissue monitoring component will be set aside in 2007 and 2008 to lessen the budgetary impact in the 2009 monitoring year.

3.4 U. S. Geological Survey Studies

The United States Geological Survey (USGS) has been a collaborating agency in the RMP since the beginning of the Program and has contributed in-kind services through Department of Interior funding, IEP funding, and other sources to enhance the RMP financial contributions designed to address basic hydrographic and sediment transport processes. An understanding of these basic processes is necessary to interpret the patterns and dynamics that are emerging from the RMP database on chemical indicators of water quality condition. The funds contributed by the RMP are generally less than half of the overall USGS costs to conduct both monitoring components outlined below.

3.4.1 Sediment Dynamics in San Francisco Bay

This study will be conducted by the USGS in Sacramento. The principal investigator is Dr. David Schoellhamer.

From 1993 to 2005, this element of the RMP focused on monitoring and understanding suspended sediment dynamics in the Estuary. This work has yielded many insights into sediment and contaminant dynamics in the Estuary. In 2006, in part in response to funding cuts, the USGS reduced the number of stations from ten to six. The RMP,

USGS, and the US Army Corps of Engineers convened a meeting in the summer of 2005 to discuss the optimal locations of suspended sediment stations in the Estuary. It was agreed to fund five fixed stations (i.e., Alcatraz, Mallard, Benicia, Point San Pablo, and Dumbarton) and one temporary station located near the Hamilton Army Airfield (San Pablo Bay). The five fixed stations will provide suspended sediment information at four embayments. The temporary site at Hamilton provides the US Army Corps with information needed to evaluate the impact of the aquatic transfer station. There was discussion in 2006 that it would be useful to conduct sediment flux calculations at the Dumbarton Bridge site in lieu of sampling at Alcatraz; however, the dredging community is particularly interested in the results from Alcatraz.

In 2007, the Point San Pablo site was replaced with a Richmond Bridge site as a result of the deterioration of a pier at the Point San Pablo site. In addition, at the writing of this report, it is not clear whether the temporary station will remain at the Hamilton Army Airfield or whether these funds may be reallocated.

In addition to the suspended sediment work, the USGS will continue to assist SFEI in the further refinement of the multi-box model.

3.4.2 Hydrography and Phytoplankton

This study will be conducted by the USGS in Menlo Park. The principal investigator is Dr. Jim Cloern.

This study will continue its measurement program in support of the RMP, with monthly water sampling to map the spatial distributions of basic water quality parameters along the entire Bay-Delta system. Measurements will include salinity, temperature and dissolved oxygen, which influence the chemical form and solubility of some trace contaminants; suspended sediments and phytoplankton biomass, which influence the partitioning of reactive contaminants between dissolved and particulate forms. This basic information is required to follow the seasonal changes in water quality and estuarine habitat as they influence biological communities and the distribution and reactivity of trace contaminants. Highlights from this work were described by Dr. Cloern in the 2006 Pulse of the Estuary. Hydrographic and phytoplankton sampling will be coordinated with other elements of RMP sampling.

Approximately 15,000 acres of salt ponds in the South Bay will be converted into wetlands. As part of this process, salt pond levees will be breached and water from the ponds released. Information on basic water quality parameters, such as salinity and dissolved oxygen, will be very important for understanding the impact of this wetland restoration on the Estuary.

3.5 Status and Trends Monitoring Field Work

This work element includes SFEI staff involvement in Status and Trends Monitoring on board ship and general sampling support. SFEI staff collect water samples for analysis of

trace organics and trace elements and assist with sediment collection and bivalve retrieval operations.

3.6 Small Fish Monitoring

Small fish have been analyzed in the RMP Exposure and Effects Pilot Study since 2006. Small fish are excellent indicators of biological uptake of contaminants, particularly mercury. Small fish have high site fidelity and are prey for higher trophic level organisms such as cormorants, harbor seals, and fish. In 2008, this element will be funded by the Exposure and Effects Pilot Study; in 2009, this will be incorporated into an annual sampling event as part of Status and Trends.

3.7 Bird Egg Monitoring

As part of the redesign of Status and Trends, bird egg monitoring of cormorants and terns will be included in the RMP on a triennial basis starting in 2008. Substantial monitoring of eggs was conducted through EEPS pilot studies.

Cormorants

Cormorants are excellent indicators long-term trends and regional spatial patterns of contaminants in open waters of the Bay. Cormorant eggs have been sampled at three locations (Wheeler Island, Richmond Bridge, and Don Edwards) in 2002, 2004, and 2006 as part of the EEPS program element. As part of the redesign process, it was recommended to collect three composites of seven eggs (previously the RMP collected two composites of ten eggs) at each of the three stations on a triennial basis. The eggs will be analyzed for mercury, selenium, PBDEs, perfluorinated compounds, PCBs, dioxin and pesticides.

Terns

Terns are valuable indicators of long-term trends and regional spatial patterns in contaminants in the shallow margins of the Bay. As part of the EEPS program, terns eggs were collected in 2002 and 2003 and analyzed for mercury. Terns have also been very extensively studied by USGS in work funded by CALFED. The results of these studies suggest that terns are at an elevated risk. The sampling design for tern egg monitoring is still under development.

3.8 Tributary Loading

As part of the redesign of the S&T program in 2006/2007, it was decided to include the following tributary loading studies in the S&T program: studies of small tributary loading (annual); large tributary loading (Mallard Island studies, triennial); and Guadalupe river loading studies (triennial).

Small tributaries form a major pathway for loads of contaminants that enter the Bay each year. Present load estimates for this pathway are uncertain. In 2007, the RMP conducted

a special study of a small tributary located in an industrialized area of Hayward (referred to as the Zone 4 Line A project). Data from this study are currently being reviewed. Information from this industrial watershed will provide valuable information on loads derived from small, low rainfall, but highly impervious, commercial and industrialized “storm drain watersheds” on the Bay margin. This is particularly important for updating regional TMDL estimates of Hg and PCBs loads derived from urban runoff. In addition, loadings studies will provide baseline data for trend analysis and input parameters for modeling efforts.

4. Pilot Studies

4.1 Exposure and Effects Pilot Study

The Exposure and Effects Pilot Study was initiated in 2002 to understand the biological effects of the chemical contamination observed in the Estuary. This pilot study enters its last year of earmarked funding (at level of \$200,000 per year). Biological effects of contaminants have increasingly become more important to regulators and regulated community (e.g. mercury TMDL which establishes thresholds for birds and fish). As a result, the RMP has expanded its monitoring program to include impacts to biota. In 2007, the EEPS workgroup is developing a five-year plan for monitoring biota. Integral to this plan is work on avian exposure and effects and fish exposure and effects. In keeping with this five-year plan, the EEPS committee has approved the following three studies for 2008:

- Avian Exposure and Effects. This study will investigate the effects of mercury and selenium on avian reproductive success. This study will analyze individual egg albumin for mercury and selenium and correlate the egg concentrations to hatchability and survival. This work will assist in the development of egg thresholds as well as aiding our understanding of the interactions between mercury and selenium. USGS will receive \$70,000 from the RMP in 2008 for this work.
- Fish Effects. EEPS will fund a study evaluating the effects of PAH-contaminated sediments on the development of juvenile flatfish. The impacts of pyrogenic PAHs (like those detected in San Francisco Bay) on juvenile flatfish development are largely unknown. This is a two-year study which in the first year will examine the effects of pyrogenic (higher molecular weight) PAHs on a model fish such as zebra fish. After the identification of biological endpoints with a model fish, in the second year, the study will examine a native species. In addition, environmental sediment samples with a PAH signature similar to San Francisco Bay will be used. NOAA researchers will receive \$40,000 for studies for the first year.
- Spatial patterns in uptake of methylmercury into the food web. The EEPS began sampling small fish monitoring for methylmercury in the Bay in 2005 and continued this work in 2006 and 2007. The preliminary results of this study

show tremendous variation spatially (e.g., higher concentrations observed in the South Bay) and tremendous variation among species (e.g., higher concentrations observed in nearshore species). Determining where methylmercury is entering the food web has been identified as a top priority in the RMP Mercury Strategy. These results are also useful for evaluating potential risk to piscivorous wildlife. This project will be refined and the budget expanded to \$150,000 in 2008.

Lastly in 2008, SFEI will produce a summary report of the work that has been conducted under EEPS in the last five years since 2002. Remaining funds in EEPS are used for labor and direct costs (e.g., costs incurred by scientific advisory panel members).

5. Special Studies

The TRC has recommended that the studies described below be included in the 2008 program. A number of mercury studies were proposed; however, based on the Contaminant Fate workgroup and the TRC meetings in September, it was recommended that a request for proposals be developed to address targeted mercury questions. The RFP is in development; in the interim, it was recommended that approximately \$200,000 be placed in reserve for mercury. Approximately \$267,000 of special studies was approved by the TRC and pending SC approval will be included in the 2008 program. These studies are discussed in more detail below.

5.1 Guadalupe River Watershed Model

High levels of PCBs and mercury have been detected in the Guadalupe River. The RWQCB, SFEI and other agencies have developed an extensive database of concentration of contaminants in water, sediment, and fish tissues in the Guadalupe River watershed. In part based on these data, the Guadalupe River Watershed TMDL identifies mercury fish targets, bed and suspended sediment targets for runoff from mining areas, and load allocations from urban areas. The Bay Hg TMDL calls for Guadalupe River watershed load reductions of 98% and the Bay PCB TMDL calls for load reductions of >95% for urban areas. In response, managers in the Guadalupe River have already started implementing management actions to mitigate contaminant effects including experimenting with aeration in the reservoirs to reduce mercury methylation and removal of contaminated sediment from drainage lines.

A wealth of information has been collecting in the Guadalupe watershed. What is currently lacking is a validated linkage between management measures and changes in watershed loading through time. Such a tool would help managers decide for example, if mass is removed from drainage lines results in an equivalent reduction in an annual load to the Bay.

The aim of this project is to begin the development of a numeric model to assist in estimating mass loads of mercury and PCBs; to extrapolate the data to determine long term average loads for the period of extensive rainfall data collection (1973-present); and to determine the proportional sources in the watershed and refine the assumptions of the Guadalupe River Hg TMDL. Ultimately the model will be used to assess the effects of

best management practices and impacts of wetland restoration (e.g., effects of South Bay Salt Pond restoration). It is envisioned that this would be a multi-year study.

Request for year 1 funding is \$75,000.

5.2 Watershed-specific Sediment Loads

Suspended sediment loads to San Francisco Bay are vital for maintaining tidal marsh and mudflat habitats and delivering nutrients and organic carbon to the base of the food web. However, suspended sediments are also frequently a source of contaminants to marshes and mudflats. As a result, the TMDLs have proposed sediment targets for watersheds of 0.2 mg Hg/kg of sediment and perhaps 0.002 mg PCB / kg of sediment. The other targets include demonstration of loading trends and/or mass removed (loads avoided). In some watersheds (such as Coyote Creek), the 0.2 Hg target is already being achieved. In other watersheds such as Guadalupe River and perhaps some of the more heavily industrialized areas, the PCB and Hg targets are not met.

At this time, there are few data to determine where management actions might be most cost-effectively applied to achieve a mass loading target, a loads avoided target, or a sediment concentration target. The need for this project, as described in the draft language for the municipal regional permit (MRP), is to quantify sediment loads by watershed and to prioritize watersheds for which empirical observations should be conducted. In addition, this project would provide data for modeling the watershed and loads to the Bay.

The funding requested for this project is \$40,000.

5.3 Remote Sensing of Sediment Transport

Monitoring suspended sediment concentrations, SSC, in coastal waters and estuaries is crucial for proper ecosystem management. Such monitoring is traditionally done in-situ, with measurements representing SSC at a few discrete points in space and time. However, recent advancement of satellite remote sensing allows for synoptic views of coastal and estuarine dynamics that would otherwise be unavailable. Results are drastically altering our perceptions of coastal ocean transport processes.

This project proposes to use moderate-resolution (250m, 500m, and 1000m) MODIS satellite imagery to investigate episodic sediment transport patterns in San Francisco Bay. Development of an event-scale sediment budget has the potential to significantly improve current estimates of contaminant loading from the Delta to the Bay. It is conceptualized that such episodic contaminant loads account for a significant portion of annual contaminant loads. However, at present we know very little regarding the percent of episodic sediment and contaminant loads that remain within the Bay.

In 2007, this project identified suitable images. Funding for 2008 will be dedicated to processing the images and delineating the boundaries of the plumes.

The estimated funding level for 2008 is \$14,000.

5.4 Characterization of Thyroid Endocrine Disruption in San Francisco Bay Fish

Animal endocrine systems are highly responsive to changes in environment, both natural and anthropogenic in origin (e.g., chemical contaminants). Thyroid hormones, part of the endocrine system, are unique in that they exert physiological effects on most tissues, and their target receptors are found in all cell types. Thyroid hormones are particularly critical for the regulation of growth and development, metabolism, and brain/neural development and function. Because alterations in the thyroid endocrine system may exert broad physiological and developmental impacts, disruption of this system by anthropogenic chemicals presents a significant concern for wildlife.

Polychlorinated biphenyls (PCBs), polyhalogenated aromatic hydrocarbons (PHAHs), and polybrominated diphenyl ethers (PBDEs) have received extensive public and scientific attention in the last several years, as these types of chemicals are persistent in the environment and have ascribed endocrine-disrupting actions. Recently published experimental studies indicate that specific congeners of each class of these chemicals can cause thyroid disruption in fish. It has been most consistently observed that the thyroid plasma T4 concentrations significantly decline as part of the endocrine disrupted condition.

The objective of this work is to characterize the environment-related disruption of the thyroid endocrine system observed in Pacific staghorn sculpin and if possible shiner surfperch. In addition, chemical contaminants in individual fish will be measured to determine whether there is a correlation between contaminants and thyroid effects. The thyroid gland function will be assessed and attempts will be made to develop markers of endocrine disruption.

The estimated funding for this project is \$35,000.

5.5 Comparison of Contaminant Patterns between the San Francisco Estuary and the Coast

The RMP has put significant effort towards understanding spatial and temporal patterns in contaminant concentrations within San Francisco Bay. In contrast, efforts to compare concentrations on the coast have been limited to DDTs. The City and County of San Francisco (CCSF) has been surveying multiple locations along the San Francisco coastline since 1987. These surveys include sediment, benthic macrofauna, and fish tissue contamination. These data may be analyzed in combination with RMP data to provide a broad assessment of patterns of contamination. The goal of this study is to compare patterns in priority contaminants present in fish within San Francisco Bay and coastline stations at the mouth of the Estuary. This study directly addresses the recommendation

of the RMP Technical Review Committee that the Program integrate data from other programs.

This project will evaluate the combined CCSF and RMP data sets to test two hypotheses of interest to the RMP:

1. Fish contaminant concentrations (Hg, PCBs, PAHs and DDTs) are higher in the Estuary than along the coastline.
2. Long-term trends in fish contaminant concentrations tissue are similar between the Estuary and the offshore coastline.

A final task will be to provide Internet access to previous CCSF data and annual monitoring reports so that other regional scientists have access to the underlying data sets and analyses. It is expected that this study will improve collaboration and comparability among the two programs, including potential modifications to the CCSF monitoring design that will benefit the RMP.

The estimated funding for this project in 2008 is \$20,000.

5.6 Perfluorinated Compounds in Harbor Seals

In 2007, the RMP collaborated with the Marine Mammal Center and Moss Landing Marine Laboratories as part of a larger three-year study of the health and well being of harbor seals. This study continues the work that was undertaken in 2007.

Partnering with the Marine Mammal Center presents a unique opportunity to collect samples from apex predators. The purpose of this study is to determine concentrations of perfluorinated compounds in Pacific harbor seals (*Phoca vitulina richardsi*). Harbor seals are an ideal indicator species for persistent bioaccumulative contaminants in the Estuary because they are apex predators that eat a diet consisting primarily of fish. Perfluorinated compounds are of particular concern because they are very stable compounds that are not known to undergo abiotic or biotic degradation (Martin *et al.* 2004).

Preliminary data from the 2007 pilot study of seals suggests that the concentration of perfluorinated compounds, particularly PFOS, are elevated in seals. Based on the limited 2006/2007 sampling and the initial results, the EC workgroup recommended continued monitoring of these apex predators. The 2008 study will help us to determine background concentrations and the influence of age and gender on concentrations observed in seals.

The estimated funding level for this study in 2008 is \$35,000.

5.7 Non-PBDE Current Use Flame Retardants in Biota

Polybrominated diphenyl ethers (PBDEs) are chemicals used as flame retardants that have been incorporated into a variety of consumer products to comply with fire safety

regulations. Studies conducted by a variety of research groups have revealed that the San Francisco Bay area has exceptionally high PBDE bioaccumulation, with concentrations in harbor seals, birds, fish, and people that are among the highest ever reported. Environmental and human health concerns have resulted in a ban of the most toxic PBDE mixtures (Penta- and Octa-BDE) in California, which became effective in 2006. Despite the unrestricted use of Deca-BDE in most states and countries (with the exception of Sweden), many large international electronics companies have reportedly phased-out the use of Deca-BDE in their products.

The decline in use of PBDEs will result in an increase in the use of non-PBDE flame retardant chemicals since consumer product flammability standards have not changed. Substantial data gaps exist for non-PBDE flame retardant chemicals in the San Francisco Estuary. Assessment of the current concentrations of these compounds in the Estuary will allow us to determine the risk of exposure of these chemicals to the estuarine foodweb and to humans consuming sport fish.

Flame retardant chemicals selected for analysis in this study are primarily based on reports by the U.S. EPA and the European Chemicals Bureau on potential PBDE replacements. The following alternative flame retardants will be evaluated as part of this study: hexabromocyclododecane (HBCD), tetrabromobisphenol-A (TBBPA), decabromodiphenylethane (DBDPE), 1,2-Bis(2,4,6 tribromophenoxy) ethane (BTBPE), pentabromoethylbenzene (PBEB), Dechlorane Plus and hexabromobenzene (HBB). For comparison, PBDEs will also be analyzed. These compounds will be quantified in the blubber of Pacific harbor seals (*Phoca vitulina richardsi*) collected in 2007-2008 and a subset of archived sport fish and cormorant egg samples collected in 2006.

The phosphate-based flame retardant chemicals such as triphenylphosphate will be quantified in surface waters of the Estuary because, based on their higher water solubility and higher susceptibility to metabolism, they are not expected to bioaccumulate in upper trophic levels.

The estimated funding level for this study in 2008 is \$48,000.