PS/SS Idea: 1 Small tributaries loading study – Watershed 2

Author: Lester McKee and RMP staff (SFEI)

Background / rational / need / time line: This project aims to implement a second small tributaries loading study. This is a long standing recommendation from the SPLWG. Davis et al. (2000) recommended that six observation watersheds be picked on the basis of land use and climate. This recommendation remains valid however is should be recognized that stratification based on rainfall and land use is not mutually exclusive. Historic and current industrialized areas are found mainly on the lower-rainfall Bay margin. To-date we have implemented just one loadings study (the Guadalupe River study). Recent literature suggests that methyl Hg is related to %wetland area in a watershed – this could also be used as a ranking criterion for selection of observation watersheds. In any case, it is easy to argue that Guadalupe is not representative of other watersheds in the Bay Area (especially for Hg). The question remains, what magnitude of loads are derived from a) small, low rainfall, but highly impervious, commercial and industrialized "storm drain watersheds" on the Bay margin or b) medium sized commercial and urban land use watersheds or c) mixed land use watersheds that include agriculture and open space. The recent PCB multi-box model suggested that the South Bay is sensitive to loads reductions. Therefore improving our understanding of loads and change through time might be most desirable for South Bay watersheds, however SLPWG members are against a south Bay focus because this might not be true for contaminants other than PCBs. The workgroup support a regional distribution of observation watersheds for loads analysis. Additional loadings studies will provide ability to measure success of management actions through analysis of trends through time, an improvement of estimation of loads from the entire Bay Area watershed to help focus management attention and provide data for improvement of models that describe processes and biological effects in the Bay.

RMP Management Questions Contributed to or Answered?

Q1. Describe the distribution and trends of pollutant concentrations in the Estuary (c)

Q2. Project future contaminant status and trends using best understanding of ecosystem processes and human activities (d,e,f,h,j)

Q3. Describe sources, pathways, and loading of pollutants entering the Estuary (e,f,g,h)

Method: Field data collection during wet season using "Guadalupe River protocol modified by lessons learned and to suit the characteristics of a new study location. Briefly this includes a real-time turbidity probe, USGS suspended sediment daily loads program, SFEI field sampling for trace contaminants, and lab analysis for the full suit of priority contaminants in the first year (Hg, MeHg, Cu, Se, PCBs, PBDEs, Endocrine Disruptors, Pyrethroids), ancillary parameters (DOC, POC, other TMs), and spot analysis of lower priority contaminants (OC pesticides and PAHs). In subsequent years, the list of parameters would decrease to include only the priority contaminants and ancillary parameters.

Approximate Expected cost: To be determined ~$150,000

PS/SS Idea: 2 Design of a Bay Area Creeks Regional Monitoring Program

Author: SF Bay Regional Water Quality Control Board

Background: This project aim to design a Bay Area Creeks Regional Monitoring Program. The RMP is a well-developed program to the point where we can call the SF Estuary the best studied estuary in the US and perhaps the world. In devoting these resources to the Bay, we have, unfortunately neglected watersheds, and we have done little regional coordination for assessing watershed stressors, transport pathways of contaminants, and loads.

There is emerging information that the local tributaries, especially the ones flowing through urbanized watersheds contribute as much sediment and contaminant mass as the central valley river systems despite delivering about 4% of the annual water volume (McKee, 2003: UR lit review). In addition there is a number of watersheds around the Bay Area that are listed as impaired for sediment, pathogens, nutrients, and diazinon yet there is generally a lack of data for these watersheds (except through the SWAMP program) or where local studies have been funded. There is an avalanche of information needs associated with these Bay Area watersheds and urban creeks, and the woefully under funded SWAMP program cannot address these needs. Here is just a sampling of what we need to find out or do.

- Urban runoff contributions to WQ problems.
- Tracking progress in implementation of solutions
- Finding sources and problem areas for stressors in the Bay Area landscape
- Addressing other stressors besides TMDL pollutants (hydro-modification (extremely important), sediment, temperature etc.)

Currently, we have an adhoc, uncoordinated approach to these pressing issues and this slows progress. Plus, because of limited resources and multiple priorities, UR programs find it difficult to do adequate surveillance. While they have expertise that would aid a watershed regional monitoring program and need to participate in that way, it would be better if they could focus their attention on solving the problem (an area where they have very high expertise) and leave aside the job of assessing progress to a coordinated effort. Coordination and centralization of this monitoring will take pressure off UR programs so they can focus on implementing solutions.

Now is the time to build a Bay Area tributaries RMP. Fortunately, we do not have to start from scratch. We have some examples to follow and build on like SWAMP, Guadalupe River loads assessment, the Southern California Stormwater Monitoring Coalition program, the Napa River sediment TMDL (and associated technical studies by SFEI, Stillwater Sciences and others, the Tamales Bay pathogen TMDL, and various monitoring elements executed by our local urban runoff programs such as BAMBI, BASMAA urban bed sediment monitoring, and most recently the BASMAA street

sweeper studies. We must first design the program in terms of objectives, methods, level of effort and staffing and then perhaps implement a pilot program.

RMP Management Questions Answered?

Q1. Describe the distribution and trends of pollutant concentrations in the Estuary (c)

Q2. Project future contaminant status and trends using best understanding of ecosystem processes and human activities (b,d,e,f, h,j)

Q3. Describe sources, pathways, and loading of pollutants entering the Estuary (a,b,c,d,e,f,g,h)

Method: Literature Review, interviews, paper exercises, conceptual model development

Expected cost: $30 – 60K

PS/SS Idea: 3 Guadalupe River Watershed Model Development

Authors: John Oram and Lester McKee

Background/ rational / need / time line: This project aims to begin development of numerical model of the Guadalupe River Watershed. Three years of monitoring concentrations of suspended sediments, metals, and trace organic contaminants in the Guadalupe River has greatly improved our understanding of the system. Our conceptual models of how the watershed responds to changes in weather patterns and land use have likewise improved over the years. It is now time to test these conceptual models with a numerical hydrologic model. At this time the proposed model development is limited to hydrology, though its ultimate use will be as a modeling tool for simulation of contaminant transport to support TMDL calculations. The model will have the additional benefits of allowing for the quantification of various management scenarios and providing load estimates for Bay water quality models.

RMP management questions answered:

Q1. Describe the distribution and trends of pollutant concentrations in the Estuary.

Q2. Project future contaminant status and trends using best understanding of ecosystem processes and human activities.

Q3. Describe sources, pathways, and loadings of pollutants entering the Estuary.

Method: Review existing EPA watershed models and select most appropriate. Compile existing data for model input: land use maps, precipitation, topography, flow diversions, etc. Develop, calibrate, and validate model using existing monitoring data.

Expected cost: $100K, rough estimate with potential match funds from SCVWD

PS/SS Idea: 4 Stormwater storm-sewershed outfall sampling

Author: Lester McKee

Background: This project aims to quantify concentrations and loads at the outfall of a range of storm sewersheds in the lower Guadalupe River watershed that contribute Hg load to the Guadalupe River. The Guadalupe River TMDL has been developed with little information on the contribution of urban stormwater to Hg loads. A better understanding of stormwater mercury loads entering Guadalupe River from the urban, industrial, and commercial areas will assist managers to make decisions about how to address TMDL goals such as targeted sediment removal, demonstrating concentrations in sediment to not exceed 0.2 mg/kg or stormwater loads reductions. Although there is a need for this kind of data in the Guadalupe River watershed, the interpretation of such data has regional significance and will allow better estimation of loads in other urban areas. Other analytes could be monitored including PCBs PBDEs, PAHs, dioxins, furans, and diazinon but clearly, measuring extra analytes have budget implications.

RMP Management Questions Answered?

Q1. Describe the distribution and trends of pollutant concentrations in the Estuary (c)

Q2. Project future contaminant status and trends using best understanding of ecosystem processes and human activities (b,d,e,f, h,j)

Q3. Describe sources, pathways, and loading of pollutants entering the Estuary (a,b,c,d,e,f,g,h)

Method: Field sampling and flow measurements

Expected cost: $20K (Hg only)-100K (Hg, PCBs, PBDEs)?

PS/SS Idea: 5 Using a coupled contaminant fate and bioaccumulation model to evaluate food web uptake for legacy organic contaminants

Authors: Ben K. Greenfield and John Oram

Previous RMP modeling special studies have provided useful information on contaminant fate, transport, and bioaccumulation (Davis 2004, Gobas and Arnot 2005, Greenfield and Davis 2005). Still, several areas of uncertainty remain. The relative importance of sediments vs. water column for contaminant uptake by biota (Burkhard et al. 2003), the importance of spatial and temporal variation in food-web structure (Gobas and Wilcockson 2002), and the impact of different management actions on future levels of legacy pollutants need further evaluation.

We propose a special study to evaluate the relative importance of different sources in determining contaminant bioaccumulation to the San Francisco Estuary food web. Depending on the stated priorities of RMP program participants and the TRC, this project would focus on PCBs, legacy pesticides, PBDEs, or dioxins. Two tasks are proposed: 1. compile the latest available data on food web transfer pathways for contaminants; and 2. link the multibox contaminant fate model (Oram et al. 2006) with the food web bioaccumulation model (Gobas and Arnot 2005) to evaluate spatial and temporal variation in contaminant sources and pathways. If funded, this work would provide a more sophisticated understanding of how potential management actions are likely to affect contaminant bioaccumulation in different parts of the Estuary.

A conceptual model has been constructed that depicts key processes believed to affect PCB uptake by target sentinel species (Davis et al. 2006). Based on this conceptual model, the first component of this project would be to synthesize the latest available information on food web transfer pathways. This would include relevant work by SFSU Tiburon, Point Reyes Bird Observatory, Bodega Marine Labs, USFWS, USGS, and local consulting firms. This synthesis would also include ongoing discussions with Regional Board staff to confirm management priorities and target species previously identified.

The second component of this project would be mechanistic model application combining the contaminant fate and food web models. Model simulations would focus on the importance of spatial and temporal variation in contaminant sources and fate. Spatial variation in contaminant fate would be ascertained by estimating water-borne sources, water column concentrations, sediment concentrations, and contaminant partitioning, in different bay segments. Spatial information on dietary uptake, when available, would also be incorporated. The bioaccumulation model would then be used to estimate the proportion of contamination in major sport fish species due to different sources. Based on these results, model simulations could also evaluate consequences of possible management actions, including: 1. the source curtailments proposed in the relevant TMDL (SFBRWQCB 2004); 2. remediation of specific contaminant hot-spots; or 3. monitored natural recovery. The final technical report would present the results of data synthesis on contaminant trophic transfer, mechanistic model simulations, and information gaps identified as priorities for future study.

RMP Management Questions Addressed:

- Project future contaminant status and trends using best understanding of ecosystem processes and human activities
- Describe sources, pathways, and loading of pollutants entering the Estuary
- Measure pollution exposure and effects on selected parts of the Estuary ecosystem

Project Budget:

This project includes three components, each of which could be funded separately or together, depending on the information needs and priorities of RMP Participants.

1. Synthesis of latest available data on food web transfer pathways for contaminants. Cost: $15,000 to $20,000
2. Combination of contaminant fate and bioaccumulation models, and model simulation. Cost: $20,000 to $40,000
3. Technical report on results of study. Cost: $20,000 to $30,000

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PS/SS Idea: 6 A Pilot Study for the Determination of the Effects of Endocrine Disrupting Chemicals (EDCs) on SF Bay Fish and Invertebrates

Authors: Dr. Chris Pincetich, Pacific EcoRisk
Dr. Scott Ogle, Pacific EcoRisk
Dr. Edward Salinas, Pacific EcoRisk

Description: Several invertebrate and fish populations in the San Francisco Bay-Delta system have undergone significant decline in recent years. The reasons for these declines are unclear, as there are numerous factors that could potentially affect these populations. One hypothesis being considered is that toxic effects from contaminants are adversely affecting these organisms.

Arguably, reproduction is the biological processes most directly linked to success of populations. This is extremely relevant as recent studies have shown that some contaminants can alter endocrine function in wild populations, and that such "endocrine disruption" may subsequently be expressed as intersex (males exhibiting female sex characteristics, and vice-versa), poor egg quality, reduced fecundity, inhibition of spawning, and reduced embryo/larval survival.

The potential for endocrine-disrupting chemicals (EDCs) to adversely affect invertebrates and fish in the Estuary is currently unknown, although there are studies underway to characterize the presence of various EDC's in ambient waters via chemical analysis. While such analyses are a sound first step, it is important to note that the number and variety of potential EDCs goes well beyond the number of analytes being included in those studies, directly analogous to relying on chemical analyses of ambient waters to predict toxicity. In the case of the latter, it is recognized that toxicity tests are the most accurate measure of whether or not there is toxicity present (from whatever source) in ambient waters.

In similar fashion, EDC "effects" assays will be essential to characterize potential impairment resulting from EDCs. The US EPA and OECD have major programs in place to develop and validate such assays (e.g., see http://www.epa.gov/scipoly/oscpendo/assayvalidation/status.htm), and there are many additional academic studies describing potentially applicable testing tools. These studies take a wide variety of forms, from cellular enzyme studies (e.g., competitive binding at androgen and estrogen receptor sites) to full-blown multi-generation invertebrate/fish reproduction tests. The former type of tests may be most applicable to a monitoring program due to the need to evaluate numerous samples (with limited volumes of water) inexpensively; while a more definitive evaluation of impacts on reproduction, the latter type of test is likely to be expensive and to require significant volumes of water.

This Pilot Study is currently conceived as a two-year project. Year 1 activities will include:

1. Review the existing EDC effects assays for potential applicability to the RMP;

2. Select the test(s) exhibiting the best characteristics for use in a monitoring program (e.g., low cost to allow assessment of a wide number of sites and low water volume requirements), and if necessary, validate that test in the laboratory using model EDCs;
3. Apply the selected tests to ambient waters collected from the Estuary.

If these tests suggest EDC-related effects in the Bay, then Year 2 of the Project will include,

1. Application of the selected tests to a wider range (temporally and spatially) of ambient water sites, with follow-up monitoring of any sites exhibiting high potential for effects;
2. Assess the ability of the EDC monitoring tools to accurately predict actual reproductive effects via performance of crustacean and/or fish reproduction study(ies) on selected samples.

Estimated Costs: Year 1 - $100,000 (scope of work can be scaled down to accommodate available funds)

Year 2 – $150,000 (scope of work can be scaled down to accommodate available funds)

Relevance to RMP Objectives and Management Questions: The proposed study will address the following RMP objectives:

1. The proposed study will describe patterns and trends in contaminant effects on the Estuary's biological resources, in a fashion that is *directly* applicable to regulatory and RMP stakeholder information needs.
2. The proposed study will help to identify general *and site-specific localized* sources and loading of contaminants to the Estuary, as measured by their effect on biota.
3. The proposed study data will take advantage of the information from other sources (e.g., CalFed EDC studies) to improve our understanding of the sources, distribution, fates, and effects of contaminants in the Estuary.

PS/SS Idea: 7 A Pilot Study for the Determination of Ambient Water Toxicity to Resident Species

Authors: Dr. Scott Ogle, Pacific EcoRisk
Dr. Edward Salinas, Pacific EcoRisk
Dr. Chris Pincetich, Pacific EcoRisk

Description: In light of increasing information documenting a serious decline in the estuary's pelagic organisms, the need for better information regarding potential adverse effects of contaminants in the Estuary has become essential. Toxicity testing of ambient surface waters has been an integral component of the RMP since its conception, and has provided a great deal of information regarding how the changing nature of upstream practices (e.g., pesticide usage) affect the Bay. Toxicity testing in 1996-1998 revealed occurrences of significant ambient water toxicity in the Bay, believed to be associated with surface water runoff events such as rainstorms and agricultural irrigation water releases. Just as importantly, that monitoring also demonstrated the subsequent trend for reductions in both the frequency and magnitude of ambient water toxicity.

However, it is important to note that the RMP's ambient water toxicity testing was performed with *Americamysis bahia* (a non-resident species) as a surrogate for the Bay's resident species.

The use of surrogates in toxicity tests is a standard practice, and it is assumed that the results of toxicity tests with surrogates can be extrapolated to similar organisms in the ambient waters. However, at least one important resident invertebrate, the crustacean *Palaemon macrodactylus*, is reported to be much more sensitive to organophosphate pesticides than is *Americamysis*, illustrating the importance of needing to comparatively assess potential toxicity to resident organisms. In order to better understand the potential role of toxicant stress on the decline of pelagic organisms in the Bay, it is critical that effects on commercially or ecologically relevant resident species be assessed.

With this in mind, we propose to perform both (1) ambient water toxicity testing and (2) benchmark dose-response chemical testing (i.e., with a model pesticide, metal, etc) using several resident and ecologically relevant species. Most of the resident species that lend themselves to seasonal toxicity testing, and may also be representative of very localized parts of the Bay. For instance, Delta smelt larvae are available only in the late spring-early summer period, and they are resident in the Napa River and upstream of the Carquinez Straits. Similarly, Pacific herring larvae are available from December-March, and are resident primarily in the Central Bay shoreline areas. Other resident species, such as *Palaemon macrodactylus*, may also have seasonal and geographical limitations. Although these species may be resident in the Bay only during specific seasons, their value as measures of their sensitivity to toxicant stress relative to the RMP's *Americamysis bahia* should not be understated.

Our laboratory already has experience working with larval Pacific herring and larval *Palaemon macrodactylus*, and we have been interacting with CalFed's Delta smelt culture program to begin working with that species as well. We also propose to investigate (and potentially use) other toxicity test-amenable resident species (e.g., a resident pelagic zooplankter) as well.

Estimated Cost: $60,000. Note - collaborative opportunities with existing RMP and CEP monitoring efforts may allow us to leverage these costs significantly (e.g., certain elements of the proposed study can leverage the field sample collection and sample analytical chemistry already being performed).

Relevance to RMP Objectives and Management Questions: The proposed study will address the following RMP objectives:

4. The proposed study will describe patterns and trends in contaminant effects on the Estuary's biological resources, in a fashion that is *directly* applicable to regulatory and RMP stakeholder information needs.
5. The proposed study will help to identify general *and site-specific localized* sources and loading of contaminants to the Estuary, as measured by toxicity to the test organisms.
6. The proposed study data will be allow assessment of current ambient water toxicity-based TMDLs.

PS/SS Idea: 8 Evaluation of Pyrethroid Insecticides in San Francisco Bay Tributaries

Authors: Daniel R. Oros (SFEI) and Million Woudneh (AXYS Analytical Services)

Description: The objective is to determine the potential sources, concentrations, and distributions of pyrethroids in San Francisco Bay tributaries. The results of SFEI's recent PRISM Grant, which focused on developing new chemical methods for measuring pyrethroids in surface water and sediment samples, showed that pyrethroids including allethrin, bifenthrin, deltamethrin, fenvalerate, flucythrinate, L-cyhalothrin, and permethrin and their synergist, piperonyl butoxide (PBO), were detectable in water and sediments from San Francisco Bay urban tributaries including Coyote Creek, Petaluma River, San Mateo Creek, San Lorenzo Creek and Suisun Creek. Pyrethroid occurrence is evidence that more work can be done to identify the sources, critical temporal periods (wet and dry season application periods) and spatial areas (e.g., critical fish spawning habitat) of the Bay where concentrations could potentially reach levels that are high enough to cause toxicity to sensitive aquatic species including fish and benthic invertebrates. Both water and sediment samples will be collected and tested for pyrethroids. In addition, sediment samples will be tested for toxicity using the benthic freshwater amphipod *Hyallela azteca*. Field sample collection and toxicity testing can be coordinated with the RMP's Episodic Toxicity Monitoring efforts. Water samples will be collected in the wet season during the period of first flush events in at least five major urban tributaries of the San Francisco Bay. The attached table lists the 20 pyrethroids and their synergist PBO that are targeted for analysis. These were selected based on their recommended uses (e.g., structural pest care, lawn and garden care, public health), use amounts (mass), and consumer product availability. Pyrethroids will be collected from 100 L water samples using XAD solid phase extraction. Water and sediment extracts will be analyzed by high resolution gas chromatography-high resolution mass spectrometry (HRGC-HRMS). This instrument provides high selectivity and mass resolution to reduce potential interferences and when combined with large volume sampling enables the method to routinely achieve very low levels of chemical detection (water at ppq-ppt range). The project deliverables will be a RMP Technical Report and a paper that will be submitted for potential publication in a peer-reviewed scientific journal.

RMP Objectives and Management Question Addressed: 1c, 1d, 2a, 2b, 2c, 3c, 4a, and 5a-c.

Time Sensitivity: This project will not exceed 2 years.

Estimated Cost: $50,000 for field sampling, data handling, toxicity testing, and project management; AXYS will provide instrumental analysis at a match that is 25% of the total budget. Efforts will also be made to collaborate with BASMAA, which could further expand this proposed scope of work.

Pyrethroids that will be analyzed by AXYS Analytical Services in this study

Allethrin-A
Allethrin-B
Prallethrin-A
Prallethrin-B
Cinerin-I
Jasmolin-I
Pyrethrin-I
Resmethrin-A
Bioresmethrin
Piperonyl-butoxide
Tetramethrin-A
Tetramethrin-B
Bifenthrin
Phenopropathrin
Phenothrin-A
Phenothrin-B
Permethrin-A
Permethrin-B
L-Cyhalothrin-A
L-Cyhalothrin-B
Cyfluthrin-A
Cyfluthrin-B
Cyfluthrin-C
Cyfluthrin-D
Cypermethrin-A
Cypermethrin-B
Cypermethrin-C
Cypermethrin-D
Cyper-flucy-calc
Flucythrinate-A
Flucythrinate-B
Fenvalerate-A
Fenvalerate-B
Delta/Tralomethrin-A
Delta/Tralomethrin-B

PSSS Idea
9 Mercury Isotope Signatures as Potential Source Indicators

Authors: Don Yee SFEI and Joel Blum University of Michigan

Description: San Francisco Bay sediments are contaminated by historic releases of mercury from both local mercury mines and from gold mining in the Sierra Nevada. However, there are also on-going mercury inputs from atmospheric deposition, both local and distant sources, and other discharge pathways (e.g., wastewater and storm water). It is currently assumed that impacts of these different pools and pathways on mercury bioaccumulation are roughly equivalent in proportion to their relative mass in the local environment, but there is no direct evidence to confirm or refute this hypothesis. Differences in Hg isotope signatures from various sources may be one way to distinguish their relative importance.

Development and commercial availability of multicollector ICP-MS instrumentation has improved the capability for more precise determination of isotope ratios of heavier elements such as Hg. A research group led by Dr. Joel Blum at the University of Michigan (UM) has measured the fractionation of Hg isotopes in fossil hydrothermal deposits. Dr. Blum's group at UM is participating in on-going work examining fractionation in atmospheric Hg pools in the Arctic and in microbial processes in laboratory cultures. Examination of Hg isotope ratios in biological tissue pools (e.g., fish and invertebrate tissues) and corresponding environmental matrices (e.g., sediments, water, and air) from potential sources (e.g., mine sediments, Bay and tributary sediments, ambient waters, stormwater, wastewater, and atmospheric samples) may provide critical information in prioritizing reductions in various sources. Although all areas of the Bay are expected to be impacted in part by all of these sources, their relative importance may differ in various areas of the Bay, and might be reflected in differences in Hg isotopes accumulated by biota. This proposal would fund in part work done at UM by a graduate student and/or postdoctoral student for measurement of isotopes in biological and sediment samples from SF Bay and development of Hg isotope determination methods in water and air samples, with measurement of Bay area samples in these matrices once sufficiently accurate and precise methods are developed.

Estimated Cost: $50K
Relevance to RMP Objectives and Management Questions: This study addresses the following objectives.

1. Describe the distribution and trends of pollutant concentrations. This study will assist us in our understanding of mercury cycling within the bay and sources of mercury to the bay.
2. Describe sources, pathways and loadings of pollutants entering the Estuary.

PS/SS Idea: 10 Perfluorinated Compounds in San Francisco Bay

Author: Meg Sedlak, SFEI

Description: In the last 50 years, fluorinated alkyl substances have been used extensively in a variety of commercially available products including fire-fighting foams, refrigerants, stain repellants in textiles, and coatings for paper used in contact with food products. Their popularity in commercial and industrial applications in part results from their unique ability to be both hydrophobic and oleophobic, that is able repel both water and oil.

Fluorinated alkyl substances are synthesized from perfluornated sulfonyl fluoride and carbonyl fluoride intermediates by electrochemical fluorination process (ECF) or telomerization fluorination processes. Because these processes are not selective, numerous by-products are produced in the manufacture of these intermediates such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

As a result of their chemical stability and widespread use, fluorinated alkyl substances such as PFOS and PFOA have been detected in marine mammals and aquatic organisms throughout the world including relatively pristine environments such as the Artic. PFOS and related perfluorinated compounds have been associated with a variety of toxic effects including mortality, carcinogenity, and adverse development. Their widespread dispersal throughout the global and their potential toxicity has caused increasing concern among scientists and regulators. In response to this concern, the US Environmental Protection Agency banned the use of PFOS and 3M Corporation initiated a voluntary phase out of the carboxylated and sulfonyl-based perfluorinated chemicals; however, PFOA and perfluorinaed carboxylic acids (PFCAs) continue to be produced in the manufacture of fluoropolymers. It is thought that these compounds degrade to form PFOS.

The objective of this study will be to determine concentrations of PFOS and related compounds in San Francisco Bay. At present, little information is available regarding the presence of PFOS and perfluorinated compounds in the Estuary. A research group at Stanford University has recently analyzed South Bay sediment and wastewater sludge for PFOS and its precursors (Higgins *et al.* 2005). PFOS observed in San Francisco Bay sediment is reported to range from 0.124 ng/g to 4.65 ng/g. The range of concentrations in wastewater sludge was approximately two orders of magnitude higher. Of particular interest was the elevated concentrations of PFOS precursors (i.e., 2-(N-methylperfluorooctanesulfonamido) acetate and 2-(N-ethylperfluorooctanesulfonamido) acetate) suggesting that it is important to monitor the precursors which may degrade to PFOS.

To date, no biological samples have been analyzed for perfluorinated compounds in the San Francisco Estuary. The RMP has a number of fish monitoring studies scheduled for 2006 including the triennial sportfish event and the mercury small fish study. The scope of works for these projects were developed in 2005 and funding for additional analyses of perfluorinated compounds are not possible within the currently allocated budgets. We propose to piggyback off these existing collection efforts and to analyze select fish samples for perfluorinated compounds. In addition, we have contacted the Marine Mammal Center which will be sampling ten young of the year pups in the summer of 2006. The Marine Mammal Center is interested in collecting blood and blubber samples for us that could be analyzed for perfluorinated compounds. In addition

to the biological samples, we would propose collecting water and sediment samples from select locations for perfluorinated analyses. These samples would be collected as part of the existing 2006 Status and Trends sampling event to again be most cost-efficient. These samples would be used to evaluate concentrations relative to other estuaries and to determine the potential for these compounds to bioaccumulate in San Francisco Estuary.

Although the funding for Pilot and Special studies is allocated for 2007, because 2006 presents a unique year for collection of tissue samples, we would collect the samples in the summer of 2006 and archive the samples for analyses until 2007 (assuming that this study is funded).

The results of this study will be summarized in a technical report and a journal manuscript.

RMP Management Objectives Addressed by this Study:

- **1. Describe the distribution and trends of pollutants concentrations in the Estuary.**
    - This study will provide some of the first data to determine the distribution of concentrations of perfluorinated compounds in the Estuary and to place these concentrations in context with concentrations observed in other estuaries.
- **2. Project future contaminant status and trends using current understanding of ecosystem processes and human activities.**
- **4. Measure pollution exposure and effects on selected parts of the Estuary ecosystem (including humans).**
    - 4.1. Perfluorinated compounds are considered an emerging contaminant. As such, it is important that we determine their concentrations in biota to evaluate whether management actions are needed
    - 4.4 Determining the concentrations of perfluorinated compounds in the upper trophic level is important for assessing both ecological and human health risks.
- **5. Compare monitoring information to relevant benchmarks, such as TMDL targets, tissue screening levels, water quality objectives, and sediment quality objects**
    - The concentrations detected in this study would be compared to known threshold effect levels, where possible.

Estimated Cost: $60,000
Proposed start date: 2006

References:

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PS/SS Idea:

11

Remote Observations of Episodic Sediment Transport Patterns in San Francisco Bay, CA.

Author: John J. Oram

Project Description: 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. I propose a special study to utilize moderate-resolution (250m, 500m, and 1000m) MODIS satellite imagery to investigate episodic sediment transport patterns in San Francisco Bay. The special study would 1) identify satellite images with a high percentage of coverage in the Bay corresponding to periods of high Delta flow, 2) process these images to produce true- and false-color images showing two-dimensional sediment transport patterns and quantifying relative concentrations of suspended matter, 3) utilize existing edge-detection algorithms to delineate the boundaries of plumes exiting the Golden Gate, and 4) compare remote observations with in-situ USGS SSC measurements collected at Mallard Island to determine the fraction of material entering the Bay via the Delta that is lost to the Pacific Ocean during a given event. The final product would be technical document that describes episodic sediment transport processes. The document would include images illustrating two-dimensional sediment transport patterns and estimates of episodic material fluxes from the Bay to the Pacific Ocean.

Potential Collaborator: Nikolay Nezlin, PhD, SCCWRP
Initial Cost Estimate: $10K, depending on level of collaboration